ENERGY DEMAND AND SUPPLY IN THE INDIAN HIMALAYA

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INTRODUCTION

Energy consumption is closely related with level of economic activities and standard of living. Peculiarities of the Himalaya region keep the use of energy in favor of noncommercial sources in this area. Pressure on these sources due to increased population and economic activities has been beyond the supporting capacity for a considerable period of time. The resulting ecological damage is a matter of concern due to its wide ranging repercussions in several spheres, including quality of life of the people in rural areas.

The Indian Himalaya has unique features like small and sparsely populated villages, high energy requirements due to climatic and topographical conditions, dependence on firewood as the main source of domestic energy, and lack of proper infrastructure, which in turn affect demand patterns and supply sources of energy. This paper attempts to provide relevant information, and is expected to be helpful in formulating an appropriate strategy to balance energy demand and supply in this region.

ENERGY DEMAND

Consumption Pattern: Survey of Micro and Macrostudies

Microstudies that have been reviewed cover mainly rural areas where noncommercial sources of energy are predominantly used. Most of the microstudies do not cover all sources of energy and all energy-consuming activities of the areas surveyed, yet they bring out the typical patterns of energy consumption in the Himalaya region.

Satsangi and Gautam (1983 a, b) covered four village clusters of Nainital District and one village cluster of Agra District on the plains of Uttar Pradesh (U.P.) and studied energy use in various rural activities. The study also brings out the difference in the energy consumption pattern in Nainital within the subregions of the hills, *bhabhar* and *Tarai*.

Noncommercial was the main energy source in Nainital village clusters, contributing 95 percent in some areas. Firewood was the single most important, with 99 percent share in total energy use in the hill cluster compared to 36 percent in the plains cluster of villages. The variation in consumption of firewood between summer and winter was pronounced in the case of the hill cluster, where average winter consumption was more than double that of summer consumption. Also, space and water heating consumed a higher percentage (29 percent) in the hill region compared to the Tarai (6 percent) and still lower in the plains.

Animate energy use was higher in the hill region (98 percent) compared to the Tarai (13 percent), indicating mechanization and pump irrigation in the plains. Industry, transport, and commerce sectors did not display any pattern, and energy consumption was dependent on type of industries, trade, mode of transport, and location of village cluster. Mix of commercial and noncommercial in these sectors was also dependent on these factors.

The next two studies are benchmark surveys of villages chosen to test suitability for a biogas program. The village of Jagaria in Kangra District of Himachal Pradesh (Agrawal 1980a) had comparatively good economic conditions. Firewood was the only source of fuel in the village for cooking and water/space heating. Dharmuchack village (Agrawal 1980b) had its households mostly from backward classes and poor economic strata. Dung was used both as fuel and fertilizer, but firewood was the main source of domestic energy.

The study by Sagar et al (Pilot Survey of Fuel Consumption in Rural Areas 1981) indicates increased use of dung as fuel moving from the hills towards the plains. In the village of Chakrata (Dehra Dun District) only wood was used as fuel whereas in Harrawala (towards the plains of Dehra Dun District), dung was also used as fuel.

Marcus Moench (1985) selected the village of Munglori in Tehri Garhwal District of U.P. for the study of biomass utilization patterns. The village selected was such that outside pressures (like commercial) were absent and the village had abundant biomass resources. Only wood and twigs were used as fuel in the village. Decline in quality and availability of forest resources over a period of time resulted in increased collection time for fuel and fodder.

The National Sample Survey (NSS) conducted a household fuel and light consumption survey, in its 18th (1963-64) and 28th (1973-74) rounds. Results from the 18th round for hill states covered in the survey (J & K, H.P., Manipur, Tripura) have been averaged on a weighted basis and presented in Table 2. The results of the 28th round are not significantly different from the 18th round.

It was observed that consumption of firewood in all hill states was more than double the all-India average. Average dungcake, electricity and kerosene use was comparatively less in hill states. Overall average per capita household energy consumption in hill areas was approximately 1.7 times that of the all-India average.

The rural northern India survey of 1975-76 by the National Council of Applied Economic Research (NCAER 1981) sampled 100 villages of rural northern India. The estimated population of hill areas covered in the study was 15.7 million. Its coverage of energy-using activities and energy sources is comprehensive. It also gives results for hills, plains, and deserts separately. Data has been collected for summer and winter both. To allocate collected fuel, it used correlation between fuel consumption per unit of foodgrains consumed and income level.

Annual household energy consumption in hills was highest (1656 kg Coal Replacement CR) which was 30 percent more than plains. Firewood accounted for 67 percent, agricultural residue 21 percent and dungcake 5 percent, with the balance being commercial sources. Noncommercial fuels were mostly collected and mainly used for cooking (88percent) and heating. Water and space heating consumed a higher percentage of energy in the hills (9.5 percent compared to 4.3 percent in the plains).

Average energy input in agriculture including fertilizer was 1788 x 10 kcal/ha in hill areas, 22 percent less than the plains. However, animate energy percentage was higher in hill areas (93 percent compared to 82 percent in plains). For establishments, separate data for hill areas is not available and hence, is taken as the same as average for the northern region. The per capita consumption of various fuels in different activities is indicated in Table 1.

Energy was also spent in obtaining drinking water, and the percentage of households using an outside water source was high in hill areas (60 percent compared to an average of 40 percent for the northern region). Overall per capita annual consumption for all sectors from all types of energy sources was 220.6 x 10 kcal, of which 74.8 percent was noncommercial, 5.4 percent commercial, 18.7 percent animate, and the balace about 1 percent fertilizer. Domestic energy constituted 90 percent of overall per capita consumption, excluding animate and fertilizer. Its share in total commercial and noncommercial was 24 percent and 95 percent respectively.

NCAER 1978-79 all-India domestic energy consumption survey (NCAER 1985) gives data by state. It covered energy consumption in commercial establishments, households, and rural industries. The weighted average per capita energy consumption has been calculated for the hill region and indicated in Table 2. Per capita annual energy consumption (excluding establishments) for the hill region was 257 kg Coal Replacement, which was 25 percent more than for the plains. The consumption of logs as a percentage of total firewood was 48 percent for the hill region compared to 3 percent (all-India average), and the highest was 75 percent in Meghalaya.

The fuel consumption data from various studies has been summarized and presented in Table 2. The variation in pattern is brought out by microstudies, for example, variation in annual firewood consumption from 231 kg to 2167 kg per capita, and dungcake from nil to 370 kg per capita. Differences in methodologies used for data collection do not permit exact comparison of macrostudies.

Demand Projections

Energy consumption estimates for hill areas from NCAER's latest study (1985) have been taken as the base for projections of domestic energy requirements. However for total energy demand projection, the share of other sectors is taken from the NCAER study (1981), which covered these sectors also. The assumptions are:

- Population growth rate is the same as in the past (30 percent in approximately 19 years).

- Per capita energy consumption will

Table 1: Per Capita Annual EnergyConsumption in Rural Hill Areas

Source	Unit	Household	Agriculture	Establishment	Construction	TPT	All Sectors
Commercial							
Coal/Coke	Kg	0.50	-	4.45	-	0.77	5.8 (10 %)
Electricity	KWH	3.71	1.26	1.40	-	0.05	6.42 (5.8%)
Kerosene	Litre	2.63	-	0.89	-	-	3.52 (75 %)
Diesel	Litre	-	0.32	0.27	-	1.27	5.38 (-)
Petrol	Litre	-	-	-	-	0.14	0.14 (-)
Furnace Oil	Litre	-	-	0.02	-	-	0.02 (-)
Non-commercial							
Firewood	Kg.	239.12	-	5.72	-	-	244.84 (98 %0
Dungcake	Kg.	47.98	-	5.17	-	-	53.15 (90 %)
Veg. Waste/ agr. Residues	Kg.	84.57	-	10.89	-	-	95.46 (89 %)
Charcoal	Kg.	3.95	-	1.10	-	-	5.05 (78 %)
Animate Manpower	Mandays	-	47.47	9.17	0.67	0.90	58.21 (-)
Draught Power	Ani. Days	-	15.14	-	-	1.00	16.14 (-)
Nitrogen	Kg.	-	9.27	-	-	-	(-)

Source: Compiled from NCAER Survey (NCAER - 1981) Figures in Bracket show percentage of Domestic Energy.

1. For establishments, energy consumptions has been determined by NCAER based on employment data
2. Not calculated
3. This is not representative of the hill region since most transport is by animate and diesel/petrol (It represents rail traction)

Table 2: Per Capita Annual Domestic Energy Consumption in Hill States (Summary of Studies[1])

FUEL	Micro Studies: Satsangi-1983 (Nainital Dist.)	Agrawal-1980a (Jagaria-HP)	Agrawal-1980b Dharmuchack- (Garhwal)	Sagar-1981 Chak-rate	Sagar-1981 Harra-wala	Sagar-1981 Kana-undi	Moench-1985 Munglori (Garhwal)
Coal/Coke kg.	-	-	-		-	-	-
Kerosene Litre	-	8.76	7.68	-	-	-	-
Electricity kwh	-	-	-	-	-	-	-
L P G	-	-	-	-	-	-	-
Fire kg.	231 to 897[2] (Wt. Av. = 371)	2167	462	1116	504	224	970
Charcoal kg.	-	-	-	-	-	-	-
Agri Res. kg.	-	-	-	-	-	234	-
Dung Cake kg.	0 to 370[2]	-	86	-	64	130	-

1. Figures are left blank (---) wherever calculation from given data in study was not possible, and where data value is nil/is not at all calculated in study (-).
2. kgCR values given in Study were converted assuming use of open chullah and hence 1 kg wood = 0.70 kgCR.

Table 2 (Contd.)

FUEL	Macro studies (Data for hill region only): NSS - 18th Round	NCAER - 1981 (only rural region)	NCAER - 1985
Coal/Coke kg	1.44	0.58	1.23
Kerosene Litre	5.04	2.63	6.05
Electricity KWH	1.92	3.71	15.36
LPG kg	-	-	0.37
Firewood kg	513	239.12	294.43
Charcoal kg	1.92	3.95	4.67
Agri. Residues kg	(included in firewood)	84.57	11.59
Dung cake kg	61.68	47.98	70.07

remain unchanged until 1991 and increase by 10 percent by 2001 A.D.

- Share of other sectors (industries and establishments, agriculture, and transport) will increase from 8 percent in 1975-76 to 15 percent by 1991 and to 25 percent by 2001 A.D. Share of commercial energy increases from 46 percent to 60 percent and to 90 percent respectively during the same period, in sectors other than domestic. Pattern of fuel mix in the domestic sector is taken to be constant.

- Efficiency of fuel use is taken as constant at the 1978-79 level. The energy demand projections have been worked out for 1991 and 2001 A.D. and presented in Table 3.

It is imperative to mention that:

1. The share of other sectors in total energy taken as 8 percent in 1975-76 is for rural areas only. Since the share is expected to be more in urban areas, total energy requirements will increase accordingly.

2. The per capita consumption taken in 2001 A.D. is equivalent to 447 kcal per capita per day of household energy, whereas the Advisory Board on Energy (ABE 1985) has the fixed target of 680 kcal; to achieve this, quantities of fuels required will increase by 50 percent.

It can be seen from the table that a huge increase in energy is required over the 1980-81 consumption level. The total fuel requirements increase by 41 percent in 1991 and by 128 percent 2001, with a mere 10 percent increase in per capita consumption in 2001. To meet the standard envisaged by ABE, the increase required is 195 percent in 2001, implying three times the present level of energy consumption. In case extra energy requirements of the hill region to maintain the same standard of living as the plains are considered, the estimates shall further increase by at least 20 percent. This is to cater to long winters, low ambient temperatures, and pressure in hill areas.

SUPPLY OF ENERGY

This section investigates the various energy supply sources, their potentials, and associated problems.

Firewood

The forested area in the country as revealed by satellite imagery results (Paryavaran 1984) is about 14 percent of the geographical area, against the official record of 23 percent. The satellite imagery indicates 15.2 million ha of forest area in the hill region. This is 29 percent of the geographical area against the recommended 60 percent by the National Forest Policy Resolution of 1952. The estimates of firewood yield from forests vary widely from 0.5 tons/ha to 4-5 tons/ha for conventional firewood forests. For fast-growing trees, it is estimated as high as 6 to 50 tons/ha (Bhatt 1983). If we assume annual yields of 3 tons/ha and 50 percent of forest area as exploitable, approximately 22 million tons of firewood availability can be expected. Plantation on barren lands, degraded forests, and farmland can give another 42 million tons of firewood

Table 3: Energy Demand Projections for 1981 and 2001 AD

Fuel	Unit except for per capita	Reference per capita domestic consumption (1978-79)	Domestic energy required qty.	CR (000) tons	Other sectors requirement CR (000) tons	Total energy required CR (000 tons)
Coal/Coke	000 tons	1.23 kg	43	54		
Kerosene	000 K. L.	6.05 lit.	213	579	1078	2223
Elect.	Mil. kwh	15.36 kwh	542	379		
LPG	00 tons	0.37 kg	13	133		
Total Comm.	CR 000 tons	-		1145	1878	2223
Firewood	000 tons	294.4 kg	10387	7790		
Charcoal	000 tons	4.67 kg	165	299		
Agri. Residues	000 tons	11.59 kg	409	213	720	9764
Dung Cake	000 tons	70.07 kg	2472	742		
Total Non Comm.	CR 000 tons	-		9044	720	9764
Total all fuels	CR 000 tons	-		10189	1798	11987

Table 3: (Contd.)

Fuel	New per capita requirement (Domestic)	Domestic energy required		Other sectors requirement CR (000 tons)	Total energy required CR (000 tons)
		Qty	CR (000 tons)		
Coal/Coke					
Kerosene	1.35 kg	62	78		
Elect.	6.66 lit	305	830	4373	6019
LPG	16.90 kwh	775	543		
	0.41 kg	19	195		
Total Comm.		-	1646	4373	6019
Firewood	323.8 kg	14852	11139		
Charcoal	5,14 kg	236	427	486	
Agri. Residues	12.75 kg	585	304		
Dung Cake	17.08 kg	3535	1061		
Total Non Comm.	-		12931	486	13417
Total all fuels	-		14577	4859	19436

NOTE: The consumption estimates vary in different surveys, especially of NC fuels. Therefore the calculation of per capita consumption up to two decimal places is not indicative of accuracy of estimates, but merely retained for correspondence with aggregate figures.

from the hill region (geographical as 6 percent of the country) based on Firewood Study Committee estimates of 242 million tons for all of India. Based on NCAER (1981) indications of 6.5 million ha fallow land for the northern region, 24 million tons (yield 8 tons/ha) to 45 million tons (yield 15 tons/ha) firewood can be made available, considering 3 million tons of this land is in the Himalaya region.

Raising plantations, however, costs money; the NCAER (1981) estimate is Rs. 25 per ton in 1975-76. Yet another problem is distribution of wood grown on such land. Village woodlots suggested by Makhijani (1977) may not be feasible for several areas due to nonavailability of such land within a reasonable distance. Lastly, there is likelihood of this wood being diverted for commercial purposes.

Dung

The livestock population of the Himalaya region was approximately 17 million in the 1977 census and has increased only marginally thereafter. Approximately 70 percent of these are cattle with dung yield of 8-10 kg per animal. The estimates for dung yield and collection efficiency vary widely. Assuming 40 to 60 percent collection efficiency, availability of wet dung could be between 16 and 29 million tons, which is equivalent to 3.2 to 5.8 million tons of dry dung. To increase this, cattle need to be kept penned, and this in turn would require adequate fodder arrangements.

Agricultural Residue/Vegetable Waste

There are varying estimates for available residue from crops. Roger Revelle (1976) and Makhijani (1977) have taken the residues to foodgrain production ratio as 2:1, whereas the NCAER (1985) study implies it to be 1.14 percent. The available residue in the Indian Himalaya in 1985 is expected to be 6 to 8 tons (with a ratio of 1.5:1). The residue has multiple uses as fodder, fertilizer, and fuel. Increased agricultural production need not necessarily increase residue as high-yielding dwarf varieties produce less straw. The priority use for residue is fodder, and increased fodder availability can increase dung yield also.

Biogas

Only 1 percent of dung is presently in use in biogas plants (Satish Chandran 1985) and the percentage is still lower in the Himalaya region. If about 25 million tons of dung are available (from indicated range) it can yield 1000 million m^3 of gas (and 2.3 times this in summer), sufficient for 1.3 million households of five needing 2 m^2 of gas per day. However, each household needs to have five or six cattle to get the required gas output from a family-size plant. The estimated number of such households is 15 percent (NCAER 1981), but in the case of some hill states like Himachal Pradesh it is as high as 30 percent (NSS 30th round). Community biogas plants can be installed wherever feasible.

Biogas technology offers several benefits like fertilizer (sludge) in addition to clean and convenient cooking fuel, improved environment, related health benefits, income-generating activities during construction of the plant, and possibility of use of biomass and human excreta, which at present do not find alternate uses. However, compared to the present almost 'zero private cost' of fuels in rural areas, it is costly. Present cost is expected to be more than Rs. 5000 for a family-size plant. Further, studies in the past have indicated biogas as uneconomic on social cost-benefit criterion (Bhatia 1977). Even community gas plants have been considered beyond the reach of a common village household due to high cost (Makhijani 1977), and undesirable from accessibility and affordability criteria in addition to sociological and organizational problems (Ranganathan 1983). However, with increasing fuel problems and changing situations this needs a fresh look. Other problems like reduction of gas output at low ambient temperatures, leakage, liquidity of sludge, high water requirements, large space requirements, maintenance of correct pH ratio and distribution of gas have yet to be resolved satisfactorily. Bhatia (1977) pointed out yet another undesirable social consequence of the biogas program: a vulnerable section of society might get deprived of fuel, as dung will not be available for collection.

Electricity

More than 50 percent of hydroelectric potential is in hill regions (including Assam) and less than 15 percent of this has been exploited. The installed capacity in the Indian Himalaya (excluding U.P., W.B. and parts of H.P. in Bhakra) was merely 2 percent and power generated, 1 percent of the total in the country in 1983-84 (based on compilation from CMIE 1984). Per capita annual consumption of electricity in this region varied from 13 kWh in Manipur (lowest in India) to 106 kWh in J and K against the all-India average of 146 kWh in 1982-83.

The projected electrical energy requirement by CEA for this region (excluding U.P. and W.B.) for 1990-91 is 6996 kWh with a peak load of 1397 MW (CEA, 1982). More than 14,500 MW of hydel capacity was under various stages of consideration and execution in the Indian Himalaya from July 1982 onwards (CMIE 1982). Mini and microhydel schemes are of special interest owing to their tremendous potential in this region and suitability for decentralized operation. The Rural Electric Corporation has identified several rural linked mini and microhydel schemes for this region.

Electricity generation might be abundant, but due to high costs of connection and appliances, it is beyond the reach of the majority of households. Even if these costs are subsidized, it is difficult for electricity to replace fuels used for cooking: the major energy-consuming activity of households. Its role is expected to be limited to use in pump irrigation and lighting. Reliability of supply has been yet another problem with electricity, calling for back-up arrangements. Mini and micro hydel may be preferable on this count, as well as the high cost of grid electrification in remote areas.

Coal and Coke

The Indian Himalaya does not have coal reserves except for a small amount of tertiary coal in the northeastern region. Use of coal for cooking has been advocated by Bhatia (1977) based on a social cost-benefit study. However, it will also need subsidy when compared with 'zero private cost' of fuels used for cooking, especially by poor classes. The distribution costs of coal are expected to be higher in hill areas due to long distance road transport and sparse population. The policy being increased use of coal and renewables, the cost of coal needs to be compared with other alternatives.

Petroleum Products

The Himalayan foothills have a small amount of oil reserves and Tripura and Nagaland have some natural gas reserves. However, policy regarding consumption of petroleum products has to be within the broad national policy framework. LPG can contribute in cities to meet cooking energy needs of households with relatively better economic conditions. High appliance and distribution costs do not favor its use in rural areas. The role of kerosene can be seen as supplementing electricity to meet lighting needs. Petroleum products have to mainly meet fertilizer and transport sector requirements.

Nonconventional Energy Sources

Solar Energy. Solar energy technology has been developed for several end uses like water and space heating, cooling, water pumping, and cooking. It is a clean fuel and potential is virtually unlimited with solar radiation intensity of 600 Watts/M^2 and above falling in India. However, the cost of most of the appliances is beyond the reach of the poor classes. Thus, the solar water heater has been found to be economically unviable for large-scale adoption at present level of cost (Painuly, Gadgil, and Natrajan 1985b). Apart from this, it was observed in the case of solar cookers that if the usage level goes down, the commercial energy requirements to manufacture solar cookers as a proportion of noncommercial energy substituted by them, increases rapidly (Painuly and Rao 1985a).

A commercially viable solution for storage of solar energy has yet to be found and hence, its use suffers from unreliability, inconvenience, and rigid timing. Therefore use of solar energy can be maintained only at a small scale, to keep the awareness level high. This will help in switching over to solar technology at an appropriate time.

Wind Energy. Being a tropical country, average wind speeds are low in India. However, there is scope for use of wind power in water pumping for irrigation. Detailed surveys will be required, to find suitable areas for operation of windmills. Field tests are in progress in several states. Present costs of windmills are quite high-$1180 (Revelle 1979)- and need to be reduced before widespread usage can be planned.

Geothermal. From the data available at present, geothermal potential is negligible. There are some indications of the presence of geothermal energy in Himachal Pradesh and development work on a cold storage unit and 5 kW power plant based on geothermal is in progress. More surveys will be needed before taking any decision to exploit this resource.

No single fuel is capable of meeting all requirements and hence, a package of fuels has to be selected. Therefore, the need for a fresh study of cost-benefits of fuels in light of developments and problems, is now faced on the fuel front. Detailed cost-benefit studies can ensure that the package of fuels selected will maximize benefits and minimize subsidy requirements, and also result in efficient use of resources.

DEMAND - SUPPLY BALANCE

General factors in balancing demand and supply of energy, and specific problems of rural areas and hill regions, are covered in this section.

Energy-Use Efficiency and Diffusion of Efficient Technology

The useful energy available to the poor is very low due to the types of fuel and appliances used. Energy-use efficiency has been taken as 7.6 percent by Makhijani (1977) and 8 percent for noncommercial (NC) by ABE (1985).

Efficiency of cooking stoves (*chulhas*) using NC fuels can be increased to 25 percent and above, as *chulhas* with efficiency 40 percent and even more have been developed. Even a 1 percent increase in efficiency of *chulhas* can save 0.25 million tons of firewood in the Himalaya region, and 3 million tons all over the country. Better design of cooking pots and pressure cooking can also increase energy-use efficiency. Modernization of tools, gadgets and efficient pumps can improve efficiency of energy-use in agriculture.

Several factors are important for success of efficient technology. First, technology has to be appropriate: cheap, and using local materials and skills. If necessary, modifications should be made to meet local requirements. Second, interveners play an important role in acceptance of technology. People who already have a role for intervention in village life like local politicians and religious persons can play an effective role in introduction and acceptance of technology (Roy 1982). Third, it has to be understood that adoption and absorption of technology is a slow process, especially in rural areas which are hardly exposed to the fast-changing lifestyle of urban areas. Also, compatability with the present system is necessary. Thus, the " technology subsystem must fit into the larger socioeconomic and cultural system of a village" (Reddy 1980). Lastly, adequate and proper extension facilities are prerequisites to the success of any new technology.

Cost of Fuel and Technology

As one of the most important points, this has to be viewed in the context of affordability and actual cost of present fuel to the users, rather than using imputed labor and time costs for analysis in an economic return framework. With more than 80 percent of fuel collected by a majority of rural population at zero private cost, they cannot be expected especially the poor, to pay for new appliances and fuel on such economic analysis criteria. It is necessary to bring down the cost of most potential technologies like biogas and solar as subsidy alone cannot sustain technology in the long term.

Methodological and Data Problems

An adequate data base on such information as energy consumption, and fuel mix, which is necessary for energy planning at the macrolevel, does not exist. There are several methodological problems in collection of data on noncommercial energy, like measurement, seasonal variations, apportioning fuel among different end uses, and between collected and purchased. In addition, there is a gradual shift from animate to physical energy in the agriculture, household, and transport sectors. Therefore, there is a need for development of a sound methodology covering various energy activities and different forms of energy, to build a sound data base.

Micro vs. Macro Energy Planning: Rural Energy Centers

Divergence in fuel consumption patterns and fuel mix indicates that although aggregate planning can be done at the macro-level, microplanning has to be area-specific. The need has been recognized, and different approaches proposed in different studies: Reddy and Subramaniam (1980), Tewari and Srinath (1980), Moulik et al (1983).

It is suggested a data base be built for different patterns of energy-use activities, energy resources and technology, and consumption patterns, and that they be grouped in 15 to 20 different types. Energy packages for each of these 'different types' can be designed using an **Integrated Energy System Approach**, to serve as basic energy packages for matching areas (villages or groups of villages). Modifications can be made to suit local requirements. A three-tier agency with high expertise at the regional level, monitoring of programs at the district/regional level, and implementation at block/area (group of village) level with adequately trained staff, can form the base for transforming energy planning into reality. The energy program should be planned to dovetail with integrated development programs like IRDP.

Problems of the Indian Himalaya

In addition to the general problems discussed in the foregoing paragraphs, hill regions have to cope with additional problems:

1. As brought out by studies, domestic energy requirements in hill areas are high. Also dependence on firewood is more than in plains areas.

2. Due to topography, pump irrigation is not possible, hence dependence on dung as manure will be more (chemical fertilizers need more water). Therefore, direct use of dung as fuel needs to be restricted.

3. For firewood alternatives like coal and LPG, distribution is a major problem. This is because villages are small and sparsely populated. Further, road transport (using diesel fuel) will be required to transport these over long distances.

4. Distribution is also a problem in many villages for community biogas for the same reason (sparse population). In addition, as temperature in winter is low, output of biogas is expected to be poor with existing technology.

5. The solar energy availability may be for a comparatively shorter period due to topography. In some villages the sun may set too early due to hill peaks.

6. The increased population and overgrazing of land by cattle, coupled with increasing industrial wood requirements has already increased the yield requirements beyond regeneration capacity in several areas. At the same time, population pressure has brought more area under cultivation (Shah 1982). Therefore, adequate land may not be available for village woodlots in all villages.

All these specific problems and characteristics of the Himalaya region will have to be kept in view while designing packages of integrated energy. This calls for specially trained staff and a specialized agency to provide support to this region.

SUMMING UP

The microstudies indicate the divergent nature of energy consumption patterns at the village level, and macrostudies, the overall picture of consumption. Therefore, although macrodata can be used for aggregate level planning for funding and technical requirements, uniform prescriptions and packages cannot work at the microlevel.

The demand is expected to increase and reach much higher levels in future (up to 2.5 times or more in the next 15 years) due to population increase and per capita consumption. Adequate supply arrangements are required for a reasonable level of quality of life to be provided to rural people. The supply potential is adequate but needs to be developed to meet increasing energy requirements. Several issues need to be resolved before energy demand-supply balance can be obtained. Area/village group-specific packages are necessary to meet specific requirements. An organizational set-up to implement and monitor the program is also needed. The Indian Himalaya has its own peculiarities in energy consumption patterns and presently available and potential energy sources/technologies. Therefore, an agency at the regional level should be specialized in these hill-specific energy characteristics.

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