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WOODFUEL FLOW STUDY OF PHNOM PENH, CAMBODIA

Prepared by the Woodfuel Flow Study Team

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Bangkok, December 1998

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FOREWORD

Cambodia joined RWEDP as a member country in 1996. Its membership was welcomed as wood is by far the largest energy source in the country and its per capita consumption of wood energy is amongst the highest in Asia. The important roles of wood energy in terms of energy supply, the economy and rural income generation have become well recognised by the government.

Since 1996 the country has organised four national workshops on wood energy development with support and advice from RWEDP. These activities have focused on improved stoves, wood energy planning, gender aspects of wood energy, and natural resource management in the Tonle Sap area. Case studies on data collection and area-based planning are also currently being prepared and more national activities are in the planning stages. Furthermore, delegates from Cambodia have actively participated in regional RWEDP consultations and training courses.

The unique features of woodfuels mean that any policies and interventions aimed at developing wood energy must, in order to be effective, be suited to local conditions and be based on a thorough understanding of local woodfuel flows (RWEDP's Report No.30 on Wood Fuel Flows (1996) gives an overview of four highly relevant studies which readers may find illuminating). The current study on woodfuel flows in Phnom Penh by a team of Cambodian researchers, with support from three international agencies, focuses on an urban market. The results add to our understanding of the situation in Phnom Penh and these and the methodologies used may also be relevant for other countries.

Many thanks are due to the study team for their excellent work under difficult circumstances, and to the project advisor for her advice and support.

I would also like to take this opportunity to thank the Cambodian ministries and the various counterpart agencies in Cambodia for their enthusiastic cooperation and the FAO representative in Cambodia who provided valuable assistance and advice.

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Staff at checkpoints around Phnom Penh and forestry officials in the provinces who joined the team in the rural areas.

CARE
National Institute of Statistics

SUMMARY

This report presents the results of a six-month inter-ministerial study of woodfuel flows into Phnom Penh. The study was initiated by the Cambodian Environmental Management Program, and the study team was drawn from the Ministry of Environment, Ministry of Agriculture, Forestry and Fisheries (Department of Forestry) and Ministry of Industry, Mines and Energy (Department of Energy).

The study highlights the importance of wood energy in government policy formulation and provides an overview of the urban market structure and the main supply areas.

Woodfuels are the most commonly used energy sources for the majority of the population in Cambodia. In Phnom Penh, the country's economic centre, 84% of households rely on firewood and charcoal as their main energy sources for cooking, and these energy forms are also used extensively by industries and services. Fuel switches to liquid petroleum gas (LPG) are observed in wealthier households, but the majority of the city's population is found in low-income households. Population growth is, therefore, likely to be highest in this sector, and it is unlikely that the demand for wood energy will decrease in the foreseeable future because it is cheap and can be bought in small quantities.

The woodfuel flow system is unregulated, informal and complex, and the urban traders provide an important link between suppliers and consumers, both within Phnom Penh and in the surrounding forest-poor provinces.

The provision of wood energy is often associated with forest loss. Although not always the main cause, demands for woodfuels by the commercial markets in Phnom Penh contribute to forest loss and degradation. Firewood and charcoal are renewable and indigenous sources of energy and require integration into forest and energy planning processes.

UNITS AND CONVERSIONS

Traditional Units

Kampong Speu
- firewood - metre, bundle
  - 1 metre = 1m x 1m x 0.5m
  - 1 bundle = 10cm x 10cm x 50cm (4 sticks)
- charcoal - sack, kg
  - 1 sack = 55 kg

Kampong Chnang and Pursat
- firewood - hand
  - 1 hand = 3 split logs
- charcoal - sack, kg
  - 1 sack = 55 kg

Kampong Thom
- charcoal - sack, kg
  - 1 sack = 55 kg

Kratie
- firewood - bundle
  - 1 bundle = 15cm x 15cm x 50cm (3 sticks)
- charcoal - sack, kg
  - 1 sack = 60 kg

Phnom Penh Markets
- firewood - stere, metre, bundle
  - 1 stere = 1 metre = 1m x 1m x approximately 0.5m
  - 1 bundle = 15cm x 15cm x 50cm (sawmill)
    - 12cm x 12cm x 32cm
    - 10cm x 10cm x 32cm
    - 8cm x 8cm x 36cm
    - 7cm x 7cm x 36cm
    - 6cm x 6cm x 32cm
- charcoal - sack, kg
  - 1 sack - weight depends on place of origin (55 or 60 kg)

Conventional Units

firewood - stere, cubic metre
1 stere = 1m x 1m x 1m (stacked wood)
1 cubic metre = 1m x 1m x 1m (solid wood)
charcoal -ton, kg

Conversions

US$1 = 2,500 Reils
1 conventional stere = 2 traditional steres or metres
1 stere of firewood produces approximately 2.5 sacks of charcoal
(this is a general estimation from charcoal producers in all the study areas)
1 stere of firewood produces approximately 795 bundles
1 stere of firewood = 600kg (MIME, 1996a)

heating values (adopted from MIME, 1996a)
1 kg firewood = 14.5 MJ
1 kg charcoal = 29 MJ
1 kg LPG = 45.26 MJ
1 kWh electricity = 3.6 MJ

carrying capacities

	firewood (stere)	charcoal (ton)
moto-cart	2.25	0.8
car	1.25	0.6
pickup	2.5	0.8
truck	7.5	2.4
train	222	5.5
boat	150	40

Note: values in tables may not add up due to rounding off.

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1. INTRODUCTION

Woodfuels are the most common sources of energy for the majority of the population in the Kingdom of Cambodia. Firewood and charcoal are often referred to as traditional fuels, yet they remain the dominant source of energy for cooking within the domestic sector, and are used extensively by industry and services.

Cambodia is a predominantly rural society, although the urban areas are the regions of most rapid growth. Data from the National Institute of Statistics (1997) show that 97.7% of the population of Cambodia uses wood energy for household cooking.

Phnom Penh is the economic centre of Cambodia. The city is divided into 7 districts with a total population of approximately 796,939, or 150,280 households, and an average density of 14,480 per square kilometer. Within Phnom Penh, 84% of households rely on woodfuels as their main source of energy for cooking (NIS, 1997). In 1995, firewood and charcoal were estimated to account for over half of the energy sources in Phnom Penh (MIME, 1996a).

As the country's economic centre, it is likely that increased incomes in Phnom Penh will lead to an increased demand for more conventional fuels such as LPG and electricity. Switches from wood energy to LPG have been observed within high-income households, although the overall demand for woodfuels is unlikely to decrease in the foreseeable future due to the increased population. Energy transitions are limited by financial and spatial constraints, and the majority of the population of Phnom Penh are low-income households.

The provision of wood energy is often associated with forest loss. Although not the main cause of primary forest loss, the demand for woodfuels in Phnom Penh contributes to forest loss and degradation. The urban centre is supplied with wood energy from forests as distant as Kratie (approximately 220 km). Unregulated forest cutting has adverse environmental impacts and the inhabitants of the supply areas have already experienced some of these.

The demand for wood energy in urban areas is of concern to relevant government departments, but in order to form and implement appropriate policies for the wood energy sector, it is important to have good information.

In view of the lack of reliable information in Cambodia, the Cambodian Environmental Management Program (CEMP), with financial support from USAID, initiated a small study project to gain an overview of the wood energy flow system in Phnom Penh. The data analysis and report writing stages of the project were supported by the International Development Research Centre of Canada (IDRC) and the Environmental Technical Advisory Programme of the United Nations Development Programme (UNDP/ETAP).

The study is an inter-ministerial one, involving the participation of the Ministry of Environment, the Ministry of Industry, Mines and Energy (Department of Energy) and the Ministry of Agriculture, Forestry and Fisheries (Department of Forestry).

The objectives of the project are:

- to describe the woodfuel distribution system, including market structures, resource flows, woodfuel types, volume estimates and prices
- to outline the social and economic aspects of energy use, particularly in the residential sector
- to promote the incorporation of wood energy analysis into relevant policy-related initiatives
- to establish and demonstrate a capacity for wood energy research and policy analysis in key government agencies.

Activities conducted to obtain the information include:

- interviews with wood energy traders in Phnom Penh
- discussions with traders at destinations outside Phnom Penh
- observation at checkpoints at the municipal boundary of Phnom Penh
- visits to brick kilns
- research in the main supply areas.

Due to the informality of the urban market, it was difficult to establish a research methodology, so traders were selected for interviews following observation tours of the main depot areas. A detailed questionnaire was prepared for traders, transporters and customers, which was field tested before the data collection began. The project was to provide a broad overview rather than a detailed assessment, so this methodology was quite efficient. Focusing on the main traders soon revealed the forward and backward links to customers and suppliers, enabling the team to quickly recognise the complexities of the distribution system, and to gain an idea of the main supply areas. The supply areas were confirmed by surveys at Department of Forestry checkpoints on the major roads into Phnom Penh, as well as on the River Mekong.

Areas which supply wood energy are Kratie, Kampong Thom, Kampong Chhnang, Kampong Speu and Pursat. Areas selected for study were determined by the proximity of the supply area to the provincial town, and security in the area of study. Therefore, Kratie, Kampong Thom and Kampong Speu were selected.

In the supply areas, a less formal approach was taken, with information gained through discussions with members of the communities. Commune and village chiefs were interviewed initially to gain background information about the area, and then individual charcoal producers and traders, firewood collectors and transporters were interviewed to gain more specific information regarding the amounts traded, sources of wood, destination of product, prices, etc.

The vast majority of woodfuels coming into Phnom Penh are consumed in the town, but onward destinations include Takhmao, Prey Veng and Svay Rieng, indicating Phnom Penh's role as a trading centre.

The information given in this report relates to a short study conducted during the dry season. The volumes traded vary depending on the season, many traders are temporary, and there appears to be no consistent pattern of buying and selling in Phnom Penh. Accurate figures concerning the quantity and value of the trade and forest loss are difficult to determine. Figures given for the supply areas relate to the study areas only and therefore they are likely to be low, as woodfuels are supplied additionally from other areas in the five provinces. However, these figures are used in conjunction with those obtained at the checkpoints. These too are slightly

unreliable as the study was undertaken during 12 hour periods in the daytime whereas some transporters reported travelling at night. The associated forest loss is also difficult to assess because fuel supply is not always the main reason for cutting trees, there is no forest inventory, and insecurity prevents detailed study in the forested areas.

The next chapter of this report identifies consumption trends and is based on a study of secondary information from the National Institute of Statistics (1995 and 1997), and the Department of Energy (MIME 1996b and 1996c). Chapter 3 provides an overview of the rural study areas with an assessment of the amounts of wood energy supplied from each area and highlights the differences between the communities in the different areas. In Chapter 4, the urban market structures are described showing the complexities of the flow system and giving estimates of volumes of firewood and charcoal entering Phnom Penh. The socio-economic issues in Chapter 5 illustrate the constraints on fuel switching and therefore, the continuing demand for woodfuels, particularly in the short term. Chapter 6 outlines the environmental impacts of the current unsustainable supply of wood energy and a consideration of those relating to alternate energy forms. An examination of current policies concerning wood energy is outlined in Chapter 7 and conclusions and recommendations are given in Chapter 8. All wood energy figures are stated in conventional units.

2. CONSUMPTION OF WOOD ENERGY

The Kingdom of Cambodia is a poor country with low living standards for the majority of the population. Throughout the country woodfuels are the most widely used sources of energy and contribute 85% of the total energy consumption (including the transport sector) (MIME 1996a). In Phnom Penh 84% of households use firewood and charcoal as their main fuel for cooking (NIS 1997), although some households use agricultural residues and others use LPG. Woodfuels are also used extensively by the industry, handicrafts and services sectors. Firewood and charcoal consumption in Phnom Penh in 1995 was estimated to account for 59% of total energy consumption (excluding transport) (MIME 1996a).

2.1 Population Statistics

The population of the Kingdom of Cambodia is predominantly a rural one. The Socio Economic Survey of Cambodia (SESC) estimated a national population for 1996 of 10.3 million (NIS, 1997), of which only 8% live in Phnom Penh. The SESC shows an annual national increase of 2.4% between 1994 to 1996. However, urban areas grew much more quickly: Phnom Penh, for example, showed an annual increase of 5.5%.

Due to the loss of records during the 1970s, and the subsequent lack of any population census, statistics from different sources give varying estimates of population for Phnom Penh as follows:

- Population register from police statistics, 1993	690,928 people	117,794 families
- Socio-Economic Survey, 1993/4	717,300 people	121,100 families
- Estimates from the Department of Forestry, 1994	784,984 people	139,215 families
- Estimates from the Department of Energy, 1996		132,000 families
- Socio-Economic Survey, 1996	796,936 people	150,280 families

This study will adopt the figures from the Socio-Economic Survey 1993/4 and 1996, as these two studies employed similar methodological techniques.

2.2 Wood Energy Consumption in Households

The National Institute of Statistics (1997) gives the following figures for domestic fuel use in Phnom Penh for 1996:

Table 1: Domestic Energy Consumption in Phnom Penh by Main Fuel Used for Cooking

Fuel Type	No. of Households	No. of People	Percentage of Households
Firewood	69,880	370,575	46.5
Charcoal	56,355	298,851	37.5
LPG	14,427	76,506	9.6
Kerosene	7,965	42,238	5.3
Electricity	150	797	0.2
Other	1,503	7,969	0.9
Total	150,280	796,936	100

Source: NIS/ADB, 1997

2.2.1 Firewood

During the study, people using firewood as their main energy source for cooking gave the following information:

Table 2 : Daily Firewood Consumption

Place of Interview	Household Size	Bundles/Day
Boueng Salang	6	4.5
Toekloak	4	4
O'Russei	5	3
Toul Tom Pong	5	2.17
Chhbar Ampeou	9	11.66
Chhbar Ampeou	4	3.67
Chhbar Ampeou	5	3.3
Chhbar Ampeou	12	5
TOTAL	50	37.3

This suggests that the average amount of firewood consumed per person is**:**

37.3 bundles/50 people = 0.75 bundles = 0.00093 steres per day.

According to the National Institute of Statistics (1997), the percentage of households using firewood as their main cooking fuel was 46.5%. This means that 69,880 households in Phnom Penh, or 370,575 people use firewood. Using the consumption figure indicated above, annual demand from households using mainly firewood for cooking is therefore 125,791 steres. The estimated demand by the Department of Energy (MIME, 1996b) for 1997 was 87,356 steres.

2.2.2 Charcoal

During the study, people using charcoal as their main cooking fuel gave the following information:

Table 3 : Daily Charcoal Consumption

Place of Interview	Household Size	Amount Used (kg)
Wat Phnom	4	1.83
Russei Keo	4	1.83
Psa Silop	6	1.5
O'Russei	6	1.33
Bodeng	5	1.66
Wat Mohamontrey	4	2.5
Wat Ko	6	1.83
Olympic	4	1.17
Bodeng	4	1.33
Chhbar Ampeou	8	2.5
Toul Tom Pong	5	1.83
TOTAL	54	19.31

This total suggests that the average consumption of charcoal per person is**:**

19.3 kg/54 people = 0.36 kg per day.

In 1996, 56,355 households consisting of 298,851 people or 37% of the population (NIS, 1997), used charcoal as their main cooking fuel. Using the average consumption figure indicated above, the annual consumption is 38,986 tonnes. The estimated annual consumption for 1997 was 21,862 tonnes (MIME, 1996b).

2.3 Wood Energy Consumption in Industry and Services

The Department of Energy estimated that in Phnom Penh the service sector would consume 7%, and the industrial sector 12% of the wood energy supplied to the city in 1997 as follows:

	Services	**Industry**
Firewood (steres)	345	22,287
Charcoal (tonnes)	3,966	276

Source: MIME, 1996

A full survey of this sector was outside the scope of the Wood Energy Study. However, as it became clear that brick kilns are huge consumers of wood, an overview is given below.

2.3.1 Brick Kilns

There are many brick and tile kilns operating in Phnom Penh to supply the construction industry. These kilns are usually of the 'boat shaped' variety because they can produce bricks faster than other types of kiln. The brick kilns consume mixed types of firewood, from natural forests, flooded forests, rubber plantations and sawmills, especially Kasotim (at Nhek Leoung) and Kolexim (at Prey Preou). As Phnom Penh has no forest areas all the firewood has to be brought from outside the area.

There are 71 brick kilns in Phnom Penh, 63 in Russei Keo, 4 in Meanchay and 4 in Dangkor. In these 71 kilns, 50% use wood from the natural forests and the others use firewood from sawmills, rubber plantations and flooded forest. Each kiln measuring 2.7m x 16m x 2.7m, consumes 30 steres of wood from natural forests, or 50-60 steres of wood from flooded forests, rubber plantations and sawmills. Each kiln can produce bricks or tiles twice per month, but this depends on the demands of the market, so most kilns produce only once a month. The annual consumption of firewood is therefore:

35 kilns x 30 steres x 12 cycles = 12,600 steres
36 kilns x 55 steres x 12 cycle = 23,760 steres

giving a total of 36,360 steres per year.

Table 4 shows the annual total quantity of firewood consumed in kilns in Phnom Penh to be 51,143 steres.

Table 4 : Quantity of Firewood Consumed by Kilns in Phnom Penh

Kiln Type	**Number of Kilns**		**Average Firewood Use Per Kiln *(stere)***		**Cycles per Year**	**Firewood Use Per Year *(stere)***		
	Firewood	Electric	Natural Forest	Other		Natural Forest	Other	Total
Brick	71	-	30	55	12	12,600	23,760	36,360
Cake	39	-	0.5	-	365	7,118	-	7,118
Bread	30	12	0.7	-	365	7,665	-	7,665
Total	140	12				27,383	23,760	51,143

2.3.2 Bakeries

There are more bakeries in Phnom Penh than in other provinces in the Kingdom of Cambodia. Bakeries are of 2 types:

- **Cake Bakeries**

There are 39 of this type which use small ovens, and the average consumption of firewood for each is 0.5 steres per day. Firewood used is purchased from stores in Phnom Penh. The annual consumption of firewood is**:**

39 bakeries x 0.5 steres x 365 days = 7,118 steres.

- **Bread Bakeries**

There are 42 bakeries in Phnom Penh of which 12 are powered by electricity and 30 by firewood. Bakeries have the capacity to produce many times each day, but for this study a production of 1 cycle per day was used. The annual consumption of firewood is**:**

30 bakeries x 0.7 steres x 365 days = 7,665 steres.

2.4 Destinations Outside Phnom Penh

The study showed Phnom Penh to be developing as a trading centre for woodfuels consumed in Kandal, Prey Veng and Svay Reing (see Table 5).

2.4.1 Firewood

According to the study, there are 13 firewood stores in Takhmao town, which sell on average**:**

26 bundles x 13 stores x 365 days
= 123,370 bundles or 155 steres per year.

Information from other sections of the study shows that**:**

3,285 steres are transported annually from Kampong Speu
4,015 steres are transported annually from Pochentong
155 steres are transported annually from other depots in Phnom Penh.

2.4.2 Charcoal

Takhmao

According to the study at Takhmao, one depot among 13 purchases from Phnom Penh, and the other 12 depots from Chhbar Ampeou. The average quantity of charcoal purchased from Phnom Penh per year is:

1 sack x 365 days = 365 sacks = 20 tonnes

The quantity of charcoal purchased from Chhbar Ampeou per year is**:**

3.67 sacks x 12 depots x 365 days = 16,075 sacks = 965 tonnes

The total quantity sold in Takhmao each year is**:**

16,440 sacks = 985 tonnes.

Nhek Leoung

The study showed that at Nhek Leoung, there are 12 charcoal depots on the eastern bank of the river, of which one purchases charcoal from Chhbar Ampeou. The average annual purchase of this depot is:

5.33 sacks x 365 days = 1,945 sacks = 117 tonnes

There are an additional 6 charcoal depots in the western part of Nhek Leoung which purchase charcoal from Chhbar Ampeou, and their annual purchases total:

0.61 x 6 depots x 365 days = 1,336 sacks = 80 tonnes.

Therefore, the total quantity of charcoal transported annually to Nhek Leoung is:

1,945 sacks + 1,336 sacks = 3,281 sacks = 197 tonnes.

Table 5 : Wood Energy Traded Through Phnom Penh

Location	Quantity of Firewood			Quantity of Charcoal		
	stere/day	*stere/month*	*stere/year*	*ton/day*	*ton/month*	*ton/year*
Takhmao	20.4	621	7,455	2.70	82	984
Nhek Leoung	-	-	-	0.54	16	197
TOTAL	20.4	621	7,455	3.24	97	1,181

2.5 Consumption of Other Forms of Energy

2.5.1 Liquid Petroluem Gas (LPG)

As the country improves its economy, the population and their living standards are likely to increase, especially in Phnom Penh. Raised incomes will allow some households to switch to LPG for cooking. LPG is also increasingly used by services such as restaurants. All LPG is imported into Cambodia, by three companies:

- Cambodia Gas Company who import from Thailand
- Uni Gas Company who import from Thailand
- Mittapheap Gas Company who import from Vietnam

It was found that these companies sell to depots in Phnom Penh for resale, so it was not possible to determine the amount sold for domestic use only. Overall, their monthly sales are:

- Cambodia Gas Company - 100 tonnes
- Uni Gas Company - 130 tonnes
- Mittapheap Gas Company - 120 tonnes

This gives a total of 350 tonnes per month, or 4,200 tonnes per year. As the study reached finalisation, another company, Totalgaz, began trading in Phnom Penh.

- **Household LPG Consumption**

According to the study, people using LPG gave the following information:

Table 6 : Monthly LPG Consumption

Name of Family	Household Size	Amount Used per Month (kg)
Psa Thmei trader	7	15
O'Russei trader	6	13
Ing Thoeng	12	23
Chea Sophea	7	30
Soum Bunthein	5	15
So Somali	11	27
Hang Bannak	5	15
Kim Seng	10	24
Ouk Heil	4	12
TOTAL	67	174

The average amount of LPG consumed by each person is**:**

174 kg/30 days x 1/67 people = 0.0865 kg per day

In 1996, 14,427 households (9.6%), or 76,506 people used LPG as their main cooking fuel (NIS 1997). Using the consumption figures above, this implies an annual consumption of 2,417 tonnes. This figure is quite close to the Department of Energy's 1997 estimate of 2,276 tonnes (MIME, 1996b).

- **Industrial and Service Sector LPG Demand**

The Department of Energy gives the following figures for LPG consumption in 1997**:**

	Terajoules	**Tonnes**
Services	118	2,607
Industry	0	0

2.5.2 Consumption of Agricultural Residues

In Cambodia, the majority of the population are farmers, and their products provide important supplies for the people of Phnom Penh. Phnom Penh generates a lot of waste, although some can be used as fuel, such as coconut husk, crushed sugar cane (bagasse), rice husks etc. Some households in Bakheng use these fuels. In other areas, sellers of sugar cane, rice and sweetcorn keep the waste for their own domestic use. Some people use sawdust from sawmills and wood processing companies for domestic use.

2.6 Estimates of Future Domestic Consumption

A comparison of energy demand forecasts by MIME and those based on more recent NIS figures illustrate the difficulties involved in planning for future energy demand, particularly in the absence of past consumption and population growth trends. The figures shown in Table 7 relate to households using a particular energy source as their main form of energy for cooking. In reality however, most households use more than one form of energy, so the figures are likely to be underestimated.

The table shows that in 1996, the estimated demand by households was approximately 87,816 steres of firewood and 21,310 tonnes of charcoal per year (MIME). In comparison, the wood energy flow study shows approximately 125,792 steres of firewood and 39,006 tonnes of charcoal. A comparison of forecasts for 1998, also shows different figures. Those of MIME are based on a per capita daily consumption of 0.37 kg for firewood and 0.196 kg for charcoal. Forecasts by the WFFS team, based on the household breakdown from NIS (1997) and from the study findings, use a per capita daily consumption of 0.56 kg for firewood and 0.36 kg charcoal.

Based on NIS (1995) data, MIME forecasted a population growth rate of 4.4% per year, with a constant household size of 5.923. In fact, the population grew at 11.1% over the 2 year period to 1996, and household size reduced from 5.9 to 5.3 (NIS, 1997).

Table 7 shows that the demand for firewood is decreasing but demands for charcoal, LPG and kerosene are increasing. The wood energy study found an energy transition from woodfuels to LPG by wealthier households, but the above figures also suggest a transition from firewood to charcoal, which indicates that the demand for wood energy will continue into the future.

Table 7 : Estimated Annual Domestic Energy Consumption

Year	Source		Firewood *(stere)*	Charcoal *(ton)*	Gas *(ton)*	Kerosene *(ton)*	Other
1994	MIME/ADB	Number of People	388,777	290,507	19,367	12,911	5,738
		Annual Consumption	88,391	20,724	663	3,258	-
		Percentage of Households	54.2	40.5	2.7	1.8	0.8
	NIS/WFFS	Number of People	388,777	290,507	19,367	12,911	5,738
		Annual Consumption	131,970	37,917	612	1,099	-
		Percentage of Households	54.2	40.5	2.7	1.8	0.8
1996	MIME/ADB	Number of People	387,090	308,108	48,484	14,858	23,460
		Annual Consumption	87,816	21,310	1,657	3,598	-
		Percentage of Households	49.5	39.4	6.2	1.9	3.0
	NIS/WFFS	Number of People	370,575	298,851	76,506	42,238	8,766
		Annual Consumption	125,792	39,006	2,417	3,597	-
		Percentage of Households	46.5	37.5	9.6	5.3	1.1
	MIME/ADB	Change in Energy Use (%)	-4.7	-0.6	3.5	0.1	1.7
	NIS/WFFS	Change in Energy Use (%)	-7.7	-3.0	6.9	3.5	0.3
1998	MIME/ADB	Number of People	384,252	326,316	86,052	17,040	38,340
		Annual Consumption	86,897	22,448	2,916	3,853	-
		Percentage of Households	45.1	38.3	10.1	2.0	4.5
	NIS/WFFS	Number of People	343,534	305,462	146,090	77,915	12,395
		Annual Consumption	116,613	39,869	4,616	6,635	-
		Percentage of Households	38.8	34.5	16.5	8.8	1.4

Notes:

- MIME/ADB: Energy Demand Forecasts (MIME, 1996b)
- NIS: Population figures and percentage of households using energy types
- WFFS: Calculations of annual consumption based on NIS figures and the findings of this study related to per capita consumption.

The figures shown in the table give different information from different sources, which highlights the need for a good information base which can be continually and consistently updated for energy planning.

3. RESOURCES AND SUPPLY AREAS

Cambodia is located in the tropical region with a humid and warm climate which facilitates tree growth. According to the records of 1970, forests covered 73% of the surface of the Kingdom of Cambodia. Due to over two decades of war, over exploitation and uncontrolled logging, the forests have decreased considerably. Estimates of forest cover now range from 63% (Japan Forest Technical Association (JAFTA) 1995) to 30% (Global Witness 1995). JAFTA's estimate is used by the Department of Forestry, and is shown below:

Table 8: Land Classification of Cambodia

Classification	Area (hectares)	Percentage of Land Cover
Evergreen Forest	4,369,820	23.1
Mixed Forest	2,323,789	12.3
Deciduous Forest	3,726,677	19.7
Wood and Scrubland	1,025,071	5.4
Pine Forest	1,090	0.0
Mangrove Forest	16,498	0.1
Rear Mangrove Forest	17,665	0.1
Flooded Forest	481,225	2.6
Flooded Area	1,066,613	5.6
Grass/Scattered Trees	2,553,081	13.5
Rice Fields	1,825,319	9.7
Rubber Plantation	39,977	0.2
Orchards/Other Trees	108,630	0.6
Slash and Burn	3,571	0.0
Town	2,024	0.0
Water	1,340,858	7.1
Other Surfaces	1,198	0.0
TOTAL	18,903,106	100.0

Source: JAFTA, 1995

The forest area (in hectares) of the provinces researched during this study is as follows**:**

Province	Total Land Area	Forest Area	Share of Forest Area
Kampong Speu	68,581,425	47,291,825	69%
Kampong Chhnang	540,599	267,954	50%
Kampong Thom	1,300,831	775,794	60%
Kratie	1,200,137	1,072,095	89%
Pursat	1,237,520	946,053	76%

Source: JAFTA, 1995

Of the five provinces which supply wood energy to Phnom Penh, Kratie, Kampong Thom and Kampong Speu were selected for more detailed study, and a brief observation visit was undertaken in Kampong Chhnang. Areas were selected for detailed study according to the level of security in the province, and its proximity to the provincial centre.

The results given in this section are from the study areas only and not for the whole of the supply area.

3.1 Kratie Province

Kratie Province is located in the Northeast of the Kingdom of Cambodia along the Mekong River, about 220km from Phnom Penh.

3.1.1 Forest Resources

Kratie has a total land area of 1,200,137 hectares with forest cover as follows**:**

Forest Type	Area (Hectares)
Evergreen	252,072
Mixed	206,026
Deciduous	601,936
Trees and Flora	1,238
Flooded	10,868

Source: JAFTA, 1995

3.1.2 Supply Area

The research team spent 4 days conducting studies in Kratie Province. The source of firewood for Phnom Penh is off-cuts from sawmills in the area, particularly those located along the Mekong River. Charcoal is supplied to Phnom Penh from the districts of Prek Prasap, Sambo, Kratie and Chhlong. The focus of this study was Prek Prasap, directly across the Mekong River from Kratie town. Prek Prasap was selected for study as it is the main charcoal producing area in Kratie Province.

- **Overview of the Study Area**

Prek Prasap consists of eight communes, of which three produce charcoal. These are Prek Prasap, Sob and Chroy Banteay. These three areas have a population of 3,522 families, of which 218 produce charcoal. Charcoal producers therefore account for a small proportion of the villagers. The majority of the families are farmers who are also involved in collecting wood for the producers, especially in the dry season. Migration is rare in the region, and other employment opportunities include growing rice, fruit and vegetables, tobacco, and working for the logging companies.

- **Harvesting**

Prek Prasap is an area with abundant natural forests. Trees used for charcoal production are cut from the natural forest, including from some concession areas about 7-15 km from the villages. Some families collect the branches which are left after the companies finish exploiting the concession areas. Ox-carts, and sometimes trucks, are used to transport wood to the charcoal kilns.

- **Land Tenure**

All the families, except for recent immigrants, have land title so are able to earn a living as farmers.

- **Living Conditions**

Most of the families are poor but have good housing and own land, and are therefore better off than many families in other wood energy supply areas. In the villages, the firewood collectors are the poorest, and they have to live in the forest if they have no means of transport. Charcoal producers hire workers, and sometimes lend money to people to buy trucks to transport wood. They themselves may be in debt to traders in Phnom Penh due to having barrowed money to build kilns. Boat owners act as middlemen buying from several producers to transport to Phnom Penh, and usually they can buy very cheaply as producers are often in debt and have to accept a low price.

- **Local Energy Sources**

People in this region use firewood or very poor quality charcoal which they would not be able to sell. LPG, kerosene and electricity are not available, but a few richer families have small generators which can be used to recharge batteries for lighting.

3.1.3 Firewood

Transportation

Information gathered at Psa Toch in Phnom Penh gave the results shown in Table 9.

Table 9 shows that the annual supply of firewood by river to Phnom Penh was 25,248 steres. This firewood is supplied to various brick and tile kilns as well as other handicrafts production units and households within Phnom Penh.

Quantity Produced in Prek Prasap

- Wood collected for charcoal production: The number of charcoal kilns is shown in Table 10, with quantities of firewood consumed in Table 11. The tables show a total of 252 kilns requiring 45,354 steres of firewood to produce 6,204 tonnes of charcoal per year. Generally, a 6m kiln uses 32 steres of wood to produce 4-5 tonnes, 6 times a year, but this depends very much on the species of wood.
- Wood collected for sale as firewood: Firewood from Kratie province is supplied as off-cuts from sawmills. Therefore, the study team was unable to conduct this part of the survey.

Table 9 : Supply of Firewood by River

Province	Type of Firewood	Means of Transport	Number of Boats/ month	Boat Capacity (st)	Trips/ Month	Quantity/ Month (st)	Quantity/ Year (st)
Kratie	off-cut	boat	2	140	1	280	3,360
Kampong Chhnang	rubber	boat	8	160	1	1,280	15,360
Kandal	off-cut	boat	2	136	2	544	6,528
TOTAL			12	150		2,104	25,248

3.1.4 Charcoal

Charcoal is produced in the three districts of Kratie, Sambo and Prek Prasap. The study focused on Prek Prasap as it is the main producing area.

In Prek Prasap there are 252 kilns as shown in Table 10. The kilns in this area are built along the river, behind the producers' homes. They are large, permanent and built with bricks.

Table 10 : Charcoal Producing Families and Kilns in Prek Prasap

Commune	Number of Villages	Number of Families	Families Producing Charcoal	Number of Kilns by Size (m)					Total Number of Kilns
				3	4	5	6	7	
Prek Prasap	5	1190	71	10	19	20	29	0	78
Sob	6	1522	114	2	16	53	67	3	141
Chroy Banteay	5	810	33	1	0	27	5	0	33
TOTAL	16	3522	218	13	35	100	101	3	252

Quantity of Charcoal Produced

The charcoal kilns operate throughout the year, and the annual production is shown in Table 11. It can be seen that 45,354 steres of firewood are used to produce 6,204 tonnes of charcoal.

Table 11 : Quantity of Charcoal Produced in Prek Prasap

Kiln Size	Number of Kilns	Firewood Used per Kiln (steres)	Charcoal Produced per Kiln (ton)	Cycles per year	Firewood Used per Year (steres)	Charcoal Produced per Year (ton)
3	13	11	1.51	9	1,287	177
4	35	18	2.48	8	5,040	693
5	100	27	3.67	7	18,900	2,566
6	101	32	4.40	6	19,392	2,666
7	3	49	6.74	5	735	101
TOTAL	252				45,354	6,204

Note: Sacks of charcoal in Prek Prasap are calculated as weighing 55kg per sack, but in fact they are packed at Chhbar Ampeou with each sack weighing 60kg.

Description of Charcoal Kilns

Charcoal kilns in this area are mostly built with bricks and are 3-7 metres in diameter. A kiln consumes 10-50 steres of firewood during each cycle. Each kiln has:

- a door to load and unload the kiln
- a chimney (bottle-shaped) located in front of the fireplace
- a fireplace for wood to fire the kiln
- small emission holes located around the kiln to ensure wind enters in the first stages of burning, and sealed after 15 days.

A circle is prepared on the ground, around which the bricks are arranged and the kiln built. The kilns are covered with clay to seal them. After the fireplace is constructed, a roof is made from palm leaves and thatch to protect the kiln from rain.

The amount of firewood loaded depends on the size of the kiln. The wood is arranged vertically, beginning in the middle with the longest pieces. The chimney and emission holes are sealed part way through the cycle to prevent the firewood burning to ash.

At the end of the cycle the door and chimney are opened, and the charcoal must be removed quite quickly to prevent the still carbonising wood from burning. The small emission holes are opened after a third of the charcoal has been removed because the remainder is still hot. The holes are resealed whilst the charcoal cools down.

These kilns can be used for over 7 years.

Charcoal Traders and Transportation

In Prek Prasap, 45 of the 218 charcoal traders were interviewed. These interviews revealed that**:**

33 families each sell 50-70 kg/day;
12 families each sell 70-130 kg/day.

Using an average of 70.642 kg per day, the sales amount to **:**

70.6 kg x 218 families x 365 days = 5,620,984 kg per year.

Studies at Kbal Chroy and Chhbar Ampeou in Phnom Penh reveal that 9 boat loads of charcoal are brought to Phnom Penh each month. The average load of a boat is 40 tonnes which is about 667 sacks. Therefore charcoal transported annually is:

9 boats x 40 tonnes x 12 months = 4,320 tonnes.

It was noted that charcoal produced at Prek Prasap also goes to Kampong Cham, and by road to Prey Veng and Svay Rieng.

3.2 Kampong Thom Province

Kampong Thom Province is located about 164 km to the north of Phnom Penh and is accessed by Route 6.

3.2.1 Forest Resources

Kampong Thom has a total land area of 1,300,831 hectares with forest cover as follows**:**

Forest Type	**Area (Hectares)**
Evergreen	525,253
Mixed	58,310
Deciduous	28,654
Trees and Flora	63,423
Flooded	63,150

Source: JAFTA, 1995

3.2.2 Supply Area

The study team spent 4 days in Kampong Thom focusing on three communes within Santuk District. The sources of firewood for Phnom Penh are the sawmills, and as such were outside the scope of the survey in the supply areas. Charcoal is mostly produced in Santuk District, which therefore became the focus of the study.

- **Overview of the Study Area**

Santuk District consists of 9 communes, 3 of which - Tipo, Kakoh and Chroab - produce charcoal. Kakoh and Chroab are located along National Route 6, but Tipo is closer to the forest, about 15 km from the road. These communes contain 24 villages and 3,349 families as shown in Table 12. In 1996, the Provincial Forestry Department banned charcoal production in the area around Phnom Santuk, and many of the kilns were destroyed. The ban is unlikely to be successful because the villagers are poor and have no immediate alternate form of income generation. Many families, however, are planting cashew trees, re-establishing an industry which was well developed before 1975. Otherwise, income is generated through growing rice, vegetables, fruit and fishing.

- **Harvesting**

Trees are cut from Srah Khachao and Phnom Penchum, about 13 km from the road, and trees cut during land clearance for agriculture are collected. Scrubland is now also being cleared in preparation for cashew plantations. Tree trunks are generally used to produce charcoal, whilst the branches are used for local cooking needs.

- **Land tenure**

Most families own land on which they can grow rice and other crops. As elsewhere, this applies only to families who lived in the village in 1979. Newer migrants clear land for themselves but have no land title.

- **Living Conditions**

Poor people in the area were described as those without cows to plough the fields, those with no land and those with big families, and these families clear tree stumps to take land and work for richer families. Wealthy families on the other hand were defined as those with a surplus rice harvest, and those able to stockpile charcoal to sell at high prices during the wet season. Some charcoal traders fall into the latter category, whilst some producers are poorer, often in debt after borrowing to build kilns.

Kampong Thom is experiencing a revival of the cashew industry, which was well developed by the Provincial Agriculture Department throughout the 1960s, and families can earn a good income from traders in Phnom Penh. Currently, 1 kg can earn 1,200R, with a good tree being capable of producing upto 100 kg in a season.

- **Local Energy Sources**

In the study area, households use firewood collected from paddy dykes and cashew plantations, and poor quality charcoal for cooking. Kerosene is used for lighting, and wealthier families use batteries. There is no LPG or electricity available.

3.2.3 Firewood

Location and Supply Quantity: Santuk District

Wood collected for charcoal production: The number of charcoal kilns is shown in Table 12, with quantities of firewood consumed in Table 13. The tables show a total of 130 kilns requiring 13,185 steres of firewood to produce 1,813 tonnes of charcoal. The amount of firewood used and charcoal produced is dependent on the size of the kiln, species of tree and arrangement of wood in the kiln.

Wood collected for sale as firewood: The supply of firewood from Kampong Thom and Kampong Cham to Phnom Penh are off-cuts which are collected by traders from various sawmills within these 2 provinces. Therefore, the study team was unable to conduct this part of the survey.

Firewood Traders and Transportation

Information gathered at checkpoints along National Route 6A shows that about 1.5 - 2.5 steres of off-cuts come into Phnom Penh each day through this route. So, the total quantity of firewood is:

2 steres x 365 days = 730 steres/year.

3.2.4 Charcoal

Location of Supply and Production: Santuk District

Charcoal Kilns and Stores

Of the 3 communes studied in Santuk, Tipo produced the most charcoal. In Santuk there are 130 kilns and 19 stores, as shown in Table 12. The kilns are small, earthen and temporary. Generally a 3m kiln produces 18 to 20 sacks of charcoal from 13 to 17 oxcarts of wood (where 1 oxcart is about 1 stere). During the dry season, each kiln can produce charcoal twice each month, but in the wet season approximately 20% of the kilns operate to produce charcoal once a month. The kilns in this area are in the forest and were inaccessible to the study team, and therefore the exact number of kilns is difficult to assess.

Table 12 : Charcoal Producing Families and Kilns in Santuk District

Commune	Number of Villages	Number of Families	Number of Kilns by Size (m)			Total Number of Kilns	Total Number of Stores
			2	*2.5*	*3*		
Tepo	11	1,069	51	46	9	106	0
Kokoh	10	1,551	2	9	4	15	11
Chroap	3	729	0	5	4	9	8
TOTAL	24	3,349	53	60	17	130	19

Table 13 : Charcoal Produced in Santuk District

Size of Kiln	Production in Dry Season		Production in Wet Season		Average Firewood Use Per Kiln (stere)	Average Charcoal Produced (kg)	Firewood Used/Year (stere)	Charcoal Produced/Year (ton)
	Number of Kilns	Cycles Per 6 Months	Number of Kilns	Cycles Per Year				
2	43	12	10	18	6	825	4,176	574
2.5	48	12	12	18	9	1,238	7,128	980
3	14	9	3	15	11	1,513	1,881	259
TOTAL	105		25				13,185	1,813

Quantity of Charcoal Produced

On an annual basis, 13,185 steres of firewood are used to produce 1,813 tonnes of charcoal, as shown in Table 13. However, the amount of charcoal produced is dependent on the species of wood used.

Description of Charcoal Kilns

The kilns in this area are mostly earthen. A hole is dug of 2-3 metres in diameter, and each kiln consumes 6-11 steres of firewood per cycle, depending on the size of the kiln.

A circular hole, 1 metre deep is dug, and the fireplace and chimneys are dug around the hole. Wood is arranged vertically in the hole, with the longest pieces in the middle and shorter pieces placed around the outside. The wood is then covered with earth from termite mounds. The earth is mixed with water and consists of 3 parts of termite earth and 1 part of sand, and covers the wood to a thickness of 10-20cm. The earth is covered with a thin layer of straw to reduce the possibility of cracks. The kiln is left to dry for 3-4 days before firing. These kilns last for 5-7 years.

Traders and Transportation

The study revealed that in Kokoh and Chroap communes there are 19 charcoal stores, supplying the markets of Phnom Penh, and one which sells to the districts of Barai and Kampong Tropbai in Kampong Thom Province. Store owners sell 3-4 sacks of charcoal per day and it is transported to Phnom Penh by car. The amount of charcoal produced annually in Santuk to supply Phnom Penh is**:**

3.5 sacks x 365 days x 18 depots = 22,995 sacks = 1,265 tonnes.

3.3 Kampong Chhnang Province

Kampong Chhnang province is located to the north west of Phnom Penh, about 91 km along the National Route 5.

3.3.1 Forest Resources

Kampong Chhnang province covers a total land area of 540,599 hectares, with forest cover as follows:

Forest Type	**Area (hectares)**
Evergreen	22,327
Mixed	65,415
Deciduous	33,080
Trees and Flora	98,903
Flooded	48,233

Source: JAFTA, 1995

3.3.2 Supply Area

This study focused on two villages in the districts of Kampong Tralach and Samaki Meanchay during an observation day. Firewood and charcoal from Kampong Chhnang are also transported to Phnom Penh from other areas of the province by train. However, it was not possible to visit those areas due to security issues, so the study area was quite limited.

- **Overview of the Study Area**

Anglongton, located in Longvek Commune of Kampong Tralach, and Speanpo, located in Samaki Meanchay, are about 10km north of Oudong market, along National Route 5. The villages include 40 families, most of the families are charcoal traders, whilst the charcoal producers are in villages closer to the forest.

- **Harvesting**

Wood is collected from Phnom Chomreay and Phnom Khmao, 30 - 40 km to the west of the National Route 5. The whole tree is cut to provide wood to the charcoal kilns located in the same area. Wood is also collected from Phnom Oral which borders the 3 provinces of Kampong Speu, Kampong Chhnang and Pursat. Firewood from other areas of Kampong Chhnang is taken to railway stations within the province.

- **Land Tenure**

The original inhabitants of the area own land that they were allocated by the Village Chief in 1979. Newcomers, however, are not granted land title.

- **Local Energy Sources**

Families in this area use firewood for cooking meals, and batteries and kerosene for lighting.

3.3.3 Firewood

Location and Supply Quantity: Kampong Tralach and Samaki Meanchay

It was estimated from information gained from the charcoal traders in the study area, that 46,720 steres of firewood was collected for charcoal production. Calculations were based on the standard conversion of 2.5 sacks of charcoal being produced from 1 stere of firewood. No firewood is supplied to Phnom Penh from this area.

- **Along the Railway**

The study team was unable to visit this area due to problems with access and security. The same train also collects firewood and charcoal from Pursat. As it is not possible to differentiate the amounts of woodfuels corresponding to each province, they have been calculated together.

<u>Wood Collected for Charcoal Production</u>

Estimates from Pochentong Railway Station suggest that 18,000 sacks are supplied to Phnom Penh each year. The firewood required to produce this amount is about 7,200 steres.

Wood Collected for Sale as Firewood
According to the study at Pochentong Railway Station, the amount of firewood collected and supplied by train is about 39,960 steres each year.

- **Annual Quantity of Firewood Collected**

The total quantity of firewood supplied to charcoal kilns in Kampong Chhnang and Pursat provinces is:

46,720 steres + 7,200 steres = 53,920 steres

and the quantity supplied for sale as firewood is 39,960 steres, giving a total of 93,880 steres.

- **Firewood Traders and Transportation**

National Route 5
No firewood is transported this way from Kampong Chhnang.

Railway
The study conducted at Pochentong Railway Station showed that three wagons with a capacity of 74 steres are loaded with firewood. Each wagon contains 15,000 hands of firewood where one hand is 3 split logs and one stere is equal to 201 hands. Each wagon is therefore able to transport approximately 74 steres. Firewood is transported every 2 days, meaning it is brought 15 times a month. The total quantity of firewood transported over a month is:

74 steres x 3 wagons x 15 times per month = 3,330 steres.

Therefore, the annual supply by train is**:**

3,330 steres x 12 months = 39,960 steres per year.

3.3.4 Charcoal

Location of Supply and Production: Kampong Tralach and Samaki Meanchay

Charcoal Kilns and Stores
Charcoal kilns are temporary and made of earth. Interviews showed that one kiln requires 12 ox-carts of wood (where 1 ox-cart = 1 stere) to produce 16 sacks of charcoal during a 15 day cycle.

Quantity of Charcoal Produced
The quantity of charcoal was estimated using information gained from the traders in the study area (see below under National Route 5).

Along the Railway

Charcoal Kilns and Stores
Information could not be gained due to problems of access and security.

Quantity of Charcoal Produced
Estimates were made using information collected at Pochentong Railway Station (see below under Railway).

Traders and Transportation

National Route 5
As the kilns are located away from the road, the charcoal is brought to stores in the study area at the end of each cycle. There are 17 charcoal stores in the village of Anglongton and 23 in the village of Speanpo.

Charcoal is sold daily from Kampong Chhnang. The average supply of charcoal from each store to Phnom Penh is 8 sacks a day. The charcoal is transported to Phnom Penh by trucks and moto-carts. The annual supply is:

8 sacks x 40 stores x 365 days = 116,800 sacks = 6,424 tonnes.

Railway
A quantity of charcoal from Kampong Chhnang and Pursat provinces is transported by train to Phnom Penh. The team was able to assess the incoming flow of charcoal at Pochentong Station. It was found that approximately 110 sacks of charcoal arrive every 2 days. Therefore, the annual charcoal supply to Phnom Penh is:

50 sacks x 365 days = 18,250 sacks = 1,004 tonnes.

Total Quantity of Charcoal Supplied to Phnom Penh
The total annual supply of charcoal to Phnom Penh from Kampong Chhnang and Pursat is therefore:

116,800 sacks + 18,250 sacks = 135,050 sacks
or 6,424 tonnes + 1,004 tonnes = 7,428 tonnes.

3.4 Kampong Speu Province

Kampong Speu province is located about 90 km to the west of Phnom Penh along National Route 4.

3.4.1 Forest Resources

Kampong Speu has a total land area of 685,814 hectares with forest cover as follows:

Forest Type	Area (Hectares)
Evergreen	96,777
Mixed	112,870
Deciduous	130,826
Trees and Flora	132,837

Source: JAFTA, 1995

3.4.2 Supply Area

Wood energy from Kampong Speu is supplied to Phnom Penh through National Routes 4 and 5. However, the study area was limited to a small section of National Route 4. The research team spent 4 days conducting studies in Phnom Srouch district. Treng Trayeng commune has 6 villages with 887 families, but the study focused on Dey Ambel, Veal Veng and Pichnil. This area was selected because the villages are very close to Kirirom National Park, and as such, firewood collection is an important consideration for the Ministry of Environment in its National Park Management Plans. This region is considered to be a main supply area for Phnom Penh (MoE/MAFF/CEMP 1997). The villagers have been completely reliant on natural resources from the forest since 1979. The area at that time had a lower population, but after 1993 security in the area improved allowing more people to move in and settle there. All the people in the area have migrated from Kandal, Prey Veng, Svay Reing, Takeo and other areas of Kampong Speu provinces, where they had no land title.

Overview of the Study Area

Veil Veng

Veil Veng, established in 1990, is located along the road into Kirirom National Park. It is located within a military development zone, which means that land is given to military families moving into the area, but has not been recognised by the local authority. Families are moving into Veil Veng from unsafe areas such as Krang Dey Vai, and others located to the north of Kirirom National Park. The majority of people here are poor and have no land to farm. Of the 50 families in the village, 5 make their living by producing charcoal, 35 from cutting trees to sell as firewood, and 10 are hired as guards by land owners. Trees are collected from the natural forest and areas cleared for agriculture, so trees are not cut primarily for firewood or charcoal production.

Dey Ambel

In Dey Ambel, 83 families are registered with the local authority, but in fact there are 123, although some of these are seasonal migrants who move to Dey Ambel during the dry season. During this study the temporary residents had returned to their home villages. Of the registered families, 4 sell charcoal, 43 collect firewood and 36 cut trees for sawmills and sell groceries.

Trees are cut from the area surrounding Kirirom National Park, 3 - 15 km to the north of National Route 4 including O Cheuteal, O Kley and Kraing Dey Vai. Others collect from land undergoing clearance for agriculture, 2 - 15 km to the south of National Road 4 towards the Koh Slah region of Kampot province.

Pichnil

Pichnil has 245 families, of whom 30% make their living by collecting firewood and producing charcoal. Another 60% cut trees to sell to the sawmills, and the remaining 10% sell groceries. Trees are cut from the north and south of National Route 4, including areas close to Kirirom National Park.

Harvesting Firewood

If trees are cut from a distance less than 5 km, the trunks are sold along the roadside, and the branches are collected for local firewood use. This is only carried out where families are clearing the forest for agriculture, and small branches, leaves and stems are left behind and burnt before rice and other crops can be grown. Over a longer distance, only the trunks are removed, and the branches are left behind in the forest. Firewood collectors must pay 2,000R per ox-cart to soldiers before they are allowed to enter the forest.

Land Tenure

Original residents of the area, especially around Pichnil were allocated land by the Village Chief, but new families do not qualify for this allocation. There were several reports, however, of new families buying land from other families, and original families selling their land to the military.

Living Conditions

Income levels vary in the region, although the majority of the people are poor. Wealthier or middlemen are rare, but they are the ones who rent ox-carts to poorer families, and are able to buy woodfuels cheaply in the dry season in order to sell them at higher prices during the wet season. Poorer families, on the other hand, rent the ox-carts at around 300-500R per sack of charcoal transported. They may also be in debt to traders in Phnom Penh due to having borrowed money to build their charcoal kilns.

Gender Division of Labour

Men generally go to collect wood and make charcoal, while women stay in the village to split, stack and sell the wood. Other job opportunities are few, and most of the people have no other experience.

Local Energy Sources

The local people use firewood and charcoal for cooking. Some people have batteries for lighting at night, but most of the people use kerosene for lighting.

3.4.3 Firewood

Location and Quantity Produced: Trey Treyeng

Wood Collected for Charcoal Production
The charcoal kilns in Veil Veng and Pichnil are shown in Table 14, with quantities of firewood consumed in Table 15. The tables show a total of 54 kilns requiring 6,561 steres of firewood to produce 902 tonnes of charcoal per year.

Wood Collected for Sale as Firewood
There are 114 families who go daily into the forest to collect 1 ox-cart of firewood, which equals to approximately 2 metres, or 1 conventional stere. Therefore, the annual collection of wood for sale as firewood is:

114 families x 1 stere x 365 days = 41,610 steres.

Location and Quantity Produced: Amleang Village
This village is located in Thpong District, close to the forest. The team could not, due to security problems, conduct the study directly in the areas where charcoal is produced. However, the study was conducted in Tep Bronom Village, Oudong District. This village collects firewood and charcoal from Amleang forest.

Wood Collected for Charcoal Production
It was estimated from information obtained at the checkpoints along National Route 5, that 2,450 sacks of charcoal produced in Amleang are transported to Phnom Penh each month. Total consumption of firewood to produce this amount of charcoal is:

2,450 sacks/2.5 sacks = 980 steres per month

Therefore, the annual consumption of firewood is 11,760 steres.

Wood Collected for Sale as Firewood
Firewood is transported from Tep Bronam village, to Phnom Penh through the National Route 5. The study showed that 10 families in this village make their living by selling firewood. About 250-400 steres are collected each month from Amleang Forest. It is estimated that the average quantity of firewood produced per year is

325 steres x 12 months = 3,900 steres

Annual Quantity of Firewood Collected
The total quantity of firewood collected for use and production of charcoal in Kampong Speu per year is:

18,321 steres for charcoal production
45,510 steres for use as firewood

giving a grand total of 63,831 steres.

Firewood Traders and Transportation

National Route 4

National Route 4 is the main route to supply firewood and charcoal to Phnom Penh. There are 99 firewood depots in Treng Treyeng Commune, 36 of which sell bundles of firewood. Some of these are supplied to Kampong Speu provincial town, but mostly to Phnom Penh. According to the information obtained, each store generally sells 0.5 - 1.5 steres and 200-500 bundles of firewood per day. The monthly quantity of firewood supplied to Phnom Penh from Treng Treyeng is estimated to be 3,440 steres, amounting to 41,280 steres annually.

Some firewood is transported directly to Takhmao from Kampong Speu. Information obtained at checkpoints revealed that 4 moto-carts daily transport firewood to Takhmao, each capable of carrying 2.25 steres. Therefore the annual quantity supplied directly to Takhmao from Kampong Speu is**:**

2.25 steres x 4 moto-carts x 365 days = 3,285 steres

National Route 5

The incoming flow of firewood to Phnom Penh through National Route 5 was observed. According to information gathered in Trep Branam village, it was learnt that there are 10 firewood stores. Some firewood is used within Oudong district and the rest is supplied to Phnom Penh. The team was informed by store owners that in general each store sells 1 stere of firewood per day. Therefore, the monthly quantity of firewood from Amleang to Phnom Penh is 300 steres, amounting to 3,600 steres per year.

Annual Quantity of Firewood Supplied to Phnom Penh

The total supply of firewood to Phnom Penh from Kampong Speu is 44,880 steres.

3.4.4 Charcoal

Location of Supply and Production: Trey Treyeng

Charcoal Kilns and Stores

In Trey Trayeng there are 54 charcoal kilns and 46 charcoal stores as shown in Table 14. The kilns in this area are fairly small, earthen and temporary. According to the study, the number of charcoal kilns could be higher than that indicated in Table 14. In Pichnil there are charcoal kilns in the forest which were inaccessible to the team, especially around Chamcacheikleu and Chamcacheikrom. The team could not obtain information from these areas because most of the charcoal producers are families of soldiers and the kilns are located inside the forest.

Table 14 : Charcoal Producing Families and Kilns in Treng Trayeng Commune

Village	Number of Families	Number of Kilns by Size (m)			Total Number of Kilns	Total Number of Stores
		2	*2.5*	*3*		
Veal Veng	50	0	1	4	5	5
Pichnil	245	12	2 4	13	49	37
Dey Ambel	83	0	0	0	0	4
TOTAL	378	12	25	17	54	46

Quantity of Charcoal Produced

In the study area, 6,561 steres of firewood are used to produce 902 tonnes of charcoal per year, as shown in Table 15. Most of the kilns are built next to houses, with the remainder being in the forest. The charcoal kilns operate during the dry season, with each kiln able to produce twice a month. However, about 45% of the charcoal kilns operate during the wet season which produce charcoal once a month.

Table 15 : Charcoal Produced in Tray Trayeng Commune

Size of Kiln	Production in Dry Season		Production over a Year		Average Firewood Use Per Kiln (stere)	Average Charcoal Produced (ton)	Firewood Used/Year (stere)	Charcoal Produced/ Year (ton)
	Number of Kilns	Cycles Per 6 Months	Number of Kilns	Cycles Per Year				
2	7	12	5	18	6	0.83	1,044	144
2.5	15	12	10	18	9	1.24	3,240	446
3	8	9	9	15	11	1.51	2,277	313
TOTAL	30		24				6,561	902

The kilns in this area are similar to those in Kampong Thom. They are made of earth, are fairly small, and last for around 5-7 years.

Location of Supply and Production: Amleang

Charcoal Kilns and Stores

Due to problems with security and access, this part of the study could not be completed.

Quantity of Charcoal Produced

Information gained at checkpoints suggests that 29,400 sacks or 1,617 tonnes are produced annually.

Total Quantity of Charcoal Produced

The annual quantity of charcoal produced in this study area is:

902 tonnes + 1,617 tonnes = 2,519 tonnes.

Traders and Transportation

National Route 4
The study showed that in Trey Trayeng commune, there are 46 charcoal stores in the 3 villages which supply Phnom Penh. The owners of the stores reported selling 2.5 sacks of charcoal per day on average. Therefore, the annual amount of charcoal sold in this area to Phnom Penh is:

2.5 x 46 x 365 = 41,975 sacks or 2,309 kg.

National Route 5
A large quantity of charcoal from Kampong Speu province is transported by truck from Amleang forest along National Route 5 into Phnom Penh. Information was collected from Prek Phnoeuv checkpoint and showed that about 50 trucks of charcoal per month are brought this way, with each truck carrying 46-52 sacks. Therefore the annual supply of charcoal from the Amleang region is about

50 trucks x 49 sacks x 12 months = 29,400 sacks = 1,617 tonnes

Total Quantity of Charcoal Supplied to Phnom Penh
The total annual supply from Kampong Speu is:

41,975 sacks + 29,400 sacks = 71,375 sacks
or 2,309 tonnes + 1,617 tonnes = 3,926 tonnes.

3.5 Tree Species Used for Firewood and Charcoal.

The species listed in Table 16 were stated by our informants to be those collected in the supply areas. For charcoal production, a mix of species is often used.

Table 16 : Tree Species Used for Wood Energy

Province	*Woodfuel Type*	*Local Name*	*Scientific Name*
Kampong Speu	Firewood	thbeng	Dipterocarpus obtusifolius
		khlong	Dipterocarpus tuberculatus
		trasek	Peltophorum ferrugineum
		chombok	Irvingia sp
		thlork	Parinarium annanmensis
		trayeng	Diospyros belferi
		longieng	Cratoxylon prunifolium
		chhlik	Terminalia tomentosa
		kroeul	Melanorrhea laccifera
	Charcoal	chambok	Irvingia sp
		trasek	Peltophorum ferrugineum
		khlong	Dipterocarpus tuberculatus
Kampong Chhnang	Firewood	thbeng	Dipterocarpus obtusifolius
		khlong	Dipterocarpus tuberculatus
	Charcoal	khlong	Dipterocarpus tuberculatus
		thbeng	Dipterocarpus obtusifolius
Pursat	Firewood	thbeng	Dipterocarpus obtusifolius
		khlong	Dipterocarpus tuberculatus
	Charcoal	thbeng	Dipterocarpus obtusifolius
		khlong	Dipterocarpus tuberculatus
Kratie	Firewood	chhoeuteal	Dipterocarpus alatus
	(from sawmills)	chambok	Irvingia sp
		koki mosau	Hopea pierrei (odorata)
		krakas	Sindora cochinchinensis
		beng	Pahudia cochinchinensis
		neang nuon	Dalbergia bariensis
		kralanh	Diallum cochinchinensis
	Charcoal	mein prey	Ephoria togana
		krakas	Sindra cochinchinensis
		pong ngro	Schleichera
		treyeng	Diospyros belferi
		angkot khmau	Dospyros bejaudii
		sokram	Xyliaddabriformis
		trasek	Peltophorum ferrugineum
		chramas	Vatica astrotricha
		chhlik	Terminalia tomentosa
		pram dumleng	Terminalia mucronata
		thbeng	Dipterocarpus obtusifolius
		khlong	Dipterocarpus tuberculatus
		sromor	Terminalia chebula
Kampong Thom		chambok	Irvingia sp
		phchek	Shorea obtusa
		krakas	Sindora cochinchinensis
		kralanh	Diallum cochinchinensis
		thbeng	Dipterocarpus obtusifolius
		khlong	Diptercarpus tuberculatus
		trasek	Peltophorum ferrugineum
		pring	Eugenia sp
		trobeik prey	Lagerstroemia rigina
		onchang	
		chhoeuteal	Dipterocarpus alatus
		thlork	Parinarium annamensis

3.6 Total Firewood and Charcoal Supplied from the Study Areas

3.6.1 Firewood

The quantity of firewood collected annually to produce charcoal and for sale as firewood is shown in Table 17. The table shows that 130,780 steres of firewood are used to produce charcoal and 85,470 steres of firewood are collected for immediate use. However, the firewood depots are estimated to sell 110,818 steres of firewood per year, a higher quantity than that found to be collected. The quantity of firewood transported to Phnom Penh through checkpoints is about 95,367 steres. Compared to the quantity shown in Table 17, this figure is low.

Table 17 : Annual Collection and Supply of Firewood in the Study Areas (steres)

Province	Annual Firewood Production			Annual Supply of Firewood			
	Charcoal Production	Use as Firewood	Total	Road	Train	River	Total
Kampong Speu	18,321	45,510	63,831	44,880	-	-	44,880
Kampong Chhnang and Pursat	53,920	39,960	93,880	-	39,960	-	39,960
Kampong Thom and Kampong Cham	13,185	SM	13,185	730	-	-	730
Kratie, Kampong Cham and Kandal	45,354	SM	45,354	-	-	25,248	25,248
TOTAL	130,780	85,470	216,250	45,610	39,960	25,248	110,818

Note: SM denotes sawmill, and as such was outside the scope of this study. This table is calculated from the study areas only. Therefore, the figures are likely to be lower than the actual amounts produced in the provinces and supplied to Phnom Penh.

3.6.2 Charcoal

The quantity of charcoal produced was 10,536 tonnes per year and is shown in Table 18. However, the total quantity of charcoal supplied from the depots in the study areas each year is 16,957 tonnes. In comparison, the survey at the checkpoints indicated a quantity of 23,802 tonnes arriving in Phnom Penh annually.

Table 18 : Annual Charcoal Production and Supply to Phnom Penh from the Study Areas

Province	Annual Charcoal Production (ton)	Annual Charcoal Supply to Phnom Penh			
		River (ton)	*Road (ton)*	*Train (ton)*	*Total (ton)*
Kratie	6,204	4,320	-	-	4,320
Kampong Thom	1,813	-	1,265	-	1,265
Kampong Speu	2,519	-	3,926	-	3,926
Kampong Chhnang and Pursat	Not Studied	-	6,424	1,004	7,428
TOTAL	10,536	4,320	11,614	1,004	16,938

Note: This table is calculated from the study areas only. Therefore, the figures are likely to be lower than the actual amounts produced in the provinces and supplied to Phnom Penh.

3.6.3 Factors Influencing the Results

The results shown in the above tables are influenced by the following:

- some woodfuels are used locally
- some families store woodfuels at their houses for their own use
- some transporters in the supply area reported travelling during the night, thereby avoiding the checkpoint survey
- transporters do not always travel to Phnom Penh every day
- some woodfuels are collected directly from the collector, thereby missing the rural depots
- this is only an estimate of woodfuels that are collected each year taken from certain study areas within the supply regions
- firewood is supplied to Phnom Penh from sawmills, which were outside the scope of this study
- some of the charcoal producing areas within the study areas were inaccessible.

3.7 Issues Affecting Communities in the Supply Areas

Firewood collectors, charcoal producers and traders revealed several reasons for their involvement in the wood energy trade, which include:

- they are clearing the land for agricultural development
- they have no land of their own, so are claiming forested areas
- there is a lack of alternate employment after the rice harvest
- the living standards are low, but they cannot do any other type of job
- they do not have enough money to set up their own businesses
- it provides employment during the dry season for temporary migrants
- some have no implements or cows for farming.

The living standards of the people vary considerably. For instance, the living standards of the families in Kratie are relatively higher than those in Kampong Speu. The main differences were noted as follows**:**

Kratie	**Kampong Speu**
• own house with tiled roof	• no large houses
• land ownership for the majority	• land ownership for the minority
• means of production for farming	• no means of production
• families have large, brick built charcoal kilns	• families use small, earthen, temporary charcoal kilns
• majority of people have batteries for lighting	• few people have batteries for lighting
• most people were born in their village	• majority of people are migrants

The living standards of families employed in the wood energy trade in different provinces can be classified as follows**:**

- Kratie has the highest living standards.
- Kampong Thom and Kampong Chhnang have fairly good living standards.
- Kampong Speu has the lowest living standards.

However, Kampong Speu is the biggest supplier of wood energy to Phnom Penh.

The rural communities face some problems during their work which include**:**

- more time is spent travelling to the forest
- difficulties in reaching the forest during the wet season
- increased flooding which destroys rice fields and farm land
- the need to rent ox-carts for transportation
- payments are required to enter the forest
- increasing threat of malaria due to deeper encroachment into the forest.

4. URBAN MARKET STRUCTURE

The wood energy trade in Phnom Penh is within the informal sector, which made it difficult to form a methodical sampling strategy. However, as this study is intended to provide an overview of the distribution system, it was sufficient to select traders to interview during observation tours of the city. The boundary of Phnom Penh was taken to be the municipal boundary.

The team interviewed 95 wholesalers and large retailers of firewood and charcoal within the 7 districts, shown in Table 19.

Table 19 : Interviews with Wood Energy Traders in Phnom Penh

District	Interviews
Dangkao	16
Toul Kork	19
7 Makara	9
Doun Penh	22
Russei Keo	10
Meanchay	8
Chamkarmon	11
TOTAL	95

The study revealed the many complexities of the distribution system, as shown on Diagram 1.

4.1 Wood Energy Flows From Rural Areas

Firewood and charcoal are transported to Phnom Penh through points such as National Routes 4, 5 and 6A and by railway and river. Table 20 shows the results of a survey of wood energy flows through Department of Forestry Checkpoints over a 2 day study period.

Table 21 indicates the daily, monthly and annual flows of firewood and charcoal. The figures represent 70,119 steres of natural forest and 25,248 steres of rubber, flooded forest and sawmill off-cuts. In conjunction with Table 5, it shows the following results:

Firewood:

95,377 steres flowing into Phnom Penh
7,455 steres flowing out of Phnom Penh
87,922 steres used in Phnom Penh

Charcoal:

23,802 tonnes flowing into Phnom Penh
1,181 tonnes flowing out of Phnom Penh
22,621 tonnes used in Phnom Penh.

Table 20 : Wood Energy Flows Over a Two Day Period at Department of Forestry Checkpoints

Location	Transportation							Quantity of Firewood			Quantity of Charcoal Sacks
	Truck	Nissan	Sedan	Truck with Cart	Moto-cart	Train	Boat	Bundle	Metre	Stere	
NR 4	6	14	46	11	93	-	-	18,900	249	-	941
NR 5	6	1	-	1	30	-	-	-	10	-	788
NR 6A	1	7	-	1	3	-	-	3,216	-	-	112
Train	-	-	-	-	-	3	-			222	100
River	-	-	-	-	-	-	3	-	-	300	-
TOTAL	13	22	46	13	126	3	3	22,116	259	522	1,941

Table 21 : Estimated Wood Energy Flows into Phnom Penh

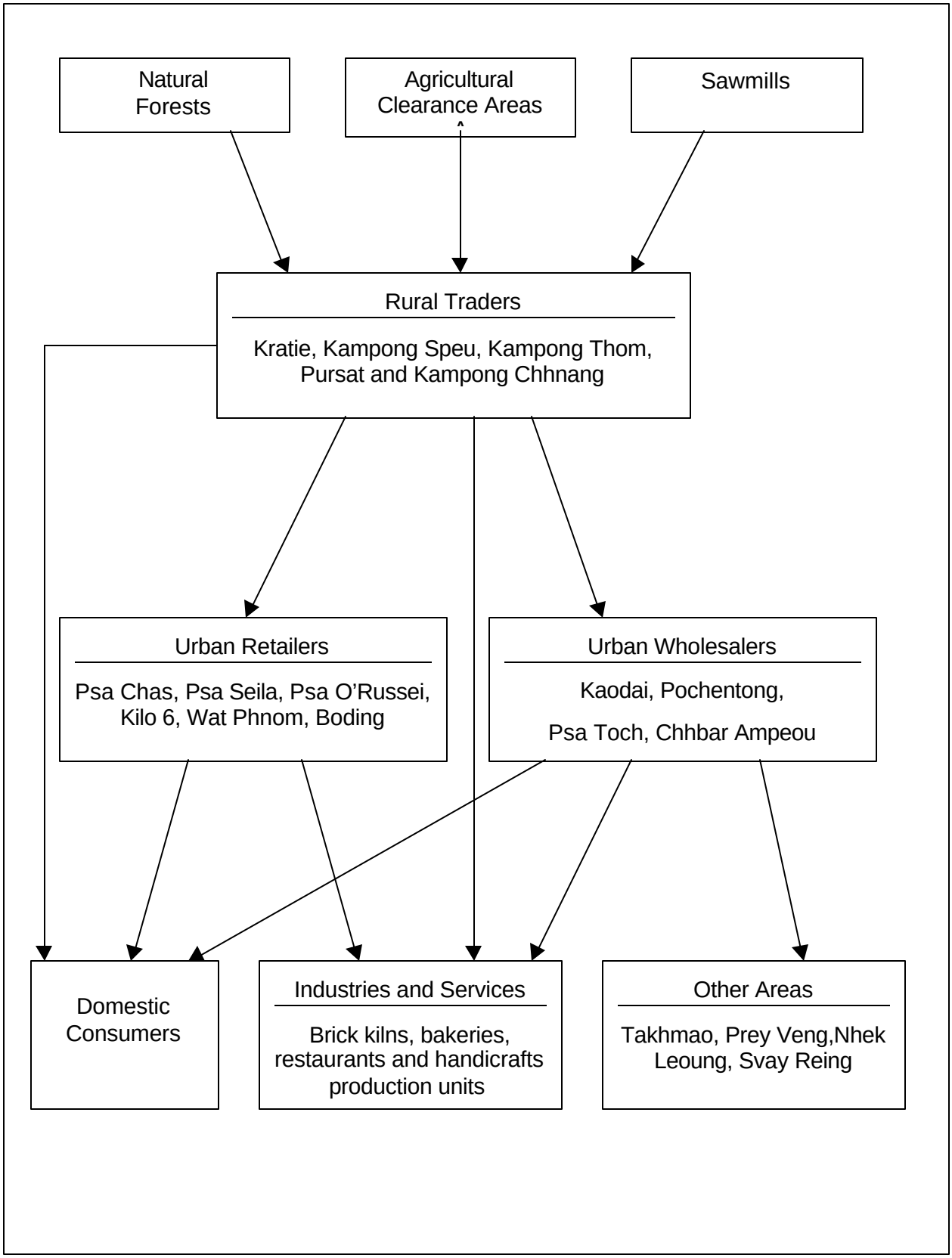
Location	Firewood			Charcoal		
	stere/day	stere/month	stere/year	ton/day	ton/month	ton/year
National Route 4	74.1	2,255	27,059	25.9	787	9,445
National Route 5	5.0	152	1,825	21.7	659	7,910
National Route 6A	2.0	61	730	3.1	94	1,124
Train	111.0	3,376	40,515	2.8	84	1,004
River	69.2	2,104	25,248	11.8	360	4,320
TOTAL	261.3	7,948	95,377	65.2	1,984	23,803

Woodfuels are transported by National Route 4 for distribution through the depots of Kaodai, Beoung Salang, Depo and Toul Kok, although some is supplied directly to Tahkmao.

The flows of charcoal and firewood through National Route 5 were distributed to depots such as O'Russei, Psa Cha and other retail stores along National Route 5 next to Chroychangva Bridge to Chraing Chamreah Quarter within Russey Kao District.

Charcoal is brought in greater quantities than firewood along National Route 6A. These woodfuels are distributed to various depots within Phnom Penh.

Diagram 1: Wood Energy Flows to Pnomh Penh



Road transport is usually by moto-cart, car, pick-up and truck. Along National Route 4, container trucks pick up firewood and stack it underneath the truck. On this and other routes, firewood and charcoal is sometimes brought as a part load on trucks and pick-ups.

The quantity of woodfuels transported by train is high. Most of this quantity arrives at Pochentong Railway Station, where the wholesalers line the railway tracks. The woodfuels are sold on to retailers and restaurants in Phnom Penh, although some is sold to supply handicrafts units and households in Takhmao. Interviews with traders at Pochentong showed 4 families transporting firewood to Takhmao daily by moto-cart, where each moto-cart carries 2 steres. In addition, 1 car from Takhmao collects firewood daily from Pochentong and carries 3 steres.

Firewood and charcoal arrives from Kratie at Psa Toch and Chhbar Ampeou by river. From the wholesalers at the ports, charcoal is delivered to retailers in the city, and some is transported out to areas such as Kandal and Nhek Loeung. Firewood transported in this way is mostly from old rubber trees and off-cuts from sawmills, and is supplied to brick and tile kilns in addition to handicrafts production units in Phnom Penh.

Kolexim sawmill is located within the boundaries of Phnom Penh. The sawmill distributes its off-cuts to handicrafts production units, restaurants and households in Phnom Penh. The Kolexim sawmill has the capacity to produce 200 cubic metres of timber per day. In general, 1 cubic metre produces the following:

processed timber	60.5%
off-cuts	15.5%
waste wood	6.0%
sawdust	18.0%

The company exports processed timber and other products are sold for local use (Lao SP, 1993). The quantity of off-cuts from Kolexim annually is:

200 cubic metres x 260 operating days x 21.5% = 11,180 cubic metres = 14,520 steres.

4.2 Wood Energy Traders

4.2.1 Depots in Phnom Penh

It is difficult to differentiate between wholesalers and retailers as they have a lot of the same characteristics, but for the purpose of this study, they are described as follows.

Wholesalers

Wholesalers buy firewood and charcoal directly from rural supply areas in quantities of 5,000 - 50,000 bundles of firewood and 50 sacks - 200 sacks of charcoal per month. They sell to retailers, restaurants, bakeries, tile and brick kilns in similar quantities to those purchased. Wholesalers also sell charcoal and firewood directly for domestic consumption in large and small quantities. Wholesalers sell only woodfuels.

Retailers

Retailers mainly buy firewood and charcoal from wholesalers, but some also buy directly from the rural supply areas. They usually buy in quantities of 500 - 2,000 bundles of firewood and 5 - 10 sacks of charcoal per month. Retailers sell mainly small quantities for domestic consumption, but sometimes sell to restaurants and for use on special occasions. Retailers usually sell other goods in addition to woodfuels at their shops.

4.2.2 Prices and Units of Sale

The prices of firewood and charcoal increase as they move through the distribution system. At each stage of trade, an amount is added to cover expenditure and to allow an income to be earned by each level of trader. Table 22 shows the stages of trade, but it is important to note that the units of trade may also change as progression is made through the system. (The units of trade are illustrated on Page iv.)

Table 22 : Stages of Trade

Trader	Pursat		Kg Chhnang		Kg Speu		Kg Thom		Kratie	
	Fuelw. Bundle	Char. Sack	Fuelw. Bundle	Char. Sack	Fuelw. Bundle	Char. Sack	Fuelw. Bundle	Char. Sack	Fuelw. Bundle	Char. Sack
Wood Collector	120	-	120	-	90	-	-	-	-	-
Charcoal Producer	-	8,000	-	8,000	-	8,000	-	8,000	-	7,000
Transporter	160	13,000	150	12,000	120	12,000	100	14,000	100	14,000
Wholesaler	180	15,000	175	15,000	170	14,000	140	15,000	150	16,000
Retailer	200	17,000	190	16,500	200	16,000	190	16,500	200	19,000

Sacks of charcoal in Table 22 weigh 60 kg from Kratie and 55 kg from other provinces. The price depends on quality, species and weight. Charcoal from Kratie is renowned for being the best quality. The preferred species is chambok (*Irvingia sp.*), because it has a high heating quality and burns without smoke, but it also has the highest price. Firewood from Pursat, Kampong Chhnang and Kampong Speu come from natural forests, and those from Kampong Thom and Kratie from sawmills.

Prices differ in the wet and dry seasons. The prices are lower in the dry season because there are more people collecting firewood. During the wet season it is difficult to travel into the forest to collect wood.

4.2.3 Income and Expenditure

Sources of Income

According to responses during the interviews with the traders, income is gained mostly from firewood and charcoal selling, especially for the wholesalers. Other sources of income include civil service, selling groceries, farming, motor and car taxi service, rice selling, pharmacy, motorbike repairs, tailor, and money exchange. Income levels are difficult to ascertain because the traders do not keep records of their accounts and are reluctant to discuss the issue. However, some traders reported that their income was sufficient only to cover their daily expenses, whilst others gained profits enough to allow them to lend to charcoal producers to build kilns, and can stock woodfuels in the dry season to sell at higher prices in the wet season. Some traders reported making a loss and were running down their businesses.

Operating costs

General expenditure of the traders include rent, guards, workers, transport, tax and police. The payments for each of these items is difficult to determine due to the nature of the trade, but generally it depends on the nature of the rest of the business and the amount of woodfuels sold. In the depots there are some workers who earn an income from loading and unloading woodfuels, packing charcoal into sacks, chopping firewood and bundling it and guarding the depots at night. Wood is split at the wholesale depots to the request of customers. Small pieces of charcoal left over from sales are sold to ironsmiths for making knives, axes, etc. Labour is usually by household members, and therefore is uncosted.

Transport of firewood and charcoal between buyers and sellers may be arranged by either party, but if the seller organizes the transport, a small amount is added to the cost of the woodfuel. Forms of transport include handcart, cyclo, moto-cart, car and truck, and the transport costs vary accordingly.

4.2.4 Trading Relationships

The study shows that firewood and charcoal traders in Phnom Penh have differences in their sales patterns. Some travel to the rural supply areas to purchase the woodfuels themselves, others buy from other depots in Phnom Penh, and others pay people to transport the woodfuels from the rural supply areas. Customers buy from depots in Phnom Penh, from moto-carts selling along the road, or arrange for the trader to deliver to their houses. Some consumers collect the woodfuels themselves directly from the rural traders, particularly from those located along National Route 4.

Trading relationships develop between the suppliers and traders. Charcoal producers wanting to build kilns, borrow, in advance from the traders. The relationship between the customer and trader is that if the customers consistently buy from the same trader, they may be given a credit facility.

Firewood and charcoal purchases and sales between traders and customers are, in the majority of cases, cash transactions, but in some cases the buyers can owe part of the amount due until they re-sell. Also, if there is a large amount of firewood and charcoal, it can be stocked at the depots with an agreement for payment to be made after the sales. This process of credit can only operate between traders who have traded together for a long time.

4.2.5 Reasons for Trade

Some of the traders have been in business since 1979, although most began after 1990. The number of traders is increasing, and the reasons for selecting this particular type of work include the need to earn a daily income, or to supplement other forms of income. Many traders appeared keen to remain in this business, but others, particularly those with low sales, are planning to end their involvement but have little idea about alternative work. It is possible to make a profit if traders operate in partnership with suppliers. Those who have been in the business longer consider it a traditional family trade and so are reluctant to change.

5. SOCIO-ECONOMIC ASPECTS OF WOOD ENERGY CONSUMPTION

The Kingdom of Cambodia is a poor country due to over 2 decades of war and therefore the living standards of the majority of the population are low. The majority of the rural population use firewood and charcoal as their energy sources for daily cooking because alternate energy forms such as LPG and electricity are generally unavailable. In urban areas, a wider selection of energy forms is usually available, but access to these is limited by financial and spatial constraints.

5.1 Income Levels and Energy Use

Since the opening of a free economy by the Royal Government of Cambodia there have been many developments. Public services, factories and enterprises are operating and are rapidly increasing and these employ huge numbers of Cambodian people.

Household incomes vary depending on the type of employment obtained, and three main categories of income level are apparent. High-income families can select energy forms such as LPG or electricity which are more convenient and cleaner than woodfuels. These families continue to use woodfuels for roasting and grilling meat and fish.

Middle-income families are more likely to use a mixture of woodfuels and more conventional fuels. In this case, LPG is used for cooking rice and boiling water, but woodfuels are used for food needing long cooking times such as soups. Levels of income within this category allow bulk purchases of woodfuels, i.e. charcoal by the sack or firewood by the stere, and this may work out cheaper than buying in small quantities.

Most low-income households use woodfuels for cooking, but some use sawdust and agricultural residues such as coconut shells and rice husks. Woodfuels are bought by the bundle or kilogram depending on the daily income earned by each household.

In 1994, the NIS (1995) illustrated that the average income was only attained by 30% of households, with the highest 10% of households earning almost 52 times the income of the lowest 10%. This is a major factor determining access to certain fuel types.

5.2 Prices of Different Forms of Energy

Table 23 shows the prices and uses of different forms of energy.

Table 23 : Prices of Different Forms of Energy

Energy Type	Unit	Energy Use per Person			Expenditure per Person (Riel)		
		Day	*Month*	*Year*	*Day*	*Month*	*Year*
Firewood	Stere	0.0009	0.028	0.34	125.7	3,823	45,877
Charcoal	Kg	0.36	10.9	131	100.8	3,065	36,783
LPG	Kg	0.09	2.6	32	173.1	5,266	63,189
Kerosene	Litre	0.2	7.1	85	233.0	7,087	85,000

Note: Kerosene consumption is based on the Energy Demand Scenario (MIME, 1996b)

The LPG price shown in the table represents 15 kg cylinders. The costs of using energies such as LPG include more than the price of the fuel itself. For instance, if LPG is used extra expenditures for stoves and LPG cylinder deposits are required, which involve large, lump sum payments. Smaller cylinders are now available in Phnom Penh, but the extra cost of the stove is likely to mean that this remains prohibitive for a large section of the population of Phnom Penh. In comparison, purchases of firewood and charcoal can be made in small, low cost quantities, more affordable to low-income families.

5.3 Changes in Energy Use

During the study, some traders were of the opinion that their sales are declining due to increased incomes leading households to switch to conventional energy forms. Although this was observed during the study, and confirmed by the surveys conducted by the NIS (1995 and 1997), it was also noted that the amount of wood energy traders in Phnom Penh has increased over the past few years, suggesting that some of the decreased sales could be due more to increased competition.

A comparison of energy use in 1994 and 1996 can be seen in Table 24. The table shows that wood energy consumption is decreasing in terms of the percentage of households using woodfuels as their main energy source for cooking, but the number of households is actually increasing. However, in terms of the number of people consuming woodfuels, the statistics do not show a great change due to a decreasing household size from 5.9 in 1994 to 5.3 in 1996.

Table 24 : Changes in Energy Use, 1994 - 1996

Energy Type	1994			1996		
	Percentage of Households	Number of Households	Number of People	Percentage of Households	Number of Households	Number of People
Firewood	54.2	65,636	387,252	46.5	69,880	370,575
Charcoal	40.5	49,045	289,365	37.5	56,355	298,851
LPG	2.7	3,269	19,287	9.6	14,427	76,506
Kerosene	1.8	2,179	12,856	5.3	7,965	42,238
Electricity	0.1	121	713	0.1	150	797
None	0.3	484	2,855	0.0	0	0
Other	0.4	3,633	21,434	0.9	1,503	7,969

Source: NIS 1994 and 1996

There has clearly been a big increase in LPG use over the 2 year period, but woodfuels remain popular for traditional dishes. At present, all LPG is imported into the country and therefore any disruption of the imports will increase the demand for indigenous energy forms, particularly firewood and charcoal.

5.4 Urbanisation

There has been a gradual increase in the population of Phnom Penh since 1979. In comparison with the national population growth rate of 4.8% over the 2 year period of 1994 -1996, the growth in Phnom Penh was 11.1% (NIS, 1997).

As the country's economic centre, Phnom Penh is attractive to migrants in search of trading or other employment opportunities. In 1996, 17% of all migration within Cambodia was for this reason (NIS 1997). In rural areas there is often a lack of employment during the dry season, after the crops have been harvested. In this period, temporary migration is often undertaken to find work in urban areas. During 1996, the NIS (1997) found 25,000 temporary migrants in Phnom Penh. Some of the migrants live with family and friends in the city, but others are accommodated in new settlements which develop within and around the city on land such as riverbanks, public parks, roadsides, railway lines, rooftops, derelict land and privately owned land, and are therefore often classed as illegal settlements. The Urban Sector Group report 20 such settlements housing over 20,000 families, a figure rapidly increasing and often excluded from local authorities population registers.

People living in illegal settlements or marginal areas have considerations other than financial in deciding which type of energy to use. In these areas people have to be mobile as there is the constant threat of eviction (in illegal settlements), or flooding (marginal settlements along riverbanks). Therefore, those in a position to cook with LPG are unlikely to want the extra burden of carrying LPG cylinders and cookers if they have to move quickly. This is also an important consideration for temporary migrants. LPG may also be considered as unsafe in the case of the taps being left on, or turned on by children, or the stove falling over.

The majority of the households in Phnom Penh are of low income households, and so are expected to account for the highest rate of population growth. Population growth is, however, not balanced with the rising incomes and the need for firewood and charcoal is, therefore, unlikely to decrease for some time.

5.5 Traditional Uses of Wood Energy

Buddhism is the dominant religion in the Kingdom of Cambodia. Ceremonies are respected and initiated by the population of each area. It was found that wholesale traders in Phnom Penh sell not only for daily domestic needs, but also for use in ceremonies such as marriages and cremations, in addition to cooking for the monks and nuns and for other uses at the pagoda. Marriage ceremonies typically use 0.5-1.5 steres of firewood and 1-3 sacks of charcoal, and cremations require 0.5-0.75 steres of firewood.

5.6 Income Generation in the Rural Areas

The wood energy trade was observed to be a major source of income generation in the rural areas. The study in the supply areas and of corresponding traders showed that firewood and charcoal was produced not only for domestic use, but also to supply brick kilns and other industries and services. People living in rural areas are mainly farmers, and the sale of firewood and charcoal supplements their incomes. Temporary migrants also join the trade during the dry season to supplement their incomes.

6. ENVIRONMENTAL IMPACTS OF WOOD ENERGY CONSUMPTION

The provision of wood energy is generally thought to be a major contributor to forest loss, although the study did not find this always to be true. In attempting to assess the environmental impact of wood energy provision and consumption, it was also necessary to consider the environmental impacts related to the provision and consumption of alternate forms of energy.

6.1 Deforestation

Forest loss in the Kingdom of Cambodia has accelerated rapidly over the last few years. The most recent information from satellite imagery between 1990 and 1993 suggests that 63% of the country is covered with forest (JAFTA 1995), a decrease from 73% in 1970. However, other sources suggest that the forest cover could be as low as 30% (Global Witness, 1995). Throughout the study, forest loss has been seen to be due to:

- more than 2 decades of war
- logging concessions
- agricultural clearance
- construction
- collection of woodfuels.

Extraction of wood within the supply areas clearly affects the forest and the environment. Some of these impacts can be seen in the study areas. The rainfall is increasingly irregular, biodiversity has been lost. Communities have experienced flooding and drought, which adversely affects the most important sector in the country's economy, that of agriculture. The local populations are concerned about these impacts, which affect not only the environment but the whole social economy.

6.2 Forest Loss in the Study Areas

6.2.1 Kratie Province

In 1970, the forest grew around the villages and wildlife was abundant. Land behind the village was cleared during the Khmer Rouge regime, and after that time trees were cut for construction of housing and to clear land for agriculture. From 1984 to 1990, the closest forested areas were about 5 - 6 km away. Now the wood collectors travel 10 - 15 km to the forest. Communities in the study area of Prek Prasap are located along the River Mekong, and the main environmental problem faced is increased flooding. In 1996, the area experienced its worst flood since 1978, when the river rose 1 metre above its bank, destroying some of the charcoal kilns. Floods were also reported for 1991 and 1994.

Until recently, there were only a few charcoal kilns and firewood was collected from the forest mainly for local consumption with few effects on the natural forest. Forest lost in this way will recover if the trees are cut using appropriate techniques. There are now large areas which have been granted to companies through logging concessions. The exploitation of logs in the concession areas, provides great benefits to the concession companies, but few to the local communities, greatly reducing their motivation to protect the environment. Charcoal production has developed on a huge scale, and Kratie is one of the main supplying areas for Phnom Penh

and the forest continues to recede. This suggests that it is the demand from the commercial markets in urban areas, rather than wood energy for local consumption which causes on forest loss.

In the areas which have been cut, young trees are growing and the communities believe that the forest can recover to its original form and attract the lost wildlife to return. They therefore see no problems with their trade, but if the demand for charcoal decreases, they expect to be able to gain an income from rice and vegetable production.

6.2.2 Kampong Thom Province

Kampong Thom had 68% forest cover in 1969 which provided a habitat for a diverse range of wildlife including tigers, monkeys and deer. Forest cover has since been reduced to 30% and wildlife has been lost due to war, logging concessions and agricultural clearance. A large amount of the forest was lost between 1992 - 1995 and charcoal production was viewed as a contributory factor. Kampong Thom has a large brick industry which also places great pressures on the forested areas as wood is used to fire the kilns.

Land is now being cleared to establish cashew plantations in the revival of an industry well established by the local agricultural department throughout the 1960s. Planting of cashew trees should enhance the environment by replacing some of the many lost trees, and should be beneficial to the local communities who can earn large incomes from the sales of the fruit.

The loss of forests is leading to a loss of soil quality and for the first time the communities in this area are noticing soil turn to sand. They also reported increasingly irregular rainfall and a hotter climate.

6.2.3 Kampong Speu Province

As recently as 1990, the forest areas were found along the roadside, and one village could not be seen from the next. Now the forest has receded a great distance, and firewood collectors spend a whole day going to the forest.

Original residents of the area cut trees to supply the commercial markets of Phnom Penh. Lands to the north and south of National Route 4 have been allocated to military or industrial developments, and landless families are prohibited from going into these areas. An earlier study (MoE/MAFF/CEMP, 1997) indicated that wood was collected from Kirirom Mountain. Recently, park rangers have been installed in the National Park, but the effect of this on wood collectors has not yet been seen.

More recent migrants have been given land within the military development area next to the boundary of Kirirom National Park, and here the provision of wood energy is secondary to land clearance for agriculture.

Temporary migrants move into the area during the dry season solely to cut trees for sawmills and the wood energy trade. They show no concern for their actions because it is not their permanent home.

There are a lot of sawmills in the forest, including some illegal ones, and many of the villagers were employed in cutting trees for this trade. Off-cuts of wood are sold as firewood to urban areas, although its supply cannot be directly linked to forest loss.

Within the study area, people are aware of the environmental impacts of cutting trees, having experienced flooding, drought and loss of soil quality, but they have no other income generating opportunities.

6.2.4 Kampong Chhnang Province

The study areas of Anglongton and Speanpo are located along the roadside. In 1979, forest covered land behind the villages, but now the wood collectors spend 2 days at a time to make a return trip to the forest. Many people expect the forest to have disappeared over the next 2-3 years, but are not too concerned as they believe that forest will regenerate on the cleared land behind the villages. The study team was unable to assess the environmental changes in the production areas as at the time of the study they were inaccessible.

6.3 The Consumption of Energy in the Household

Burning woodfuels within the household creates indoor pollution as firewood and charcoal both produce smoke on burning. The extent of this problem depends on the species of wood and the quality of charcoal, both of which are becoming poorer. Effects on the user include respiratory and eye problems.

Cooking with LPG or electricity eliminates these problems but are clearly outside the financial limits of low-income households.

6.4 Alternative Energy Forms

There are environmental impacts connected to all types of energy use and these need to be considered in planning for a sustainable energy mix. A recent study estimates emissions from generators within Phnom Penh as follows:

Emission	Amount (in Tonnes)
Gas	1,000
Sulphur Dioxide	7,700
Nitrogen Dioxide	4,400
Hydrocarbons	2,300
Carbon Monoxide	52,000

Source: MoE, 1996

The air pollutants are mostly concentrated in the urban areas, but their impacts affect a much wider area. The emissions are low in comparison to neighbouring countries, but will increase with development. Noise pollution related to generators is also a big problem in Phnom Penh.

Fossil fuels, such as LPG and oil are becoming increasingly popular in the country. Increased combustion of these fuels will increase CO2 and other emissions. If the increased use of these fuels means that trees will be left standing, the impact of these emissions can be reduced through absorption of CO2. However, a sustainable supply of wood energy would allow an indigenous, renewable energy source which also provides other forest products and environmental stability.

Within the Kingdom of Cambodia, energy developments are focusing on hydropower development. Energy from river sources can be hugely beneficial in economic terms, but the environmental impacts may be devastating to the country's unique hydrologic cycle.

It is clear therefore, that environmental impact assessment is crucial in energy planning.

7. WOOD ENERGY IN GOVERNMENT POLICY

The Royal Government of Cambodia adopted a National Programme to Rehabilitate and Develop Cambodia, in 1994. Within the programme are directions and strategies for sectoral development. Departmental policies have been based on this document, but as a multi-disciplinary issue, wood energy development needs to be addressed through inter-ministerial co-operation. This section will examine the current status of the Forestry, Energy and Environmental Policies in order to identify the strengths and weaknesses in each in relation to wood energy development.

7.1 Department of Forestry and Wildlife

The Department of Forestry and Wildlife is an institution established in 1979. It is a technical institution under the jurisdiction of the Ministry of Agriculture, Forestry and Fisheries, and its work is implemented in co-operation with other governmental departments. The Department of Forestry is currently undertaking a policy review to cover all levels of government, to ensure the management and protection of the nation's forests.

The main objectives of the Department of Forestry and Wildlife are towards sustainable forestry and the maintenance and stability of forest biodiversity. The Royal Government, particularly the Department of Forestry and Wildlife, are greatly concerned about the destruction of the forests in the past, and to address this major issue the Department aims to achieve**:**

- Management of firewood coupes
- Management of concession areas
- Reforestation through plantations, concession forestry and community forestry.

In maintaining the system of firewood coupes, the Department of Forestry has recognised the ongoing demand for wood energy. The Provincial Forestry Department submits land areas assigned for firewood coupes to the Department of Forestry on an annual basis. Auctions are then arranged in each province to sell the land to companies for exploitation and forestry officials provide technical advice in coupe management. The area devoted to firewood coupes in various Provinces between 1994 and 1997 is shown in Table 25.

Table 25 : Firewood Coupes in Different Provinces, 1994 - 1997

Year	Provinces	Total Hectares	Total Steres	Amount of Trees
1994	Kampong Thom			
	Pursat			
	Battambang			
	Kampong Speu			
	Kratie			
	Sihanoukville			
	Koh Kong			
		20,590	158,353	106,500
1995	Kratie			
	Kampong Chhnang			
	Pursat			
	Battambang			
	Koh Kong			
		15,498	151,443	59,800
1996	Kampong Chhnang			
	Pursat			
	Kratie			
	Koh Kong			
		14,498	146,443	93,095
1997	Kampong Chhnang			
	Pursat			
	Kratie			
	Koh Kong			
		15,498	152,943	43,000

Source: Department of Forestry

The strengths of the firewood coupe system were best illustrated before 1970, when the Department of Forestry, in co-operation with enterprises, operated under formal agreements to provide a sustainable supply of wood energy to Phnom Penh (Yin Kim Sean, 1972).

Today, the coupe areas are illegally encroached upon by the local communities and armed forces, and none of the above firewood coupes have been sold. Anarchic cutting allows lower prices in the markets and firewood coupes cannot compete with the freely exploited wood energy.

Concession management plans are prepared by the Department of Forestry for forest concession areas. Included in the management plan is a requirement for the stumps and crown of the trees to be removed from the concession area, along with the trunk of the tree. However, the study showed that this requirement is not met; stumps and crowns are removed instead by local communities living around and within the concession areas for use as firewood. Access roads within the concession areas invariably open up previously inaccessible areas of forest to local communities which, in view of the difficulties of upholding regulations in the more insecure areas, is likely to lead to further illegal encroachment.

Today, the Department experiences great difficulties in regulating the forest areas due to the amount of illegal cutting by local communities and the armed forces, and the insecurity within the forested areas.

7.2 Department of Energy

The principle objectives of Energy Policy (MIME, 1995) cover the provision of adequate supplies of low cost energy for homes throughout Cambodia, and the supply of energy to all sectors of the Cambodian economy whilst minimising environmental effects. To assist national development, energy planners must consider all economic, financial, environmental and social factors. The Department of Energy is the principle government agency for the energy sector, and due to the interaction of energy with all sectors of the economy, this department must work closely with other government departments.

In the sustainable development of energy, emphasis is given to renewable energy sources, although the focus is on hydropower. Concerning woodfuels, the Energy Policy states that responsibility for forests must be within the Department of Forestry. Nevertheless, it recognises the need for the Department of Energy to work closely with the Department of Forestry and Ministry of Environment to ensure that adequate supplies of wood are provided sustainably throughout the country.

Planning for wood energy must be part of a broader energy plan, encompassing the full mix of possible energy sources to satisfy the end users. At present, however, energy planning within Cambodia is limited by the lack of data regarding the supply and consumption of energy within the country as a whole. Collection of this information is difficult due to the insecurity in some parts of the country. Whilst human resources have been lacking in the past, the capacity of the staff of the Department of Energy has been greatly improved in recent years.

The importance of wood energy planning has been recognised within the Department of Energy, and a Wood Energy Planning Unit is currently being established.

7.3 Ministry of Environment

The Kingdom of Cambodia has for a long time suffered war, illegal exploitation of natural resources and environmental catastrophes. The complex issues related to these problems must be addressed by the Royal Government and Cambodian society in order to enhance the living standards of the population and to assist the country's development.

The Ministry of Environment is an institution established in November 1993, following the general election. It has a broad mandate to protect the natural resources of the country and to prevent environmental degradation. Although not directly involved in wood energy planning, the Ministry must, within this mandate, be consulted about energy and forestry developments. The long range goals of the Ministry of Environment include**:**

- management and protection of natural resources to ensure sustainable environmental development
- strengthening co-operation with relevant ministries to control and improve environmental quality
- control and review of environmental impacts of all development projects within the country.

Forest loss has occurred within the coastal zones, hills and flood plains. The associated environmental impacts, and some of the reasons for deforestation have been outlined above. The Ministry of Environment is working in co-operation with relevant government departments and other organisations concerning wood energy development.

As the Ministry of Environment has no direct role in the development of the energy base, it is reliant on the relevant government departments to inform it of energy developments which require environmental impact assessment (EIA). The Ministry of Environment should conduct EIA on all private and public development projects throughout the country. EIA is important to identify the environmental, social and economic impacts of an activity before that activity is undertaken; and to identify alternatives to that activity. In the Kingdom of Cambodia, it is hoped that this will**:**

- ensure sustainability of socio-economic development
- maintain the natural resource base now and in the future
- protect the national socio-culture from the impacts of resource exploitation and development.

Wood energy developments, like other development projects, require environmental impact assessment to indicate the conditions which will maintain sustainable extraction rates and regeneration of the forested areas. Environmental impacts of other energy developments should also be assessed and integrated within environmental impact analysis.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

Wood energy from rural supply areas to consumers in Phnom Penh flows through an unregulated and informal system which encompasses many traders. The majority of households, as well as many industries, rely on woodfuels as their main energy source. The study has shown that the demand is unlikely to decrease in the foreseeable future and suggests that woodfuels are supplied to the urban market in an unsustainable manner. It is clear however that policies related to wood energy can only be successful if they are formed from a good information base which enables a true understanding of the nature of the trade, the people relying on it for their living, the needs of the consumers and their constraints in fuel switching.

Firewood and charcoal comes from forested areas in Kratie, Kampong Thom, Kampong Speu, Pursat and Kampong Chhnang. Since 1970, the forested areas have been greatly reduced due to war, agricultural clearance, construction and logging concessions. Communities within the supply areas reported that forest loss and degradation have been most rapid over the last few years, and the reasons given for this include agricultural clearance and firewood collection. The provision of wood energy is often associated with forest loss, but involvement in the wood energy trade is often a secondary factor and cutting trees to obtain land for agricultural use is the primary factor.

Within the rural areas, most of the wood for local consumption is collected from agricultural land, such as paddy dykes, which suggests that it is the supply to the commercial urban markets which has the greatest impact on the forests. A main issue in these areas was that of land ownership, as it is mostly those without land who are engaged in the trade.

Permanent residents of communities in the supply areas are concerned about the disappearance of the forests, and the environmental impacts relating to this. Some areas have already experienced flooding and drought, and have observed biodiversity loss. Now the quality of wood species is poorer, yet the prices increase due to the increased travel distance to the forest. However, in areas lacking alternative income generating activities, they have little option but to continue with their trade.

Conditions in the supply areas differed according to the community involved in the wood energy trade, living standards within the area, and also their relationship with the relevant provincial forestry department. These factors highlight the requirement for provincial wood energy planning.

Within Phnom Penh, the majority of the population use wood energy for their daily cooking needs. Increased incomes tend to lead to fuel switches, and this was observed in Phnom Penh where there has been a switch to LPG by wealthier households. However, it was also noted that a loss of income, or increased prices, can lead to a return to wood energy consumption. The National Institute of Statistics (1995 and 1997) indicates a decrease in the proportion of households using woodfuels as their main source of energy for cooking but, as is noted by the Department of Energy (MIME 1996c), the demand is likely to remain due to the increased

population. However, most households use more than one fuel, and wood energy remains popular within all income groups for traditional dishes and ceremonies.

The growth rate of the population of Phnom Penh is high, and low-income households form the largest sector of the society. Access to energy is determined mainly by incomes, and therefore low-income households use wood energies because they are cheap and can be bought in small quantities.

The demand for wood energy from industry and services is smaller than the demand from households, but industries such as those using brick and tile kilns are likely to continue to require firewood to fire the kilns to meet the needs of the construction industry. Some bakeries were found to be using electricity.

The traders in the urban market are the important link between the suppliers and consumers, and provide an essential service for the population of Phnom Penh. Woodfuels supplied to Phnom Penh are distributed by an array of traders and transporters in the city. The study has illustrated the complexity of the distribution system and the amount of people employed in the urban wood energy markets.

There is increasing competition in Phnom Penh, and the traders rarely appear to make a large profit from their trade. However, in the city there are alternate job opportunities, and in this respect, the urban traders are better-off then their rural counterparts.

The study shows a little over 95,000 steres of firewood and almost 24,000 tonnes of charcoal entering Phnom Penh each year. However, it was also found that some of this amount is sold on to forest-poor provinces, which highlights Phnom Penh's role as a trading centre for wood energy. Although this appears to account only for a small amount of woodfuels at present, it is unlikely to decrease whilst neighbouring provinces have no other forms of supply, and it is an important consideration for wood energy planners.

Fossil fuels are becoming increasingly popular in the country, as wealthier households switch to LPG for cooking, and electricity becomes more available in urban areas for lighting and powering appliances. Although LPG and electricity are cleaner and more convenient to use, the levels of carbon dioxide emitted during their use contribute to global warming. At the moment, electricity in Cambodia is generated from oil which, along with LPG, is a finite energy source. Wood, on the other hand is renewable and indigenous, and provides other forest products and environmental stability.

Wood energy planning is addressed by the policies of the Department of Energy and the Department of Forestry. The Department of Forestry has responsibility for the supply of wood energy, and this is done through firewood coupes. These areas of forest are not successful at the moment because they are uncompetitive in an urban market supplied with freely exploited wood. Within rural areas, officials have great difficulty in ensuring their forestry techniques are maintained due to problems with security.

The Department of Energy is responsible for providing a supply of energy to meet the requirements of the end users throughout the country. Plans currently focus on the provision of electricity in order to encourage economic development. However, woodfuels provide over 80% of the total energy supply for Cambodia, and must be addressed in energy planning. Energy demand forecasts will be met from a mix of energy forms, which will include firewood and charcoal. Energy is central to all sectors of the economy and therefore it is a multi-disciplinary field which requires inter-ministerial co-operation. Wood energy planning necessitates a close working relationship between the Department of Energy and the Department of Forestry if the objectives of both departments are to be successfully met.

8.2 Recommendations

Energy policy should promote wood energy planning to achieve its aim of providing energy to all sectors of society. Woodfuels are indigenous and potentially renewable forms of energy, and also provide many other benefits to local communities and the country as a whole.

Within forest policy, wood energy provision must be fully integrated into forest management plans. It is an opportune time for the Department of Forestry to allow the local communities to participate in firewood coupe schemes, whereby the communities in the supply areas could benefit from technical advice to obtain a sustainable source of wood. In return, the Department of Forestry would gain revenue and communities to assist in forest management.

In order for the true costs of extraction to be reflected in the price of wood energy, the Department of Forestry should examine alternatives for setting a charge to rural traders, which would contribute to the revenue of the department, and would enable firewood coupes to become more competitive.

The working relationship recently initiated between the Departments of Energy and Forestry need to be further developed to ensure successful wood energy planning.

In rural areas, the issue of land tenure must be addressed as most of the firewood collectors are those without land.

Community forestry projects must include local wood energy provision especially in forest poor areas. This requires the community forestry units of the Department of Forestry and the Ministry of Environment to maintain their strong working relationship.

Provincial wood energy planning is necessary to address the local specificity of wood energy supply and consumption.

In making changes to wood energy policy, it will be necessary to consult other relevant government departments such as the Ministry of Environment, the Ministry of Agriculture and the Ministry of Rural Development.

Rural improved cookstove programmes should be extended into urban areas to improve the efficiency of wood energy consumption.

Further research into wood energy supply, distribution and use is necessary to successfully plan for future demands to be met. This will require training of government staff in the importance of data collection and analysis in this field. This could include consultation with experts from other countries within the region, and international and non-governmental organisations.

A data base should be established to provide the information necessary to formulate effective policies. It should be continuously updated.

Surveys at checkpoints at the municipal boundaries of Phnom Penh and in the urban markets should be undertaken on a regular basis to assess changes in the trade over time which would assist wood energy planning, energy forecasting and forest management plans.

For any of the above recommendations to be implemented it is necessary to strengthen institutional structures through legislative and regulatory frameworks and the securing of political will.

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