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ENERGY DEMAND PATTERN AND END USES

Overview

Nepal's energy sector is dominated by few resources. Traditional resources, such as fuelwood, agricultural waste, and animal dung, are by far the most important sources of energy, providing about 95 per cent of the total energy consumed. Commercial energy, in which petroleum products, coal, and electricity are prominent, accounts for the remaining five per cent.

The dependence on traditional fuel has obvious implications for the forests. For various reasons (of which energy is only one) forests have been "consumed" at a rate that far exceeds their regeneration. *Between 1964 and 1985, the area of natural forests was reduced by about 570,000 ha or 22,800 ha annually. During the same period reforestation has been only 69,200 ha or 3,295 ha annually ..... at present, the rate of deforestation and degradation are estimated as 44,166 ha/year and the reforestation rate as 4,000 ha/year* (Banskota et al. 1990). The declining forests have led to use of agricultural residue and dung on an enhanced scale, and the use of agricultural residue and dung for energy rather than for their traditional use as plant nutrients has obvious disadvantages.

Currently, approximately 12 per cent of all energy consumption in Nepal is monetised. Fuelwood is now monetised in the towns and is increasingly becoming so in parts of the *Terai*.

The demand for electricity and imported hydrocarbon sources has grown annually at approximate rates of 14 per cent and 7 per cent respectively over the 1980s. The past fluctuations in growth rates of different types of energy demonstrate a sensitivity to the reliability and availability of supply.

The transport and industry sectors rely on a steady supply of imported hydrocarbons. In the foreseeable future, petroleum products and coal will continue to be imported through India. Petroleum and coal import costs have accounted for about 25 per cent to 30 per cent of merchandise export earnings, accounting for as much as 50 per cent in some years. Kerosene, commonly used for lighting in rural areas, is subject to high distribution costs, especially in remote areas.

Hydropower is Nepal's major resource endowment. However, out of a theoretical potential of 83,000 MW, the current installed capacity is only 230 MW. Numerous run-of-the-river and multipurpose hydro schemes have been identified but remain undeveloped. Small and micro-hydro potential remains virtually unused in the hill and mountain areas.

Despite Nepal's small size, only about nine per cent of the population has access to electricity and about half of all domestic connections are concentrated in the Kathmandu Valley.

The per capita consumption of energy was less than 400kg of oil equivalent (KOE) in 1988/89 which is far lower than that of many other countries in the region. The consumption of energy is highest in the domestic sector; being 95 per cent of the total and 24.4 per cent of the commercial energy consumed in the country.

An improvement in Nepal's energy situation is essential for sustainable economic growth and the alleviation of poverty. Investments to expand energy supply is required to meet growing needs. The 1989 trade and transit impasse with India underlined the importance of promoting a self-reliant energy development programme in the long run. Excessive dependence on imported energy has political and economic implications as is commonly observed not only in Nepal but also in other oil importing countries.

Energy Demand Patterns: Current and Projected Trends

The Current Situation

Table 1 provides data on energy demands in different sectors of the economy. During the 1980s there has been an increased consumption of agricultural and animal waste to meet domestic energy needs. This indicates that people in rural areas are finding it difficult to rely solely on the forests to meet their energy needs. The overall demand for energy grew at an annual rate of 7.5 per cent during the 1980s. The growth rate is seen to be highest for animal waste (48.5%) and lowest for fuelwood (4.8%). Commercial energy consumption during this period increased at an annual rate of approximately 8 per cent.

The data gap precludes an analysis of energy demands by sectors in different geographical regions of the country. Nevertheless, it will not be misleading to say that there has been a substitution of fuelwood by agricultural residue in the hills and by animal dung in the *Terai*.

Population growth is one of the main causes of the increasing energy demand in the domestic sector. Growth in the demand for commercial energy has matched the pace of development of the modern industrial sector, transport sector, and other non-agricultural sectors of the economy. Limited use of commercial energy for lighting, has been made in rural areas. In the urban centres, commercial energy is used in the domestic sector to meet different needs such as lighting, heating/cooling, cooking, etc.

A set of *status quo* energy demand projections has been prepared by the Water and Energy Commission Secretariat (WECS) for the five major sectors of the economy: namely, the domestic, industrial, transportation, agricultural, and commercial sectors. The projections were generated from computer-based, end use models. These models simply serve as a basic tool for energy planning and rely on the use of data available from various field surveys and studies initiated by WECS, supplemented by information obtained from HMG ministries and external agencies. Demand/supply profiles were developed by WECS for the base year of 1985.

In 1985/86, the total consumption of energy was 244.5 million gigajoules (GJ) out of which approximately 231 million GJ were used in the domestic sector. The industrial and commercial sector was estimated to have consumed 5.8 million GJ and 4.9 million GJ respectively. For the remaining sectors, the consumption was almost 3 million GJ. Table 2 provides details of energy demand by sectors.

Table 1: Sectoral Energy Demands 1980/81 and 1988/89

	Energy Demand by Type ^000 Tons of Oil Equivalent (TOE)						
Sector	Fuelwood	Agricultural Waste	Animal Waste	Petroleum	Coal Coke	Electricity	Total
Domestic							
1980/81	3110.2	55.2	21.1	31.3		6.8	3224.5
1988/89	4499.8	652.2	497.7	53.8		15.9	5719.4
Industrial							
1980/81	21.8	-		4.9	22.5	4.3	53.5
1988/89	47.6	5.9		8.7	29.3	15.1	115.1
Commercial							
1980/81	9.3			6.7		2.0	18.0
1988/89	14.4			22.0	17.3	2.6	56.3
Transport							
1980/81				69.3	0.7	0.1	70.0
1988/89				105.8	1.1	0.1	107.0
Agricultural							
1980/81				5.2		0.3	5.5
1988/89				7.3		1.2	8.5
Others							
1980/81						0.6	0.6
1988/89						4.7	4.7
Total							
1980/81	3141.3	55.2	21.1	117.3	23.1	14.1	3372.1
1988/89	4561.7	658.1	497.7	197.7	47.7	39.7	6011.1
Annual Growth Rates (%)	4.8	36.3	48.5	6.7	9.5	13.8	7.5

Source: WECS. Energy Balance Sheet of Nepal. 1990.

Note:

1. Figures rounded up to one decimal place. Total may not exactly tally.
2. Due to the trade impasse in 1989, the last three months of 1988/89 show a lower supply of petroleum and coal corresponding to the same period in 1987/88.

Out of the total of 244.5 million GJ consumed in 1985/86, fuelwood supplied 184.5 million GJ of energy. Further, 47.7 million GJ were from agricultural residue and animal dung. Commercial energy, such as petroleum products, electricity, gases, and coal, supplied only about 12 million GJ that year. Details on the share of different energy sources are provided in Table 2.

Projections for 2000 A.D

Demand projections were made for the year 2000 A.D. In these projections, total energy consumption for all sectors of the economy, including the use of traditional and commercial forms of energy, was estimated to rise from about 244 million GJ in the year 1985/86 to 325 million GJ by the year 2000. This works out at two per cent per annum. Since traditional sources play such a large role in the total energy picture and, given that traditional components, especially fuelwood, are becoming scarce, there will be some changes in the relative importance of each energy type. The projections for the domestic sector are provided in Chart 1.

The projections (Table 2 and Table 3) show that the energy demand will increase most rapidly in the agricultural sector (8.5 % annually), followed by the transport sector (5.2% annually), and the industrial sector (5.1% annually). The annual increase in demand in the commercial sector is expected to be about 4.5 per cent annually. The growth rate in demand in the domestic sector is expected to be about 1.7 per annum; the least of all sectors. However, because of its size, the domestic sector will still be consuming about 91 per cent of the total energy consumed in the country by the turn of this century.

The projections show that by 2000 A.D. there will be a relative shift in demand for various energy sources. Fuelwood, which met 75.5 per cent of the demand for energy in 1985/86, is expected to meet only 54.7 per cent of the demand in 2000/2001 A.D. The projections not only show a decline in the share of fuelwood but also show a decrease in absolute terms. Other energy sources show positive growth rates during the period and they range from 3.3. per cent to 8 per cent per annum. Commercial energy sources are expected to contribute 8.4 per cent of the total energy in 2000/2001 compared to 5 per cent in 1988/86.

The major change over the medium-term will be in traditional energy types with fuelwood being increasingly substituted by dung and agricultural wastes, particularly in the *Terai* where the fuelwood deficit is most pronounced. Estimates giving the percentage of the population, whose energy demands will be satisfied sustainably from the forests (assuming that efforts to implement the Forestry Sector Master Plan are successful) were derived as a separate planning exercise by WECS. The results vary by development and physiographic regions but it is believed that, if fuelwood consumption is kept at a sustainable rate, it will be able to meet 64 per cent of the traditional energy demands by the year 2000; a drop from 71 per cent in 1990. WECS estimates that fuelwood met approximately 79 per cent of the demand in the 1985 base year. With the inclusion of supplies from other traditional energy sources, and given the successful distribution of Improved Cooking-Stoves (ICS) and biogas plant installations, about 92 per cent of the population can be served on a sustainable basis by the year 2000; still leaving a deficit. The deficit will be most critical in the *Terai* regions; particularly in the eastern districts.

The projected deficits indicate that there is a need for effective management of the energy sector in order to meet the expected demand by 2000 AD. Energy management has to be planned and implemented on the basis of domestic resource endowments, barring which recourse to large-scale imports of fossil fuels may be required. The capacity of the nation to follow this course is severely limited. Alternative technologies, thus, assume a far greater significance than they have so far been accorded, as these technologies, if promoted and implemented properly, have the potential to meet the demand for rural energy.

Table 2: Sectoral Energy Demand Projections

(in 10^6 GJ)

Sector	1985/86	%	2000/01	%	Average Growth % Over Period
Domestic	230.8	94.4	296.0	91.1	1.7
Industrial	5.8	2.4	12.3	3.8	5.1
Commercial	2.6	1.1	5.0	1.5	4.5
Agricultural	0.3	0.1	1.1	0.3	8.5
Transportation	4.9	2.0	10.5	3.2	5.2
Total	244.5	100.0	324.9	100.0	1.9

Source: WECS. Energy Issues and Options and the Eighth Five Year Plan. 1989.

Table 3: Total Energy Demand Projected by Source of Energy

(in 10^6 GJ)

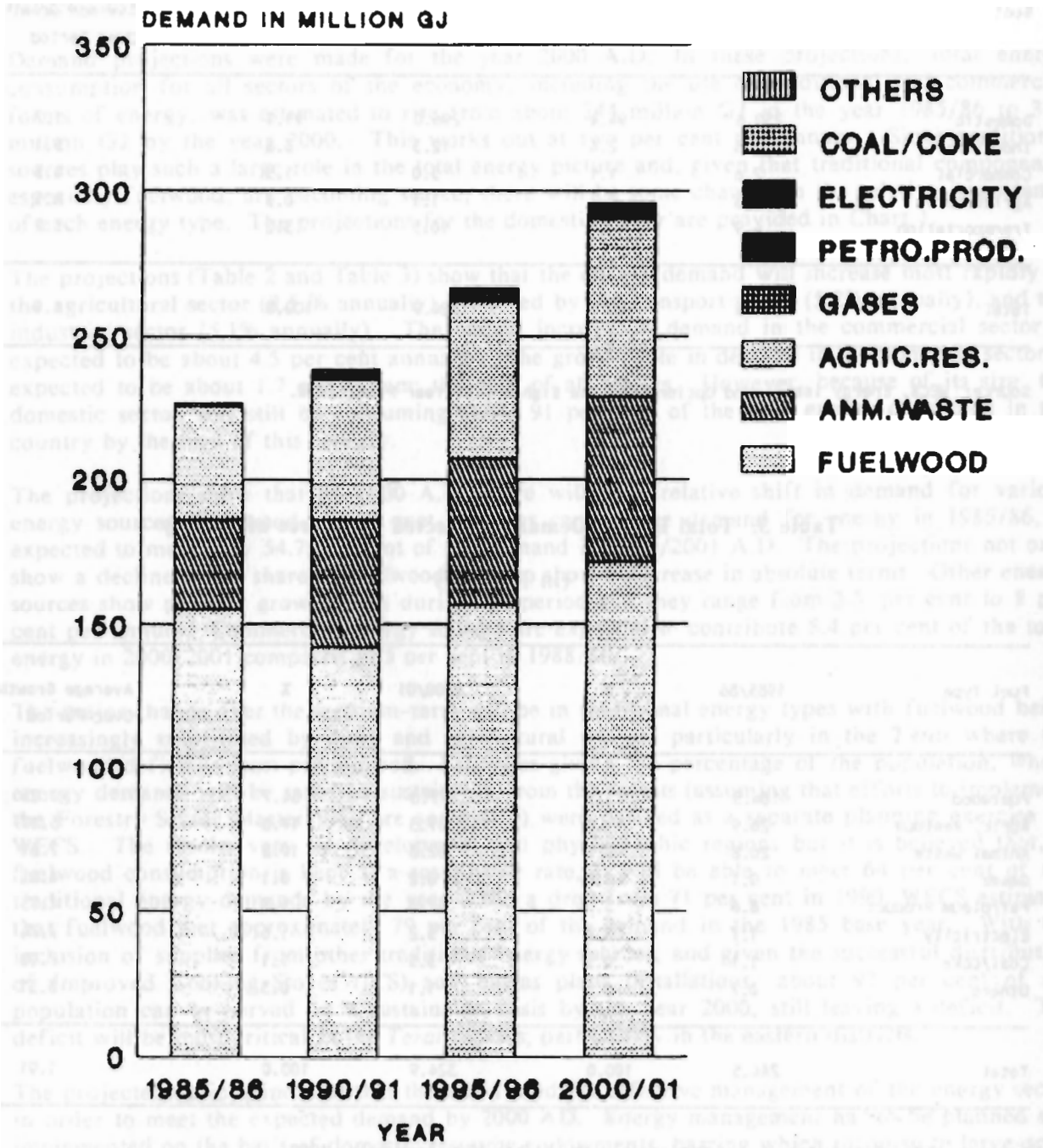
Fuel Type	1985/86	%	2000/01	%	Average Growth % Over Period
Fuelwood	184.5	75.5	177.8	54.7	-0.25
Agric. Residue	26.9	11.0	57.3	17.6	5.17
Animal Waste	20.8	8.5	62.3	19.2	7.61
Gases	0.1	0.0	0.2	0.1	4.03
Petroleum Product	8.6	3.5	17.3	5.3	4.75
Electricity	1.7	0.7	5.2	1.6	7.74
Coal/Coke	1.1	0.5	3.5	1.1	7.98
Others	0.7	0.3	1.1	0.3	3.31
Total	244.5	100.0	324.9	100.0	1.91

Source: WECS. Energy Issues and Options and the Eighth Five Year Plan. 1989.

Note: Total may not add up due to rounding.

CHART 1

DOMESTIC SECTOR
ENERGY DEMAND PROJECTION



Source: Nepal Oil Corporation, 1988.

Over the longer term, and assuming that the Forestry Sector Master Plan Programmes are implemented and begin to yield satisfactory results, the proportional share of fuelwood will increase again (HMG/N, FINNIDA, and ADB 1988). The share of commercial energy in the total national energy demand profile will grow marginally, although the significance of commercial energy use in terms of foreign exchange expenditure will remain high. If the measures to launch afforestation programmes, outlined in the Forestry Master Plan, are not implemented immediately, a much higher level of commercial energy consumption can be expected. The domestic sector, which now accounts for about 94 per cent of the total energy consumption, will be reduced to about 91 per cent of the total consumption while the industrial, transport, commercial, and agricultural sectors will grow at a faster rate and account for the balance.

Sectoral End Uses and Projections

It is important to know the end-use specificity of various energy types as well as end use specificity by sector. This information indicates to what extent one form of energy can substitute another in use in various sectors of the economy. A relatively high end use specificity indicates difficulties in substituting one form of energy by another. Planning implications in such cases are that the relative importance of each form remains more or less at the same level over a certain period of time. The energy sector in Nepal gives the following picture.

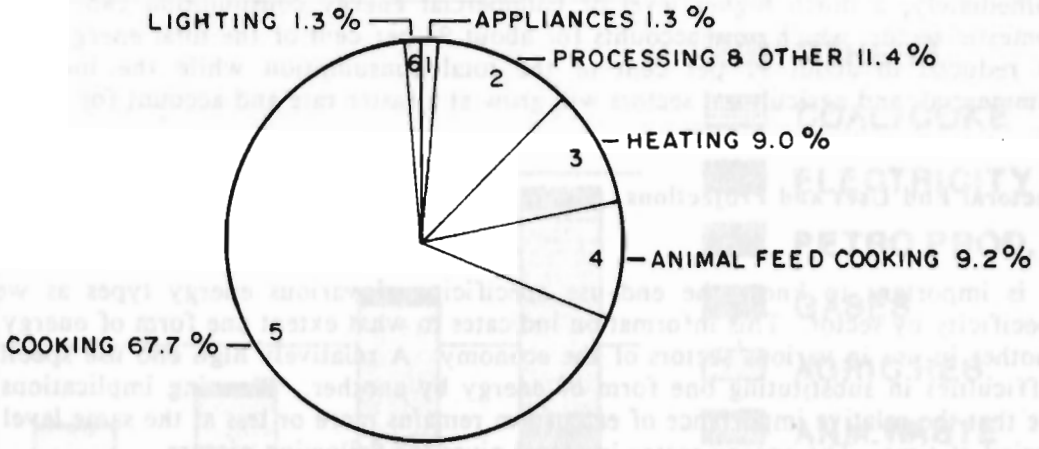
Domestic Sector

The domestic sector, which consumes nearly 95 per cent of the energy, relies mainly on traditional energy sources. This is mostly non-monetised consumption. Commercial energy use includes petroleum products, electricity, and fuelwood that is purchased for cash. Commercial energy use accounts for about five per cent of the total domestic energy use and, perhaps more significantly, for about 26 per cent of the consumption of petroleum products, mostly kerosene, for cooking and rural lighting.

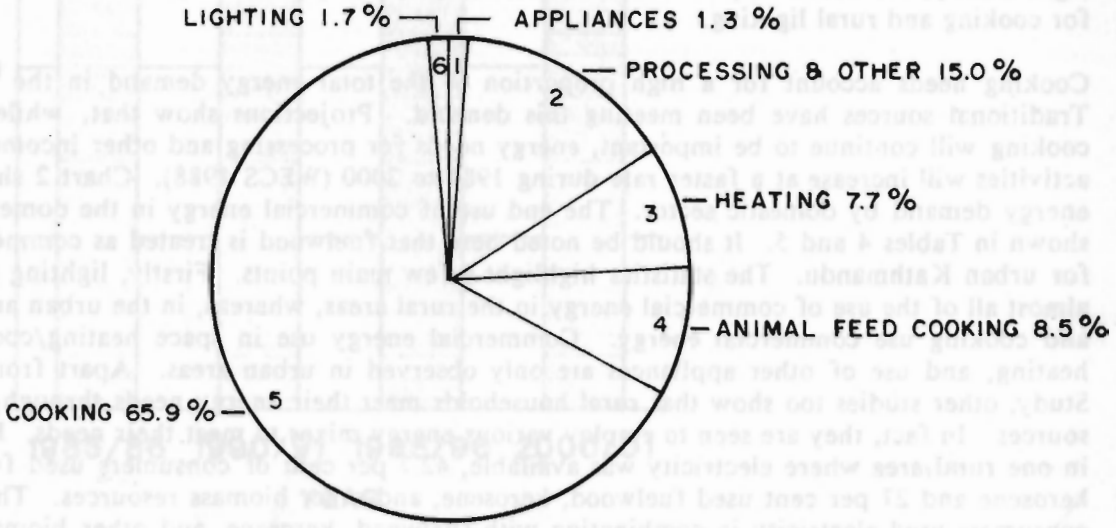
Cooking needs account for a high proportion of the total energy demand in the rural sector. Traditional sources have been meeting this demand. Projections show that, while energy for cooking will continue to be important, energy needs for processing and other income-generating activities will increase at a faster rate during 1985 to 2000 (WECS 1988). Chart 2 shows end use energy demand by domestic sector. The end use of commercial energy in the domestic sector is shown in Tables 4 and 5. It should be noted here that fuelwood is treated as commercial energy for urban Kathmandu. The statistics highlight a few main points. Firstly, lighting accounts for almost all of the use of commercial energy in the rural areas, whereas, in the urban areas, lighting and cooking use commercial energy. Commercial energy use in space heating/cooking, water heating, and use of other appliances are only observed in urban areas. Apart from the WECS Study, other studies too show that rural households meet their energy needs through a variety of sources. In fact, they are seen to employ various energy mixes to meet their needs. For example, in one rural area where electricity was available, 42.7 per cent of consumers used fuelwood and kerosene and 27 per cent used fuelwood, kerosene, and other biomass resources. The rest of the consumers used electricity in combination with fuelwood, kerosene, and other biomass resources (Sharma 1988). The same study reports the use of commercial energy to be at a very low level. In the urban context also, the study conducted in urban Kathmandu indicates that domestic energy needs are satisfied by a combination of traditional and commercial energy mixes. There are very

CHART 2

DOMESTIC SECTOR
END USE ENERGY DEMAND
1985



END USE ENERGY DEMAND
2000



Source: Nepal Oil Corporation, 1988

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In the rural areas, *the cost of using fuelwood (measured by a proxy variable-time taken) has clearly increased in the last 5 years. Almost two-thirds of the sample households reported more than 6 hours as [a] fuelwood collection time per day* (Sharma 1988). Almost 75 per cent of the households reported an increase in fuelwood collection time.

Other Sectoral Demands

The industrial sector (1.9%), the transport sector (2%), the commercial sector (1.1%), and the agricultural sector (0.1%) are the other principal consumers of energy. The industrial sector uses about eight per cent of all petroleum products consumed in Nepal. The industrial energy demand increased by 41 per cent between 1974/75 and 1984/85 and is expected to grow at a rate of around five per cent annually until 2000 A.D. (WECS 1989). In the industrial sector, fuelwood still accounts for the highest share of the energy demand (about 51%), followed by coal/coke (20%), furnace oil (9 %), electricity (7 %), charcoal (6 %), agricultural residue (3 %), diesel (3 %), biogas (1 %), and kerosene (0.7%). The energy intensity of the sector is increasing (UNDP-ESCAP 1987) and is likely to continue to do so in the future (Banskota et al. 1990).

The transport sector uses about 53 per cent of imported petroleum energy and the demand is expected to increase at a rate of 5.2 per cent during the 1990s (WECS 1984).

The agricultural sector at the moment consumes very little of commercial energy but the demand in this sector is expected to increase at a rate of 8.5 per cent annually. Shallow tubewells, estimated to number about 17,000 in 1988, lift irrigation units, and tractors account for the use of energy in the agricultural sector.

Details of energy consumption in all these sectors are provided in the Annexes.

Table 4: Commercial Use of Energy in the Domestic Sector By End Use

(Estimates for 1988)

	Energy GJ (000s)		As % of Total Commercial Energy Use in Domestic	
	Rural[2]	Urban[1]	Rural	Urban
End Use				
Cooking		948	-	31.8
Lighting	1,260	552	42	18.4
Others				
- Space Heating/Cooling	-	77		2.6
- Appliances	-	156		5.2
- Water heating	-	3		-
Total	1,260	1,736	42	58

Source: WECS, June 1989.

Table 5: Distribution of Commercial Energy Demand in the Domestic Sector by Fuel Type

	% Kathmandu	% All Urban
Fuelwood	42	74.0
Kerosene	33	15.4
Electricity	14	7.6
LPG	5	1.5
Others	6	1.5
Total	100	100

Source: WECS. *Energy Issues and Options and the Eighth Five Year Plan.* 1989.

Note: Assumes that 65% of fuelwood consumed in urban areas, other than in Kathmandu, is monetised consumption.