

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 NCAER¹ and NSS² 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.	<i>Van Panchayat</i> 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. *Khoya*, 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. *Khoya* is produced only during the flush season. Therefore, it was not possible to assess fuelwood consumption in this activity. Two households presently involved in *khoya* 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.