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ENERGY PLANNING AND MANAGEMENT IN ALMORA DISTRICT, U.P., INDIA

A CASE STUDY

Jami Hossain
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PREFACE

A programme on 'Strengthening Rural Energy Planning and Management in the Mountain Districts of the Hindu Kush-Himalayan Region' was organised during the time course of January 1987 to November 1988, funded by the European Economic Community. Various activities were implemented under this programme. Six case studies, relating to 'Energy Management and Planning', covering five regional countries (Bhutan, China, India-2, Nepal, and Pakistan) were also conducted. It is hoped that the ultimate use of these case studies will be to develop energy management and planning guidelines that could be used for training district level officers working in the field of energy-related issues. This study is one among these six cases studies, and was conducted in Almora District, situated in the hills of the Uttar Pradesh Province of India.

This paper investigates issues in energy management and planning in Almora District of the U.P. Hills of India.

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List of Abbreviations

Madua	=	Millet
Samba	=	Millet
Kharif	=	Main (Monsoon) season
Rabi	=	Winter season
LPG	=	Liquified petroleum gas
Quintal	=	100 kilograms
Van Panchayat	=	A voluntary organisation at the village level comprising of the right holders of a Panchayat forest
Chulha	=	Cooking stove
Khoya	=	Processed milk product used in sweet making

Energy Content and Conversion Factors

	Natural Units	kcal ('000)	TCE	TOE	Others
Non-commercial					
Fuelwood	ton	4,000	0.57	0.39	1.43 m^3
	m^3	2,800	0.40	0.27	700 kg
Dried Dungcake	ton	2,600	0.37	0.25	--
Agricultural Residues	ton	3,000	0.43	0.29	--
Commercial Fuels					
Diesel					
	kl	9,080	1.29	0.88	0.826 ton
	ton	10,960	1.57	1.07	1,210 litre
Light Diesel Oil	kl	9,350	1.34	0.91	0.853 ton
	ton	10,960	1.57	1.07	1,172 litre
Petrol	kl	8,000	1.14	0.78	0.709 ton
	ton	11,290	1.61	1.10	1,411 litre
Kerosene	kl	8,660	1.24	0.84	0.778 ton
	ton	11,130	1.59	1.08	1,285 litre
Liquefied Petroleum Gas	ton	11,760	1.68	1.14	--
Coal	ton	6,000	0.86	0.59	--
Electricity	MWh	860	0.12286	0.083576	--
Other Conversion Factors					
1 TCE			1.00	0.680272	
1 TOE			1.47	1.00	

Heat Content of Different Fuel Types

1 kg wood	=	15 Megajoules (MJ)
1 kg coal	=	26.5 MJ
1 litre of kerosene	=	43.6 MJ
1 kWh of electricity	=	3.57 MJ

INTRODUCTION

Background

The majority of the population in the hills of the Central Himalayan Region of India depend on traditional sources of energy such as fuelwood, agricultural wastes, etc. The consumption of commercial sources of energy such as electricity and kerosene is not significant and is mostly limited to lighting. Fuelwood is the single most important source of energy in the area. This report presents the findings of a case study on energy planning and management in Almora District which is situated in the hills of the Uttar Pradesh Province of India.

Objectives of the Study

The overall objective of this case study is to investigate issues in energy planning and management in the Almora District of the U.P. Hills in India. The specific objectives of the study are given below.

1. To assess energy resources and their pattern of use in the district for different end uses.

2. To assess energy consumption levels and to project energy demand in the district, based on available secondary information.

3. To develop appropriate energy strategies based on the available energy technology and resource management options.

4. To assess the infrastructure and management needs of decentralised energy development.

Methodology

The study mainly uses secondary data from official sources. Information and data available from other sources have also been used. The secondary data on energy resources in Almora and also on energy supply from outside the district, along with internal biomass supply, have been compiled. A further analysis has been done to obtain energy supply levels for different end uses. The resource data are analysed to estimate the potential for exploitation of these resources for energy generation. Energy consumption levels have been estimated and energy demand projections have been attempted based on secondary data. An exploratory survey of the present energy systems is carried out to evaluate the present energy situation and to arrive at a realistic energy planning strategy. Villages in the range of 1,300 to 1,500 m altitude were selected for survey in order to represent the population distribution by altitude.

Introduction to the Area of Study

This case study is on one of the mountain districts in the Kumaon Region of the Central Himalayas in India. This region is prone to landslides caused by seismicity and tectonic stress. The Central Himalayan Region is drier than the Eastern Region but is more humid than the Western Region. The contribution of winter rains to the total rainfall in this region is less than that in the west. A number of perennial and annual rivers originate here. The monsoon rainfall (mid-June to mid-September) accounts for 60 to 80 per cent of the total rainfall. The amount of monsoon rainfall is around 1,000 mm in the foothills, 2,000 mm in the middle region, and 500 mm in the higher elevation and interior regions.

According to the 1981 census, the population of eight districts of the Indian Central Himalayas was about 5.1 million, of which 3.47 million lived in the mountains. Eighty-two per cent of the mountain population was rural, with a density of 722 per km^2 in the rural sector and 776 per km^2 in the urban sector.

The mountain economy is at the subsistence level and is based mainly on agriculture and animal husbandry. About 15 per cent of the total area constitutes an agro-ecosystem (cropland, current fallow, rural houses, etc) and less than 2 per cent is an urban-industrial system, leaving 83 per cent as natural systems. While the productivity of forest ecosystems in the region is higher than in similar forests in the world, productivity of grasslands and agro-ecosystems is low. Some of the reasons for low grassland productivity in this region are excessive grazing, frequent burning, and shorter growth periods. In addition, energy inputs into agriculture are also limited.

Almora District

Almora is one of the eight hill districts of Uttar Pradesh. It has a total area of 5,385 km^2, most of which is hilly and lies in the upper/middle Himalayan range. The altitude of the district ranges from 750 m to above 1,800 m.

The soils in the Almora District are generally brown and acidic (pH < 5.5). One estimate of annual soil loss in the middle Himalayas is 12 tons per hectare, which is equivalent to 0.8 mm of top soil. Hence, soil erosion is a major environmental problem with implications for biomass use for energy.

The district has a maximum temperature of up to 28.5° C and a minimum of -13° C. In 1985, the annual rainfall in different parts of the district ranged from 1,045 mm to 1,224 mm. The average normal rainfall of Almora District is 1,050 mm (average from 1901 to 1950). The microclimatic conditions in different locations depend on (i) direction of ridges, (ii) degree of slope, (iii) sunny or shady aspects of slope, (iv) intensity of forest cover, and (v) nearness to glaciers.

According to the 1981 Census, the district has a population of 800,000 belonging to about 152,000 families. This amounts to an increase of 12.58 per cent in the number of families since 1971. The population grew by 14 per cent between 1951 and 1961, while the decennial growth was 17 per cent between 1961-71 and 1971-81. The density of population per m^2 is 141. Ninety-three per cent of the villages in the district have a population below 500.

The literacy percentage in Almora District is 38 per cent, higher than the State average. In 1981, the literacy percentage was 57 per cent for males and 20 per cent for females. Some important statistics of Almora District are given in Annex Table 1.

Agriculture. Agriculture is by far the largest economic activity in Almora District. Cultivators and agricultural labourers constitute 75 per cent of the total workforce of the district. The majority of the cultivated land lies on terraced hillsides (1,000-500 m) and is rainfed or unirrigated, producing three crops in two years. In 1984/85, approximately 107,311 hectares were under cultivation, of which 71,862 hectares were cropped more than once per year.

According to the 1981 agricultural census the total number of landholdings is around 179,000 covering an area of about 105,000 hectares which has been classified in terms of size of landholdings in Table 1. The percentage of the area under smallest landholdings (< 1 ha) is very high in the district compared to that in the hill region (23 %) or in Uttar Pradesh (26 %). This probably explains the large number of cultivators in the district. The percentage of smallest landholdings is also higher in the district.

Important crops grown in the district include paddy, maize, *madua* (millet), *samba* (millet), wheat, barley, and mustard. The total area cultivated during the Kharif (summer) season is 106,800 ha. The areas under paddy, *madua*, and *samba* constitute 35, 37, and 18 per cent of the total cropped area respectively. During the Rabi (winter) season, 72 thousand hectares of land are under cultivation. The share of wheat, the most important crop of this season, is 83 per cent, followed by barley (10%) and mustard (3%). In 1984/85 the total production of all crops was 136,298 metric tons. The production of paddy, wheat, and *madua* constituted 32, 22, and 26 per cent of the total respectively of foodgrain production. In 1984/85, 764 metric tons of chemical fertiliser were distributed in the district and this comes to about 4.26 kg/ha, far below the Indian average of 45 kg/ha.

Table 1 : Percentage of Landholdings According to Number and Area of Landholdings

Size	Number of Landholdings	Area of Landholdings (ha)
< 1 hectare	81	47
1 - 2 hectare	14	28
2 - 3 hectare	3	15
3 - 5 hectare	1	7
> 5 hectare	< 1	3

Source: Agricultural Census, 1981.

The total livestock population as per the 1978 livestock census was about 0.7 million. Cattle, goats, and buffaloes constituted 49, 25, and 20 per cent of the total livestock population respectively. Other important animals are sheep, horses, and mules. To make dairying a viable industry in this region, fodder production is being encouraged in *panchayat* forests and civil forests.

Industries, Transport, and Communications. Industrially, Almora is a very underdeveloped region. In the district, there are about 9 factories in addition to a few magnesite processing units. Other small-scale industries are mainly agriculture and forest-based. Tourism is a growing industry in Almora.

The total length of all roads in the district is 2,050 km. In 1986, 431 post offices and 87 telegraph offices were functioning. There were 19 telephone exchanges with 789 telephone connections, of which 613 were urban and 176 rural.

Forest Resources. Almora has two predominant forest types: the subtropical pine and the Himalayan moist temperate forests. Very few natural oak forests exist in the district. They have been destroyed by lopping, charcoal production, harvesting of wood for farm implements, grazing, and fire. Pine, on the other hand, is fire resistant, is not grazed, cannot make good charcoal and is not useful for making tools. Most parts of the Almora District now have *chir pine* (*Pinus roxburghii*) forests.

East Almora and West Almora are the two main forest divisions in the district. They overlap to a minor extent with other districts. Four different agencies have control over the forest resources as shown in Table 2.

Though the total forest cover in the district is about 73 per cent of the total geographical area, the crown density differs in each category of forest. Hence, the effective forest coverage in the district is reduced to 20 per cent as against the recommended cover of 60 per cent. The species and the growing stock in the district are shown in Annex Table 2.

ENERGY SUPPLY ANALYSIS

Electricity

The main transmission line to Almora is a 132 kV line from Bhavani in Nainital District. There is a 132/66/33 kV substation in Almora. A 66 kV line from Almora is taken directly to Pithoragarh District. The district itself does not have any electricity generation capacity except for a 20 kW standby diesel generating set and a 55 kW micro-hydel plant in Bageshor which is non-functional at present. Of the 3,056 villages in the district, 1,682 (55%) are supplied with electricity. The extent of electrification in various development blocks in the district varies between 36 per cent and 93 per cent.

Table 2: Control of Forest Area by Different Agencies in Almora

Controlling Agency	Forest Area Hectares	Percentage of Total Forest Area	Estimated Cover (%)	Effective Area (ha)
1. Forest Department	149,481	38	40	59,792
2. District Administration (Civil and Soyam)	182,100	46	10	18,210
3. *Panchayat* Forest	62,799	16	50	31,400
4. Private Forest	52	-	-	-
Total	394,432	-	100	100,402

Source: Department of Forest, Almora District.

The electricity consumption in the district by different sectors is given in Table 3. The figures for 1985/86 are provisional and show the lower consumption level of electricity for water supply compared to earlier years. In 1984/85, domestic lighting and small electricity use accounted for 41 per cent of the total electricity consumption, followed by water lifting and water supply (37%), industries (16%), irrigation (3%), and commercial lighting (2%). Per capita electricity consumption in the district is around 31 kWh/year.

Table 3: Electricity Consumption in Almora by Sector

S. No.	Sector	Electricity Consumption ('000 kWh/yr)		
		1983/84	1984/85	1985/86
1.	Domestic lighting and small electricity consumption	8991 (37)	9686 (41)	12831 (60)
2.	Commercial lighting and small electricity consumption	390 (1.6)	395 (1.7)	549 (2.6)
3.	Industries	4153 (17.1)	3897 (16.4)	4766 (22.1)
4.	Irrigation	1513 (6.2)	752 (3.2)	811 (3.8)
5.	Water lifting and water supply	8969 (37)	8842 (37)	2451 (11.4)
	Total	24222	23756	21517
Per capita electricity consumption (kWh)		31.98	31.37	28.41

Source: *Sankhiyakia Patrika*, Almora District, 1986.
Note: Numbers in brackets indicate per cent of total.

Kerosene, Coal, and LPG

The annual average consumption of kerosene in the district is approximately 5,500 kilo litres. Kerosene is mostly used for domestic lighting and to some extent for cooking in urban areas. The monthly sales of kerosene from the four major dealers in the district are given in Table 4.

Table 4: Kerosene Sales by Major Dealers in 1987 (in '000 lt)

	January	February	March	April	May	June
1. Almora	223.2	220.8	196.8	212.8	232.2	188.8
2. Ranikhet	33.6	18.0	16.0	28.0	28.0	30.0
3. Ram Nagar	141.6	140.0	138.0	140.0	141.0	85.0
4. Pageshwar	80.0	72.0	70.0	76.0	79.0	141.0
Total	478.4	450.8	420.8	456.8	480.2	484.8

Source: Department of Supplies, Almora District.

Coal is supplied to the district only in the winter and is mostly used for space heating in the government departments. The annual coal consumption in the district is approximately 500 metric tons. The annual sale of LPG is approximately 1,050 thousand kg (65,700 cylinders)

Fuelwood

While the supplies of electricity, coal, kerosene, and LPG are from sources external to the district, fuelwood is available within the district. It is supplied through commercial as well as informal marketing systems. In rural areas it is also gathered for personal use. Hence, an accurate estimation of its supply is difficult. The commercial supply system is managed at the State level by the Forest Corporation of India (FCI) set up in 1974 to facilitate the scientific management of forest produce. The corporation pays royalty to the Forest Department to harvest the forest produce. The felling, processing, and transportation to its depots located in the foothill towns are managed by FCI. Wood is stacked in four categories: 1) softwood, 2) hardwood, 3)fuelwood, and 4) mixed wood. The wood is auctioned or sold through a private contract system. In 1981/82, a total of 111,462 m^3 (74308 tons dry weight) of fuelwood was harvested by FCI.

The informal system of fuelwood use is based on the right of the hill population to collect fallen dry twigs from the reserve forest area for their own consumption. The poor economic level of rural population and the scarcity of other fuel sources have prompted the rural poor to sell dry twigs to urban households and roadside eateries. Fuelwood collection is carried out exclusively by women and is restricted to reserved forest areas allotted to the villages. There are also dealers who purchase fuelwood from individual collectors and resell at higher prices.

Fuelwood is supplied to the users on the basis of ration cards. A family of up to 5 persons is allotted 100 kg of fuelwood per month and for a family with more than 5 persons the allotment is 200 kgs. However, shortage in supply is common.

Fuelwood is extensively used at the household level *khoya* (milk product used for preparing sweets) preparation industry in rural areas near the towns in Almora District. In some villages, where fuelwood is available at a close distance, about 40 per cent of the families are engaged in this activity.

Energy Supply Analysis

The level of energy supply is calculated on the basis of the total population of the district in the year under consideration. The annual growth rate of population is derived from the decennial growth rate by assuming a compound annual growth rate. Table 5 summarises the level of energy supplies by purpose in Almora District. The detailed calculations are shown in Annex 1.

The supply data analysed here were collected from various district offices. The analysis presented is a simplistic one but indicates the levels of energy consumption. The supply level of fuelwood is underestimated as the fuelwood collected by the rural households is not included.

Table 5: Energy Supply Levels by Source in Almora District

	Item	Unit	Number
1.	Electricity for lighting	kWh/hh/day	0.218
2.	Kerosene for lighting	kl/hh/day	8.27×10^{-5}
3.	Energy use for lighting	kcal/hh/day	813
4.	Kerosene for cooking	kl/cap/day	2.063×10^{-6}
5.	Fuelwood for cooking and space heating	kg/cap/day	1.3
6.	Energy use for cooking and space heating	kcal/cap/day	5815
7.	Water lifting	kWh/cap/day	0.03
8.	Irrigation	kWh/ha irr/annum	33.46

Source: Author's estimation based on the level of consumption of different energy items.

Biomass Resources

Biomass energy resources include forest fuelwood and crop residues useful for fuel and animal dung. Sewage and human excreta can also be included as energy resources in this group. However, because of the constraints in their immediate present use, these have not been discussed. Crop residues that contain rice husks are usually used as fuel. But considering the existing cropping patterns, rice husks may only be available on a limited scale in the district for energy purposes. Unlike in the plains, dungcakes are not used for fuel purposes in Almora District.

In 1981, the reserved forests had produced 36,349 m^3 of timber and 111,462 m^3 of fuelwood. The present demand for fodder and fuel is much higher than can be used in an environmentally sound manner. According to a Forest Department study, the fuelwood requirements of 900,000 residents at the rate of 0.65 ton per capita per annum will be 585,000 tons, i.e., 1,500,000 m^3 stacked (1 ton = 1.6 m^3 solid and 1 m^3 solid = 1.6 m^3 stacked). From Annex Table 2, assuming a conversion of 1 m^3 of fuelwood (stacked) for 1 m^3 round of timber, we can estimate a productivity of 2,60,000 m^3 stacked. This is only 16 per cent of the requirement. Thus, the forest cover is depleting at a very fast rate. According to the Forest Department, two thirds of the forest area (269,120 ha.) are suitable for grazing. This area is adequate to support 538,240 annual units of animals whereas the actual number of animals is five times higher. The data on deforestation caused by timber harvesting is not available. At present biomass resources for further exploitation on a commercial scale can be ruled out. The development of these resources has been attempted through social forestry and other afforestation programmes.

Wind Potential

The nearest station for which wind speed data is available is Mukteshwar in Nainital District. Since Almora does not have any wind station, this station is assumed to be representative for our analysis. The potential for wind electric generation in the district is estimated at 954 MkWh.

Solar Energy

In the hills the availability of solar radiation depends on the slope and the direction of settlement. Radiation data are available for one solar station in the district. Similar data can be collected and used for estimating the potential for using solar radiation for cooking, space heating, lighting, pumping,etc.

ENERGY DEMAND ANALYSIS

Norms or Standards of Energy Consumption

The specific energy or fuel requirements for different end uses vary considerably from region to region depending upon altitude, ambient conditions, end use characteristics, and the type of devices used for energy conversion. In general, it is expected that the energy needs in mountainous regions would be higher because of lower ambient temperatures. Before attempting to develop the energy and fuel requirement norms for Almora District, it is worthwhile to examine and compare the existing standards.

The standard norms of energy requirements according to different sources and various macro- and micro-study findings are shown in Annex Tables 3 to 5. It is evident that the energy requirements per capita per day are higher for the mountain region than for the plains' areas. The equivalent gross energy per capita per day from some of the micro studies are comparable with FAO norms for the mountain region.

Per Capita Fuelwood Consumption

The draft of the Sixth Five Year Plan of the Forest Department assumes the per capita annual fuelwood consumption in the hills to be 650 kg. The results of the wood balance study by the Forest Department for Almora District are summarised in Table 6.

Table 6 shows that the per capita daily energy consumption from fuelwood varies between 8,000 to 21,000 kcal across villages. From the table, a positive correlation between the level of development and fuelwood consumption can also be seen, although the relationship between consumption and the type of household is not obvious.

Table 6: Fuelwood Consumption in Different Types of Villages by Different Family Types

Sl. No.	Village Type	Family Type	Per Capita Annual Consumption kg/capita/yr	Equivalent Gross Energy kcal/capita/day
1.	With electricity and roads	A	990	12884
		B	1000	13014
		C	1610	20952
2.	No electricity but weather roads	A	890	11582
		B	810	10541
		C	1180	15356
3.	Development Block Headquarters	A	770	10021
		B	720	9370
		C	670	8719
4.	No electricity, no all weather roads	A	640	8329
		B	860	11192
		C	860	11192
5.	Scheduled caste villages	A	550	7158
		B	780	10151
		C	680	8849
	Average		867	11287

Source: Department of Forests, Almora District.

A - Head of the village
B - Poorest of the poor
C - Random household

In a more recent study of the *Van Panchayat* system in Almora, estimates of fuelwood consumption for cooking have been made. Table 7 presents the summary of the results of this study.

According to this study the daily per capita energy consumption from fuelwood varies between 9,000 to 21,000 kcal across the villages. The level of fuelwood consumption seems to be related to fuel resources in a village and its economic level.

On an average, a household in the hills consumes 33 per cent more energy than a household in the plains (ABE 1985). The energy consumption is higher in the hills mainly in cooking, space heating, and water heating and to some extent in lighting. The energy consumption for Almora may still be higher due to higher altitude and much lower ambient temperatures. The useful energy per person per day for a rural household for lighting, given by both NCAER[1] and NSS[2]32nd round, is 2 kcal per person per day.

[1] National Council for Applied Economic Research.

[2] National Sample Survey.

Table 7: Fuelwood Consumption in Selected Villages of Almora

Sl. No.	Parameter/Village	Kung	Silpar	Chausuli
1.	Development Block	Lamgara	Lamgara	Hawalbag
2.	Altitude (m)	1400-1550	1500-1650	1100-1300
3.	No. of households	37	68	106
4.	*Van Panchayat* Area	43 (degraded)	206 (good forest)	120 (very poor forest)
5.	Average landholding (acres)/hh	1.2	2.0	0.7
6.	Average cattle holding/hh	3.8	3.2	2.5
7.	Tree consumption kg/yr/capita (kcal/capita/day)	30 (18,35,47)	12 (15,36,42)	16 (9,34,53)
	Economic group			
	Poor	1643 (21375)	1533 (19950)	767 (9975)
	Medium	1314 (17100)	1387 (18050)	657 (8550)
	Rich	1533 (19950)	1205 (15675)	657 (8550)
	Average	1497 (19475)	1314 (17100)	694 (9025)

Note: Figure in parenthesis for the economic groups show energy consumption in kcal basis.

Exploratory Survey on Energy Consumption

In view of numerous existing norms of energy consumption and the supply levels, a detailed survey for Almora District to determine these norms was not felt necessary. However, a need was felt to assess the fuel requirements in the hills to identify specific problems related to energy and to assess the fuel consumption pattern. A small exploratory survey of three villages, Khunt, Balasa, and Dhamas, was carried out for this purpose and also for a realistic energy demand estimation.

A total of 351 households - 85 in Khunt, 35 in Balasa, and 231 in Dhamas - were selected for the survey. All three villages are located on either side of the Kosi River within 10 km of the district headquarters and are connected by the same road. In all, twelve households were surveyed, four from each village. The survey was carried out by the Tata Energy Research Institute (TERI) professionals by interviewing members of the sample households.

All three surveyed villages are connected to the electricity grid but the supply is intermittent and kerosene is used for lighting during periods of power breakdown.

None of the households in the surveyed villages possessed tractors or other farm machinery. Ploughing is done by traditional wooden ploughs driven by bullocks.

Fuelwood, fodder collection, and cooking is mostly done by women, while men play a more important role in farming. The daily distance covered for fuelwood and fodder collection varied from 3 km to 12 km and the time spent varied from 3 hours to 8 hours.

Survey Findings

The major findings of the survey are outlined below under specific headings.

Lighting

Kerosene is used mainly for kindling the fire in the fuelwood stoves and for lighting during the period of powercuts. Information regarding the actual break up of kerosene consumption for the two end uses could not be gathered in the survey. The kerosene consumption for initiating the fire can be roughly estimated by assuming a consumption of 10 ml for making each fire and lighting a stove twice a day. Following that, the monthly kerosene consumption is roughly 0.6. The annual kerosene consumption per household for lighting is estimated at 59.2.

The annual consumption figures per household for lighting in the supply analysis presented above were 29.7 for kerosene and 79.77 kWh for electricity. The NCAER norms of annual kerosene consumption for lighting per rural household is much lower than the 59.2 estimated by the survey. According to NCAER, the annual kerosene consumption for lighting in rural houses with electricity supply is 9.1, while it is 17.81 for rural houses without electricity supply.

The higher kerosene consumption in the villages surveyed can be attributed to the nearness of these villages to district headquarters which provide them with easy access to supply points. As these figures may not be representative for the entire district we have followed norms from the supply analysis and the NCAER norms for the purpose of demand projection.

Cooking

The fuel mix of fuelwood and kerosene for cooking would differ from region to region depending upon availability of kerosene which in turn is related to the accessibility of the areas under consideration. The village level information on kerosene consumption is not available. Therefore, two simple assumptions have been made: first, the villages with electricity supply are accessible while the villages without electricity supply are remote, and second, in villages with electricity supply, kerosene is used for cooking only to a certain extent. The kerosene consumption for the villages surveyed was found to be unusually high. The level of kerosene consumption in the district for cooking was 620.4 kl, as estimated in the supply analysis. The population in the villages with electricity supplies in 1987 is estimated at 450,456. The per capita annual consumption of kerosene for cooking for this section of the population is estimated to be 1.39.

Fuelwood continues to remain the major fuel for cooking. The fuelwood stoves are crude, without chimneys, and thicker logs are used. Improved stoves (*chulhas*), which were introduced some time ago, are not popular, primarily because they are slow in cooking. It appears that the distance covered for fuelwood collection has little effect, if at all, on its consumption level. The daily per capita consumption for all villages is estimated at 2.09 kg. Assuming a *chulha* efficiency of 8 per cent and a calorific value of 4,750 kcal/kg, the useful thermal energy required for cooking from fuelwood per person per day is 794.2 kcal. The useful thermal energy from kerosene for cooking is calculated as 16.27 kcal per person per day, assuming 50 per cent efficiency for the kerosene stove, 0.83 kg as the density of kerosene, and 10,300 kcal/kg as calorific value. The useful thermal energy supplied by kerosene is equivalent to 0.042 kg of fuelwood per person per day. This additional quantity of fuelwood is required for inaccessible villages to meet the cooking energy deficit compared to the cooking energy supplied by kerosene in accessible areas.

Space Heating

The fuelwood consumption in winter months (December to March) is nearly 60 per cent more than that in summer as it is used for space heating as well. Space heating in rural areas is done by burning more wood for a longer time in the same stoves.

Again, the distance of the village from the forest did not seem to have any effect on the consumption of fuelwood for space heating. The average daily fuelwood consumption per household in winter months is 14.66 kg, of which 4.86 kg/hh/day was for space heating.

Local Industry

'*Khoya*' making or milk processing is the major local industry in the district. *Khyoa*, which is used as an ingredient in sweet making, is sold within the villages or in nearby towns. Traditional fuelwood stoves are used for processing milk. This activity is not a full time occupation for most households. *Khyoa* is produced only during the flush season. Therefore, it was not possible to assess fuelwood consumption in this activity. Two households presently involved in *khyoa* production reported an approximate fuelwood consumption of 20 kg/day for this activity.

Gross Energy Needs

The gross energy needs for subsistence in the surveyed villages are essentially a summation of energy needs for different end uses without taking into account the device efficiency. The energy needs per household per day for different end uses are summarised in Table 8.

Table 8: Energy Needs for Different End Uses

End Use	kcal Per hh Per Day
Lighting	1,025(1)
Cooking(2)	116,897
Space Heating(2)	22,086
Total	141,008

(1) Of this, 187 kcal is from electricity and 838 kcal from kerosene.
(2) Based on an average household size of 11.75.

The per capita gross energy needs per year for subsistence are 12,000 kcal/day, and this is well within the range of FAO norms of 11,084 kcal/day to 13,040 kcal/day for the mountain region.

Demand in 2001 AD

The demand for energy and fuel in a district or a block in a particular year is a function of population, number of households, and access to electricity.

The population figures for different blocks of Almora District for 1987 and 2001 are shown in Annex 2, Table 6, and they have been estimated by assuming the population growth rate to be constant between

the two years. The number of households in electrified and unelectrified villages in different blocks for the years 1987 and 2001 is shown in Annex 2 Table 7. Since we are looking into the decentralised energy supply and power generation options, the ratio of villages with and without electricity supply is assumed to be the same in the years 1987 and 2001.

The daily per capita fuelwood consumption for cooking is estimated to be 2.09 kg for the villages with electricity supply which translates into 762.85 kg/person/year. In villages without electricity supply, an additional quantity of 0.042 kg of fuelwood per person per day is required for cooking. Thus, the annual per capita fuelwood consumption for cooking in villages without electricity supply is estimated to be 778.18 kg. The per household fuelwood consumption for space heating is estimated to be 1,774 kg. The fuelwood demand for cooking and space heating in different blocks is given in Annex Table 8. The total fuelwood consumption in the district in 1987, thus, was 860.8 thousand tons while it is projected to be 1,049.61 thousand tons in 2001, an increase of approximately 22 per cent.

The annual kerosene consumption for lighting is estimated in the supply analysis to be 29.7 l/hh/year and the ratio of kerosene consumption in households with electricity supply to that in households without electricity supply is estimated by the NCAER study to be 9.1:17.8. Assuming this ratio to hold for the district, the annual kerosene consumption in households with and without electricity supply in the district can be estimated from the following relationship:

$$29.7 = py_1 + (1-p)y_2 \text{ and}$$

$$y_1/y_2 = 9.1/17.8$$

Where y_1 is the kerosene consumption in households with electricity supply, y_2 is the kerosene consumption in households without electricity supply, and p is the percentage of households with electricity supply.

Following the above relation for Almora District, the annual kerosene consumption in the households with or without electricity supply is estimated to be 20.7 l/hh and 40.62 l/hh respectively. Such an exercise could be carried out for all the blocks separately. Since the average annual kerosene consumption for lighting per household was not available, the norms are developed for the district as a whole and are assumed to be applicable to all blocks. On the basis of these norms the kerosene consumption for lighting is computed in Annex Table 9, assuming the y_1 and y_2 values to be constant for all blocks.

The kerosene consumption for cooking in households without electricity supply was assumed to be negligible, while for villages with electricity supply it was estimated to be 1.39 per capita per year. The kerosene consumption for cooking in different blocks is also shown in Annex Table 10.

In the supply analysis, the electricity consumption for lighting was estimated to be 79.77 kWh/hh/year and that for water supply to be 10.88 kwh/cap/year. The demand for electricity is calculated only for households with electricity supply. The electricity consumption in the domestic sector and for water supply in different blocks is presented in Annex Table 11.

ENERGY DEVELOPMENT STRATEGY

The supply analysis indicates that the levels of total energy supply in the district are comparable with FAO norms or Advisory Board on Energy (ABE) recommendations. However, the analysis of energy consumption, particularly for fuelwood, shows a higher level of consumption than is environmentally viable. The apparent consequence of such a consumption scenario is a degrading ecosystem, particularly the rapidly disappearing forest area. An intensive effort to improve the biomass situation is long overdue.

In general, the existing environmental degradation would necessitate that the district development strategy move away from the dependance on hill resources and/or that hill resources be managed in an environmentally viable manner. This would imply a closer examination of activities that can lead to environmental degradation, for example, excessive use of biomass for timber, fodder and fuel use, and land use patterns (construction, mining, industries, etc).

The strategy for energy development in the district should focus on the following in order to reduce the almost total dependance on hill resources for energy supply and to improve the energy supply situation in the district:

i) reducing absolute biomass energy consumption and improving the biomass fuel situation in the district and

ii) expanding rural electrification by extending grid and expanding electricity generation capacity.

The implications of this general strategy of energy development on different end uses is discussed below.

Household Cooking, Water Heating, and Space Heating (Thermal Heat Requirements in the Domestic Sector)

The use of biomass fuel is high in these end uses because it is locally available at no monetary cost. It has been observed that as the economy of a region develops, household fuels also change from biomass to non-biomass (kerosene, LPG, electricity, etc) depending on their availability. In urban areas this fuel shift implies moving from one commercial fuel to another. But in rural areas, due to easy access to biomass fuels, these changes do not occur very rapidly. Hence, in rural areas, despite the improvement in the economy, dependance on biomass fuel continues. The shift from biomass fuel to non-biomass fuel would be particularly appropriate in the hills because of environmental reasons. However, this does not seem viable in the present socioeconomic context, as pointed out earlier. Hence, energy conservation coupled with the management of fuel resources becomes the immediate task. Various remedial measures have been suggested, such as i) improved stoves, ii) use of pressure cookers, iii) biogas plants, iv) solar cooking devices, v) solar water heaters, and vi) integrated systems for space heating, water heating, and cooking.

In Almora District, previous attempts to popularise improved cooking-stoves became largely unsuccessful mainly due to the slowness of the units. A closer examination of the sociocultural and other practices associated with domestic energy consumption should precede the introduction of any energy device. On the other hand, use of solar cookers or biogas plants would depend upon solar radiation, ambient temperatures, etc.

Household Lighting

The use of improved kerosene lamps can be encouraged in villages without electricity supply. Attempts to encourage electric lighting using fluorescent tubes in areas with electricity supply can lead to efficient use of electrical energy.

Commercial Uses

The measures to conserve energy can be more effective in the commercial sector than in the domestic sector. Hence, these should be considered on a priority basis. Some of the conservation measures include the use of i) efficient stoves for cooking in restaurants and eateries and ii) efficient space heating in offices, hospitals, etc.

Service Sector

Water pumping and street lighting are two major energy consuming activities in this sector. Although the use of street lighting has been currently limited only to urban areas, in the long run its extension to rural areas can be foreseen. In rural areas the use of electricity is mostly for pumping water for irrigation and drinking purposes.

Energy Consumption in Industries

The development of new industries should be governed by environmental criteria. In the existing industries , particularly those based on biomass, fuel energy audit should be carried out to look into the possibilities of energy conservation and cogeneration.

The end use oriented energy development strategy discussed above would require a bottom-up approach in planning when the local energy needs are identified through a participatory approach. The planning for energy development in the service sector, industries, and agriculture can be done at the district level, taking into account environmental and economic factors.

PLANNING AND MANAGEMENT FOR ENERGY DEVELOPMENT ACTIVITIES

In this section of the study an attempt has been made to identify the issues related to planning and management for energy development. The emphasis is more on the use of the existing structure and how it could be modified to meet the objectives of energy development. Weaknesses of the local level institutions have been identified and measures to strengthen and reinforce them have been suggested.

Van (forest) *Panchayats*

A *Van Panchayat* is a voluntary organisation at the village level, consisting of the right holders of a *Panchayat* Forest who may belong to more than one village. The objectives of a *Van Panchayat* are:

- to protect and develop the forests and to distribute the forest produce among the right holders in an equitable manner,
- to demarcate the forest boundary by fixing stone pillars, and
- to develop grass and bushes in a *Panchayat* Forest (a *Van Panchayat* may enclose some portion of the forest area in which animals are not allowed to graze).

Management of a *Van Panchayat*

A *Van Panchayat* can be formed by the decision of more than two third holders who are required to elect five to nine members known as *Panchas* from among themselves. One of the members must be from the scheduled caste/scheduled tribe (SC/ST) group. The members elect a *Sarpanch* who is responsible for the management of all organisational works of the *Panchayat* Forest.

A *Van Panchayat* can raise funds from the sale of forest resources. Except for the operating expenditures for forest management, all other expenses require the approval of the District Magistrate, thus limiting the authority of *Van Panchayats*.

The Forest Department is authorised to extract the resin from pine trees in a *Panchayat* Forest. Ten per cent of the total income is to be deposited at the District level Resin Royalty Fund, of which 40 per cent

can be drawn by the *Panchayat* for forest development and the other 40 per cent for development projects, both with the approval of the District Magistrate.

Present Situation of the *Van Panchayat*

Decline in People's Participation

The number of meetings of a *Van Panchayat* is taken as an important indicator of the level of people's participation. As shown in Table 9 the frequency of such meetings has been declining over the years, indicating a decline in people's participation in the activities of *Van Panchayats*.

Table 9: Details of Meetings of *Van Panchayats* (1964-1980)

	Years			
	1964-68	1969-73	1974-78	1979-80
Total number of meetings held	26	16	13	8
Average per year	5.2	3.2	2.6	4.0
Number of meetings held with participation of villagers	17	12	11	3
Without participation of villagers	5	4	2	-
No information about participation	4	-	-	5

Source: Records of the *Van Panchayat* Office. District Magistrate, Almora.

Inability to Obtain Resources

According to district officials, this problem stems from the fact that the *Van Panchayat* members are not able to develop appropriate plans for area development.

Limited Effectiveness in Dispute Settlement

There are many unsettled cases of encroachment and mapping of lands resulting in illegal felling of trees.

Absence of Women's Participation

Women do not play any role in the activities of *Van Panchayats*.

Weaknesses of *Van Panchayat* Administration

1. In Almora District there are 1,717 *Van Panchayats* which are managed by four *Panchayat* Forest Inspectors. They do not have adequate field support and their mobility is restricted because of heavy workloads. A system of incentives to motivate fieldwork is also missing.

2. Elections of the functionaries have not been held in many cases, indicating a weak organisational structure.

3. The skill of the village level staff is low due to the inadequacy of the training imparted to them.

4. There is a lack of communication between forest officials and *Van Panchayats* regarding villagers' preferences for plant species, time schedule for the availability of planting materials, etc.

Energy Planning

Current planning activities are largely concentrated in the office of the State-level authorities overlooking the role of grassroots' level workers. Contrary to this a bottom-up approach should be the essence of the new energy planning process. Since the energy development plan should be based on the assessments of energy resources, micro-level surveys should assume importance. These surveys should aim at identifying the energy requirements and related parameters of different end uses. Any village energy development plan, which does not have an organisational design for implementation with a participatory approach for involving villagers, has limited value. This brings us to two important related aspects:

1. training of extension personnel
2. strengthening of local institutions.

Training of Extension Personnel

An extension worker ideally should not only be technically equipped in the area related to his job but also should have social understanding to perform the role of the facilitator for village groups. In a participatory development approach this is of utmost importance.

An extension worker at the village level should have comprehensive training in various aspects to enable him:

a) to deal with village groups effectively,
b) to prepare plans for project implementation and to develop proposals,
c) to carry out surveys in energy-related aspects,
d) to gain technical knowledge in energy-related aspects, and
e) to train villagers in developing capabilities to run village institutions.

Strengthening Local Institutions for Energy Development

The existing local institutions (*Van Panchayats*) have demonstrated mixed results with respect to their effectiveness. However, their existence itself provides potential scope for future development of the programme. Hence, the important task is to revitalise the existing *Van Panchayats*. This can be accomplished by emphasising the following aspects.

Organisational Capabilities. Strengthening organisational capabilities at the grassroots' level through the formation of a need-based organisational structure, election of functionaries, and definition of roles of functionaries.

Skill Development. Training the *Van Panchayat* members in skills (such as bookkeeping, leadership skill, etc) required to run institutions without much external help.

Participation in Activities Relating to Other Energy Sources. Since the system of *Van Panchayat* is a progressive step in participatory development and is already involved in one sector of energy, viz., fuelwood, it would be worthwhile to introduce it in the implementation of other energy-related activities.

Access to Funds. According to present arrangements, the income from the sale of forest produce and 40 per cent of the *Van Panchayat*'s Resin Royalty Fund can be used in development projects only after the approval of the District Magistrate. This authority should be decentralised to make funds easily accessible to *Van Panchayats*.

Women's Participation. Women's participation can be increased by disseminating energy alternatives and proper reorientation of forestry programmes. Women should be trained in running institutions such as *Van Panchayats*, and the possibility of *Van Panchayats* managed entirely by women's groups should be explored.

Federation of Village Level *Panchayat* Forests. The possibility of federating the village level *Panchayat* forests at the block level, should be explored as local concerns are reflected through this platform. Similarly, the problems of the district authorities can be understood by the people at the implementation level. This enhances the effective implementation of plans.

Suggested Changes in the *Panchayat* Forests' Administrative Structure

As pointed out earlier, the *Van Panchayat* administration has a weak organisational structure. In Almora District a *Panchayat* Forest Inspector looks after 500 *Van Panchayats*. This has resulted in poor monitoring and follow-up actions. The following paragraphs deal with the restructuring of administration for effective planning and follow-up activities.

An important element of any organisational structure is hierarchy. Hierarchy is primarily an integrative device and a coordinating mechanism. In designing any organisational structure, two factors should be kept in mind: i) vertical span of control and ii) horizontal span of control.

For an implementing agency involved in field-based activities such as integrated energy development, a tall hierarchy with many levels has negative implications for upward and downward flow of information. Hence, a short hierarchy at the district level is proposed.

In addition, hierarchy is also a way of dividing work. Since the Chief Executive Officer of the district organisation is expected to be involved largely in non-routine, unstructured, and complex problems and in making strategic decisions that have long-term consequences, sufficient authority should be provided to him/her. Since a Village Level Extension Officer is at the lower end of the continuum of strategic decision-making, a middle level authority between the Chief Executive Officer of district organisation and the Field Level Extension Officer is proposed. The village level officers will report to the proposed middle level authority, thus reducing the burden of the Chief Executive Officer for field level coordination. The horizontal span for each new middle level authority can be suitably determined to achieve a balance between cost and efficiency. The suggested structure is shown in Figure 1. At the field level, each Extension Officer will be responsible for five villages and the Unit Manager (middle level authority) will have four such extension officers under him.

Control System

Each Extension Officer will prepare a monthly progress report for each village and submit it to the Unit Manager. The Unit Manager will compile information on his area and submit it to the district office. The information from such reports will be standardised for use as indicators of the progress of the programme. The instruction flow from the district level and the unit level will follow the proposed organisational structure.

District level planning will be based on the bottom-up planning approach. Each extension worker will prepare his own annual target according to his past performance and other factors. Such a plan will be submitted at the unit level. Each Unit Manager will submit his/her annual target and budget requirements

at the district level. A review session will be organised to review the submitted plans by the extension officers in the light of broad organisational objectives.

SUMMARY AND CONCLUSIONS

The energy situation in Almora District represents a typical case of the Central Himalayan Region of India where the majority of the population is dependant on traditional sources of energy such as fuelwood and agricultural wastes. Commercial sources of energy, among which electricity, kerosene, LPG, and coal are prominent, account for only a small percentage of total energy comsumption.

Lighting is the principal end use of kerosene. Urban households use kerosene also for cooking. Those urban households that have access to electricity use it mainly for lighting. Electricity is also used in some areas for lifting water, irrigation, and drinking water purposes. Only five per cent of the total villages in the district are supplied with electricity. The consumption of coal and LPG is negligible.

The primary source of energy in the district is fuelwood. Fuelwood is sold in urban areas through formal as well as informal marketing systems. The informal marketing system constitutes a large number of villagers who collect fuelwood and sell it in the foothill towns. *Khyoa*- producing industries, the most important type of industry in Almora, consume a substantial volume of fuelwood. For various reasons, forest resources have been exploited at an alarming rate without much attention given to their regeneration. An extensive effort to improve the biomass situation in the district is long overdue.

The strategy for energy development in the district should focus on reducing the biomass energy consumption and on improving the biomass fuel supply in the district. It should also promote rural electrification by extending the electrical grid and expanding the electricity generation capacity.

The existing local institutions such as the *Van Panchayats* provide readily available grassroots' level network for energy planning and management. However, the present organisation and management of *Van Panchayats* are too weak to accomplish the desired level of effectiveness. This is partly due to inadequate support from the district level forest unit. *Van Panchayats* have limited access to the fund generated through the sale of forest products. In addition, the skills of the functionaries of *Van Panchayats* are inadequate for mobilising funds and implementing programmes. Hence, grassroots' level institutions must be strengthened in order to accomplish effective decentralised energy planning and management.

Detailed Calculations of Energy Supply Levels in Almora District

1. *Number of Families and Population in Almora*

	Decennial Growth Rate (%)	Annual Growth Rate (%)*	Number		
			1981	1986	1987
Families	12.58	1.19	151,608	160,846	162,760
Population	16.77	1.56	757,373	818,320	831,086

Note: Decennial growth rate is converted into annual growth rate by assuming compound growth rate.

2. *Electricity Supply*

a) Total domestic consumption of electricity = 12,831,000kWh
Assuming that entire domestic electricity consumption is for lighting'

the annual electricity consumption for lighting per household = 79.77kWh

b) Annual consumption of electricity for drinking water supply = 9,089,549kWh

Annual consumption per capita = 10.9kWh

c) Annual consumption of electricity for irrigation = 343.92kWh

Total irrigated area = 10,280 ha

Annual consumption per ha of irrigated land = 33.46kWh

3. *Firewood Supply*

Average family size = 5.1
Wood allotment per family per month = 200kg
Total fuelwood supply per month = 32,552 tons
Annual per capita supply = 470 kg
Energy per kg of wood = 4,500kcal
Annual energy consumption per capita from firewood = 2,116,800kcal

4. *Coal Supply*

Annual consumption of coal = 550 tons
Since coal is used for space heating during winter months (October-March), we can assume that this consumption is for six months only.

Coal Consumption per day = 3,005 kg
Energy per kg of coal = 4,000 kcal
Energy consumption per day from coal = 1.202×10^7kcal

5. *Kerosene Supply*

Total annual kerosene sale = 5543.6 kl

In the State of Uttar Pradesh 88.7% of the total kerosene consumption is used for lighting and 11.3% is used for cooking. We assume that this consumption pattern holds for Almora District as well.

Total kerosene supply for lighting = 88.7%x5543.6 = 4917.2kl

Total kerosene supply for cooking = 11.3%x5543.6 = 626.4kl

Annual kerosene consumption per household for lighting = 30.2 lt

Energy consumption per household from kerosene used for lighting = 30.2x9100kcal/kgx.83kg/lt = 228,100 kcal

Annual kerosene consumption per capita for cooking= 0.753lt

Energy consumption per capita from kerosene used for cooking= 0.753l/capx9,100kcalx0.83kg/lt = 5,687 kcal

Table 1: Selected Statistics of Almora District by Development Block

Block	Area (Km^2)	No. of Villages	Avg.Area Per Village (sq km)	Population (as in 1981)	Avg. Population Per Village	Population Density (Per sq.km)	Literate Men (%)	Literate Women (%)	Land Under Cultivation (in ha) Rabi	Kharif	Total	Irrigated Area (in ha)	Pump Sets	Fertiliser Consumption (kg/ha)	Cows No.	Buffaloes No.	Electrified Villages (%)
Takula	315	158	1.99	53971	342	171	56	23	4112	7452	11564	1528	5	3.6	23818	10777	74
Dhaula Devi	323	242	0.75	52930	219	164	36	10	4376	6838	11214	1401	-	3.4	21817	9872	36
Bhasiyachanna	376	90	4.20	29736	330	79	47	13	3541	5658	9199	1249	-	4.1	11494	5281	43
Lamgara	213	207	1.03	39205	189	184	42	13	4281	6905	11186	1105	-	5.8	15907	7198	51
Hwalbagh	204	234	0.87	50712	217	249	51	24	4562	6934	11396	1739	14	2.9	21460	9711	91
Kapkot	1416	214	6.62	62301	291	44	51	11	5668	9141	14809	1824	-	3.6	39102	14747	43
Garur	215	189	1.14	49585	262	231	58	17	5392	7007	12399	2074	1	6.9	31827	12003	86
Bageshwar	440	395	1.11	58550	148	133	65	22	5339	7107	12446	2256	5	8.4	38765	14617	37
Chaukhutia	181	171	1.06	47863	280	264	61	24	4794	6927	11721	2256	2	10	20791	8650	70
Tarikhet	234	267	0.88	58746	220	251	63	24	5798	7438	13236	1749	5	3.3	25430	10579	47
Dharahat	307	212	1.45	57109	269	186	60	20	6378	8008	14386	1247	5	3.1	26120	10866	69
Bhikiaren	167	202	0.83	40545	201	243	59	20	4851	7492	12343	1217	4	1.8	19005	7906	69
Syaldeh	244	194	1.26	48369	249	198	58	17	5998	9014	15012	1389	3	2.5	21487	8940	47
Sult	305	258	1.18	57481	223	188	51	13	7248	11014	18262	1258	-	2.3	26943	11222	47

Table 2: Species and Growing Stock, East and West Almora Forest Division

Species (Local/English Name)	Botanical Name	Potential Increment (m^3)	Annual Number of Trees (1000)	Total Volume (1000 m^3)
Chir/Pine	*Pinus roxburghii*	175,020	21,105	13,490
Banj/Oak	*Quercus spp.*	3,570	451	238
Sarai/Himalayan or Bhutanese Cypress	*Cupressus torulosa*	844	65	132
Utis/Alder	*Alnus spp.*	649	97	33
Chamkharik	*Caspinus vimiensa*	643	285	64
Putti/Maple	*Aoer spp.*	388	338	86
Fir/Silver Fir	*Abis/Pindraw*	338	151	202
Pangar/Horse Chestnut	*Aesculus indica*	274	80	45
Kathbhoj/Alder Birch	*Batula alnoides*	128	50	31
Deodara/Himalayan Cedar	*Cedrus deodara*	108	36	23
Samroj/Cherry	*Prunus*	101	179	4
Others		< 100	255	24
Total		182,000	23,072	14,372

Source: Working Plans, East and West Almora Forest Division, 1981.

Table 3: Gross Energy Needs for Different Agroclimatic Zones

	Agroclimatic Zone	Gross Energy Needs kcal/capita/day
1.	Arid	1956 - 3260
2.	Mountainous	11084 - 13040
3.	Dry tropical	3912 - 6520
4.	Permanent agriculture in humid tropical areas	5216 - 7824
5.	Shifting cultivation in humid tropical areas with high population density	6520 - 9120
6.	Shifting cultivation in humid tropical areas with low population density	6520 - 9120

Table 4: Energy Norms from Different Sources

Source	Energy Norms (kcal/capita/day)
NCAER[3]	283
NCAER[4]	265
NSS 32nd round[5]	228
ITES[6]	330
Bowonder[7]	113-567
KVIC[8]	650
Fuelwood study committee[9] of planning commission	685
ABE[10]	620

[3] NCAER, Domestic fuel survey, 1978/79

[4] NCAER, Rural Energy Consumption in North India, 1980

[5] NSS 32nd round, 1983

[6] Institute of Techno-economic Studies (ITES), Rural Energy Consumption in South India, 1981

[7] Dr. Bowonder of the Administrative Staff College of India, Hyderabad

[8] KVIC, Gobar Gas: Why and How, 1975

[9] Fuelwood study committee of the planning commission 1982

[10] ABE, Towards a Perspective on Energy Demand and Supply in India in 2004/05, 1985.

Note: All above figures are quoted by ABE, 1985.

Table 5: Fuelwood Consumption Norms from Different Macro and Micro Studies for Hill Regions

S. No.	Study	Fuelwood (kg/capita/yr)	Equivalent Gross Energy (kcal/capita/day)
1.	NCAER - 1981 (Macro)	239	3111.8
2.	Satsangi - 1983 (Nainital District)	231-897	3006-11673
3.	Agarwal-1980a (Jagaria-H.P.)	2167	28200
4.	Agarwal-1980b (Dharmuchak-Garhwal)	462	6012
5.	Sagar 1981		
	- Chakrate	1116	14523
	- Harrawala	504	6558
	- Kanakundi (Garhwal)	224	2915
6.	Moendi-1985	970	12623
7.	NSS-18th round (Macro)	513	5676
8.	NCAER 1985 (Macro)	294	3831

Source: "Rural Energy Planning for the Indian Himalaya", Kumar and Ahuja; *In Energy Demand and Supply in the Indian Himalaya.* J.P. Painuly, 1986.

Note: Estimated by using a calorific value of 4,750 kcal/kg for fuelwood, same value is taken by ABE, 1985.

Table 6: Population in Electrified and Unelectrified Villages in Different Blocks of Almora District in 1987 and 2001

S.No.	Development Block	Population in Electrified Villages		Population in Unelectrified Villages	
		1987	2001	1987	2001
1.	Takula	53994	66920	5158	6392
2.	Dhaula Devi	56180	70909	2279	2877
3.	Bhasiyachanna	24434	30930	8447	10698
4.	Lamgara	30380	38387	12945	16358
5.	Hwalbagh	38974	50466	17666	22875
6.	Kapkot	48001	62561	21788	28397
7.	Garur	27973	36222	27409	35490
8.	Bageshwar	30739	39198	34194	43603
9.	Chaukhutia	24753	30789	27768	34539
10.	Tarikhet	30023	36830	34060	41783
11.	Dharahat	25805	28999	34206	38441
12.	Bhikiaren	17912	19590	24214	26483
13.	Syaldeh	19326	23474	33219	40349
14.	Sult	21962	25960	39746	46983

Table 7: Number of Households in Electrified and Unelectrified Villages of Almora District in 1987 and 2001

S.No.	Development Block	No. of Households in 1987		No. of Households in 2001	
		Electrified	Unelectrified	Electrified	Unelectrified
1.	Takula	11296	1079	13122	1253
2.	Dhaula Devi	11753	477	13904	564
3.	Bhasiyachanna	5112	1767	6065	2098
4.	Lamgara	6356	2708	7527	3207
5.	Hwalbagh	8154	3696	9895	4485
6.	Kapkot	10042	4558	12267	8397
7.	Garur	5852	5734	7102	5568
8.	Bageshwar	6431	7154	7686	6959
9.	Chaukhutia	5178	5809	6037	8550
10.	Tarikhet	6280	7126	7222	6772
11.	Dharahat	5399	7156	5686	8193
12.	Bhikiaren	3747	5066	3841	5193
13.	Syaldeh	4043	6950	4603	7912
14.	Sult	4595	8315	5090	9212

Table 8: Fuelwood Consumption in Cooking and Space Heating in Different Blocks of Almora District in 1987 and 2001

Block	Consumption in Cooking				Consumption in Space Heating	
	1987		2001			
	Electrified	Unelectrified	Electrified	Unelectrified	1987	2001
	(Thousand Tons)		(Thousand Tons)		(Tons)	(Tons)
Takula	41.18	4.01	51.04	4.97	21.24	25.50
Dhaula Devi	42.85	1.77	54.09	2.23	19.45	25.66
Bhasiyachanna	18.84	6.57	23.59	8.32	10.25	14.48
Lamgara	23.17	10.07	29.28	12.72	14.18	19.04
Hawalbagh	29.73	13.74	38.49	17.8	19.13	25.51
Kapkot	36.61	16.95	47.72	22.09	22.21	31.63
Garur	21.33	21.32	27.63	27.61	18.08	24.94
Bageshwar	23.44	26.6	29.09	33.93	22.02	28.80
Chaukhutia	18.88	21.6	23.48	26.87	17.75	22.72
Tarikhet	22.9	26.5	28.09	32.51	21.71	27.34
Dharahat	19.68	26.61	22.12	29.91	22.30	23.45
Bhikiaren	13.66	18.84	14.94	20.6	16.22	16.02
Syaldeh	14.74	25.85	17.9	31.39	18.34	22.20
Sult	16.75	30.92	19.8	36.56	23.01	25.37
Total	343.56	251.35	427.26	307.51	242.88	332.66

Table 9: Kerosene Consumption in Lighting and Cooking in Different Blocks of Almora District in 1987 and 2001

Block	Consumption in Lighting				Consumption in Cooking	
	1987		2001			
	Electrified Households	Unelectrified Households	Electrified Households	Unelectrified Households	1987 (kl)	2001 (kl)
	(kl)		(kl)			
Takula	226.25	42.40	267.85	50.20	75.05	93.01
Dhaula Devi	211.34	30.70	250.26	36.39	78.09	98.56
Bhasiyachanna	88.86	60.32	105.23	71.40	33.96	42.99
Lamgara	116.06	97.04	137.40	114.91	42.22	53.35
Hawalbagh	153.65	136.68	181.93	161.83	54.17	70.14
Kapkot	178.33	158.82	211.16	188.07	66.72	86.95
Garur	106.58	204.92	126.22	242.66	38.88	50.34
Bageshwar	121.67	265.61	144.07	314.52	42.72	54.48
Chaukhutia	97.62	214.87	101.30	282.51	34.40	42.79
Tarikhet	118.69	264.23	140.53	312.89	41.73	51.19
Dharahat	111.98	291.04	132.50	344.66	35.86	40.30
Bhikiaren	80.50	213.57	95.32	252.90	24.89	27.23
Syaldeh	78.74	265.57	93.23	314.52	26.86	32.62
Sult	95.57	339.38	113.14	401.85	30.52	36.08

Table 10: Electricity Consumption in the Domestic Sector and for Water Supply in Different Blocks of Almora District in 1987 and 2001

Sl. No.	Development Block	Consumption in Domestic Sector		Consumption for Water Supply	
		1987 (Th.kWh)	2001 (Th.kWh)	1987 (Th.kWh)	2001 (Th.kWh)
1.	Takula	871.80	1032.22	587.45	728.08
2.	Dhaula Devi	814.45	964.41	611.23	771.48
3.	Bhasiyachanna	342.45	405.55	265.04	336.51
4.	Lamgara	447.27	529.5	330.53	417.65
5.	Hawalbagh	592.13	701.09	424.03	549.07
6.	Kapkot	687.21	813.73	522.25	680.66
7.	Garur	410.73	486.43	304.34	394.09
8.	Bageshwar	468.88	555.19	334.44	426.47
9.	Chaukhutia	376.19	390.39	269.31	334.98
10.	Tarikhet	457.40	541.55	326.65	400.71
11.	Dharahat	431.15	510.60	280.75	315.50
12.	Bhikiaren	310.22	367.34	194.88	213.13
13.	Syaldeh	303.44	359.23	210.26	255.39
14.	Sult	368.29	436.02	238.94	282.44

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