An Overview of Wood Energy Development in Cambodia and Appropriate Policy Options

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1. INTRODUCTION

Country Background

The Kingdom of Cambodia is a country of 11.4 million people, growing at an annual rate of 2.4%. Rural areas are home to 84% of the population, although the urban areas are the regions of most rapid growth. Over half the population is female, and the rate of dependency is high, with 53% of the population below 18 years of age (MoP 1999a).

Conventional energy is supplied almost entirely from imported petroleum products. Its contribution to energy consumption is increasing in percentage terms following growth in the commercial and industrial sectors, and a rapid rise in demand from the transport sector. 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, as well as the expanding informal sector. Despite widespread recognition of wood fuel consumption, wood energy development is not viewed as a high priority.

The last forest inventory was conducted in 1969, and at that time, forests covered 73% of the total land area. Estimates of current forest cover vary considerably, although 58.6% (MRC/GTZ 1997) is adopted by the Department of Forestry. Stock and yield tables are not available for any land types. Land tenure and land use rights remain constraints for sustainable forest management, and wood energy development in general.

Economic growth is generally linked to an increase in income, which is expected to lead to an increase in demand for conventional fuels such as LPG and electricity. Whilst a higher consumption of LPG has been observed in high-income households within urban areas, it is used to complement wood fuels. Energy transitions are limited by financial and spatial constraints, leaving the majority of the country’s population reliant on wood fuels. Combined with rapid population growth, demand for wood energy is unlikely to decline in the foreseeable future. It is therefore increasingly important to recognise the contribution of wood energy within the national energy balance, and to plan for a continued and sustainable supply.

Since 1997, the Departments of Energy and Forestry, and the Ministry of Environment have been working in cooperation to promote the relevance of wood energy development and planning. However, outside this core team, misconceptions about wood energy abound particularly in relation to deforestation, energy transitions, and the value of wood fuels. Given the current policy trends of banning wood-cutting and use, the encouragement of LPG use, and the ongoing policy reviews, it is essential to examine and clarify certain issues and misunderstandings, in order to ensure the selection of appropriate policy options for wood energy development.

Background to this Document

The purpose of this document is to provide an overview of developments related to wood energy, in order to assist policy makers within the country to identify and prioritise challenges and tasks for the future. It will also form part of the end-of-project document from RWEDP to the Kingdom of Cambodia. Cambodia has been a member of RWEDP since 1996, and during that time, relevant government departments have received support through training and capacity building in data collection and analysis, planning and policy formulation.

Material for the paper has been obtained from a range of secondary sources, and discussions with key individuals within the Departments of Energy and Forestry. Whilst information has been taken from sources considered by the author to be the most reliable, it needs to be treated with caution. The most comprehensive coverage of energy statistics date from 1994/95, prepared by the Asian Development Bank, and which note the limitations of the data in quantity and quality (MIME 1996a). With regard to forest and non-forest resources, there are no reliable figures concerning forest cover, and no information related to stocks and yields exists, so best estimates have been adopted.
Misconceptions about Wood Energy

Firewood Collection is a Major Contributor to Deforestation

In Cambodia, the collection of firewood is generally perceived to be a major contributor to deforestation, although little evidence exists to support such an assumption. In the words of Cor Veer, "the bulk of deforestation is due to processes that would proceed at the same pace with or without fuel wood use; and the bulk of fuel wood in most countries originates from non-forest lands" (cited in RWEDP 1997). This quote is supported by studies from countries within the region, which indicate that two thirds of all wood fuels originate from non-forest land. In Cambodia, it can be assumed that half of all wood fuels originate from non-forest areas (Hong 1997). "In most countries, forests are disappearing not because people want the trees to burn, but because they want the land under the trees for agriculture." (Eckholm, Foley, Barnard and Timberlake 1984, cited in RWEDP 1997). In Cambodia, some areas of high fuel wood production correspond to areas undergoing land use conversion. The primary reason for forest clearance in these areas therefore is to obtain settlement or agricultural land, from which the trees cut are used or sold as firewood or charcoal. In this case, fuel wood collection is not a cause of deforestation.

Economic Growth will Lead to Increased Incomes, and Energy Transitions

Substitution of wood fuels for conventional fuels is expected following economic development and increased incomes. Whilst this is observed within urban areas, particularly the capital city of Phnom Penh, conventional fuels usually complement, rather than replace wood fuels. Fuel switching is enabled when two main conditions are met, described by Leach and Mearns (1988) as "access to dependable supplies of modern fuels in sufficient quantity", and "sufficient income to invest in the devices for using them or to overcome other barriers to adopting modern fuels". Such switches are therefore constrained by financial and spatial factors. As the majority of the country's households are in rural areas, with low-income and poor access to markets, it is unlikely that the demand for wood fuels will decrease significantly over the short-term. In view of the lack of town planning, the increased demand for low-cost housing from a rising urban population will lead to the development of shanty areas or slums without access to services (MoE 1994), and the demand for wood fuels is therefore likely to continue.

Firewood has Little Value

The contribution of wood fuels to the national energy balance is largely overlooked by policy makers and planners. The most recent figures indicate traditional fuels to contribute 85% of the national energy supply, of which 80% is firewood and charcoal, and in absolute terms, the demand for wood fuels is increasing. It is therefore useful to determine the value of wood fuels, especially as all conventional fuels are imported. The significance of such a calculation is the impact on the national import bill, were wood fuels to be discouraged from use in favour of conventional fuels. As an example, a similar calculation for Thailand, where wood fuels account for less than 30% of all energy use, shows the value of wood fuels to be more than 50% of its energy import bill for 1994 (RWEDP 1997). This indicates that for Cambodia, where wood fuels account for a large proportion of total energy use, substitution would be impossible, given the high percentage of export earnings required to facilitate such a change.

2. DETAILED REVIEW OF THE WOOD ENERGY SECTOR

Consumption

Wood Fuels in the National Energy Balance

The most recent national energy balance relates to 1995. During that year, conventional energy contributed only 15% of the total energy supply (MIME 1996a). Conventional fuels are all imported into the country. In 1993, imports of oil amounted to 289,000 tons, of which 35% was used for electricity generation (World Bank 1995). By 1998, oil importation had increased to 564,790 MT (Camcontrol 1998). Only 10% of the country's households have access to electricity (MIME 1999). LPG is imported through the private sector. The most important energy sources are therefore, traditional fuels, of which firewood contributes the major part (MIME 1996a).

Energy data for the years 1993 – 1995, the period before forecasting began, must be treated with caution. Energy supply and consumption information shows an annual increase for conventional fuels, but a constant figure for firewood and charcoal, which is unrealistic given the high rate of population growth, and limited availability of alternate energy sources.

Energy Consumption within Economic Sectors
In 1995, the residential sector consumed 99% of the traditional energy supply. Rural households consumed 93% of this total, reflecting the high percentage of the rural population within the overall total. The remaining traditional fuels were consumed by the service and industrial sectors. Within the industrial sector, the main uses of wood fuels are for charcoal production, palm sugar production, fish smoking, tobacco drying, brick and tile manufacture, bakeries and handicrafts such as pottery. Commercial users include restaurants, street food vendors, laundries and animal rearing. Firewood and charcoal is also used in traditional ceremonies such as weddings, funerals and cremations, in addition to daily use within pagodas.

In 1995, conventional fuels were consumed mainly by the transport sector, accounting for 82% of the total, followed by households (11%), services and industries. Energy consumption data is unavailable for the agricultural sector, as it is mainly dependent on human labour and animal draft power for its energy needs. However, conventional energy is required to power tractors and irrigation, although this is thought to be included within the transport sector demands (MIME 1996a).

**Socio-Economic Factors Related to Household Energy Consumption**

The available energy statistics suggest that the residential sector is the major consumer of traditional fuels, and therefore requires more detailed examination in order to plan for future supply. A series of socio-economic data collected by the National Institute of Statistics between 1994 and 1999 includes population growth and energy types used by households as their major cooking fuel. The heavy reliance of the household sector on wood fuels for cooking is due to a number of factors, including household income, prices of different fuels, energy availability and reliability, and social/cultural issues.

**Population Distribution and Energy Consumption**

Between 1994 and 1999 the population grew from 9.87 to 11.56 million, and over this time the average household size decreased from 5.6 to 5.3. The population distribution has remained fairly constant, with around 85% of the population living in rural areas, although the fastest growth rate is within urban centres. The reliance on wood fuels for cooking remains at 96%, although this average masks a range of 86% in urban areas, and 97% in rural areas. The exception is Phnom Penh where the figure drops to 78%. Urban households consume a greater proportion of charcoal than rural areas, as it is a cleaner fuel and the preferred option in commercial markets. In comparison, in rural areas, firewood is generally freely available for collection, and is therefore preferred to charcoal.

The provincial breakdown, shown in Table 1, reflects the energy availability in different areas. The coastal mangrove areas of Kaoh Kong and Krong Preah Sihanouk show a higher percentage of charcoal use, whilst forest poor areas such as Prey Veaeng and Svay Rieng have a higher consumption of other energy types. The use of wood energy for cooking varies significantly across the country, the highest being Prey Vihear, an area only recently accessible, and the lowest being Phnom Penh, the economic centre.
Income and Energy Consumption

The most recent information regarding income indicates that the poorest 10% of the population earn only 3.6% of the total income, in comparison to the richest 10% who earn 29.8% of the total (MoP 1999b). Within each income band, distribution is uneven between urban and rural areas, with households in Phnom Penh earning more than their counterparts in rural areas. It was estimated in 1999 that the richest households spend 17 times more on fuel and power but only 4 times more on wood fuels than the poorest households (MoP 1999b). Such large disparities in income and expenditure has a clear impact on household choice of energy types, as they suggest that richer households purchase more expensive forms of energy, such as LPG for cooking, and electricity for lighting. Poorer households, meanwhile, are restricted to cheaper forms of energy, such as firewood and charcoal for cooking, and kerosene or candles for lighting. In rural areas, expenditure on fuel and power is lower, as wood fuels are generally collected freely.

The critical factor for the consumer, especially low-income households, is that wood fuels can be purchased in small, frequent, low-cost quantities, although this may mean that they pay more over the same period of time than a consumer of more conventional energy types. However, energy sources such as LPG and electricity require lump sum payments, and the costs of using such energies include more than the cost of the fuel itself. For example, the use of LPG involves additional expenditure for a stove, and a deposit for the LPG cylinder.

Energy Availability and Consumption

Conventional energy forms are concentrated in urban areas. Petroleum products are imported through Kampot Som, Phnom Penh, and town on the Thai and Vietnamese borders. They are distributed along the main supply routes and therefore only reach easily accessible areas. The expansion of the electricity supply is constrained by limited infrastructure development. There is no transmission network, and only 10% of households have access to a supply (MIME 1999). In rural areas, supplies of conventional energy forms are less readily available and less reliable, and the majority of the population is therefore likely to be reliant on wood fuels for the foreseeable future.

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Table 1 - Percentage of Households by Main Type of Fuel Used for Cooking 1998

<table>
<thead>
<tr>
<th></th>
<th>Firewood</th>
<th>Charcoal</th>
<th>Kerosene</th>
<th>LPG</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banteay Mean Chay</td>
<td>60.0</td>
<td>5.3</td>
<td>1.8</td>
<td>1.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Bok Cambang</td>
<td>62.4</td>
<td>4.4</td>
<td>1.6</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Kompeng Chmen</td>
<td>56.7</td>
<td>1.0</td>
<td>1.6</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Kompeng Chheng</td>
<td>65.8</td>
<td>1.0</td>
<td>1.8</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Kompeng Gpous</td>
<td>56.7</td>
<td>1.1</td>
<td>1.8</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Kompeng Thom</td>
<td>56.6</td>
<td>1.7</td>
<td>2.4</td>
<td>0.3</td>
<td>N</td>
</tr>
<tr>
<td>Kompot</td>
<td>63.5</td>
<td>4.0</td>
<td>1.9</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Komda</td>
<td>66.6</td>
<td>1.7</td>
<td>1.0</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Kdei Kong</td>
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<td>24.2</td>
<td>1.4</td>
<td>2.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Krasahe</td>
<td>65.3</td>
<td>3.1</td>
<td>1.2</td>
<td>0.4</td>
<td>N</td>
</tr>
<tr>
<td>Moneo Kri</td>
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<td>0.5</td>
<td>1.5</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Phnom Penh</td>
<td>43.1</td>
<td>34.4</td>
<td>5.0</td>
<td>16.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Pissan Vhean</td>
<td>59.4</td>
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<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Puri Veang</td>
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<td>1.2</td>
<td>1.1</td>
<td>0.4</td>
<td>5.3</td>
</tr>
<tr>
<td>Pousat</td>
<td>64.9</td>
<td>1.9</td>
<td>2.5</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Rotanak Kiri</td>
<td>66.2</td>
<td>1.6</td>
<td>0.9</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Siem Reap</td>
<td>56.1</td>
<td>1.4</td>
<td>2.1</td>
<td>0.4</td>
<td>N</td>
</tr>
<tr>
<td>Krong Pissan Sihanouk</td>
<td>68.7</td>
<td>27.3</td>
<td>1.7</td>
<td>2.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Stueng Treng</td>
<td>54.6</td>
<td>4.4</td>
<td>0.3</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Svay Fieng</td>
<td>69.4</td>
<td>0.6</td>
<td>1.4</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Teak</td>
<td>66.2</td>
<td>1.0</td>
<td>1.7</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Otar Mean Chay</td>
<td>67.4</td>
<td>1.6</td>
<td>0.8</td>
<td>0.2</td>
<td>N</td>
</tr>
<tr>
<td>Krong Kaeb</td>
<td>56.3</td>
<td>1.4</td>
<td>2.0</td>
<td>0.3</td>
<td>N</td>
</tr>
<tr>
<td>Krong Painin</td>
<td>40.5</td>
<td>55.5</td>
<td>1.6</td>
<td>1.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>


N = Negligible
Social/Cultural Issues and Energy Consumption

In wealthier households, LPG appears to be the popular cooking fuel. However, even within these households, wood fuels are important for grilling and food requiring long cooking times, which suggests that factors other than increased incomes and energy availability influence the types of energy consumed. Wood fuels remain important energy sources for traditional festivals and ceremonies.

Consumption Technologies

Wood fuels are most frequently consumed using traditional technologies with high inefficiencies in heat conversion. The most comprehensive study of cook-stove use is from the province of Kampong Chhnang, which shows a high utilisation within the household sector of the Siam stove, three stone stove and Lao bucket stove (CFSP undated). Within Kampong Chhnang, improved cook-stoves have been introduced for household cooking, sugar palm production, and for institutional use. CFSP are currently planning to introduce an improved household cook-stove into Phnom Penh.

Energy Demand Scenarios

Energy demand scenarios developed by the ADB (MIME 1996c) suggest a continuing decline in the share of traditional fuels in total consumption to 72% in the year 2010. However, in absolute terms, the scenarios indicate an increase over the same period from 80 to 109 petajoules. The household sector will continue to consume the majority of traditional energy supplies, and a small increase is expected within the industrial sector. The transport sector will continue to dominate the consumption of conventional energy, and an increase in the share of consumption by the service and industrial sectors is expected to increase, whilst a reduction/stabilisation is anticipated within the household sector.

Implications for Policy Development

Despite the reduction in relative terms of the use of wood fuels within the national energy balance, figures show a clear increase in the amount of households using firewood or charcoal as their main sources of energy for cooking. The important role of wood fuels must therefore be recognised within energy policy, and due consideration should be given to increasing the efficiency of its use, through improved consumption technologies. Plans for future wood energy consumption must be made in cooperation with the Department of Forestry to ensure a sustainable supply.

Energy consumption data is most comprehensive within the household sector, in relation to the main sources of fuel for cooking and lighting, although the annual amounts consumed are limited and vary depending on location and availability of energy types. Little information is available on energy use within industry and services, although it is thought that wood fuels are used extensively within these sectors, as well as the expanding informal sector. However, it is apparent that wood fuels are the dominant sources of energy and it is expected that local scarcity and abundance exists according to the level of accessibility to wood fuels. Planning can therefore proceed without such detailed information. Future studies will enable the current data gaps to be filled and time series data to be obtained to allow district level planning that considers local specificities of energy consumption.

Supply

General consensus in Cambodia is that wood fuel collection is a major contributor to deforestation. However, there is no evidence to support such an assumption, and research related to wood fuel supply is limited.

Sources of Wood Fuels
Wood fuels originate from a variety of sources, including natural forests, agricultural land, land conversion, land around houses, along canals, roads and railways, as wastes from the timber industry, and wood recycled from construction, packing, etc.

**Availability of Wood Fuels**

The amount of forest in Cambodia varies between sources, depending on their definition of forest cover. The last forest inventory was conducted in 1969, at which time 73% of the total land area was classified as forest. More recent information from MRC/GTZ (1997) indicated 58.6% of the total land area to be forested, and is the figure adopted by the Department of Forestry. This figure masks wide differences in forest cover between and within provinces (see Table 2), leading to wood surplus in some areas, and deficit in others. The southern and central areas are extremely forest-poor, although the high consumption of wood fuels in these areas suggests a supply from other types of land use, and/or from other provinces.

Stock and yield tables for different land types are unavailable, and it is therefore difficult to determine how much wood is available for energy from forested areas, and likewise from non-forested areas. Of course, not all of this is available for energy, other users of wood include the timber industry, construction, furniture, handicrafts, etc. Some wastes from these industries eventually enter the wood energy market.

The Department of Forestry calculated that 6 million cubic metres per year are supplied to households to satisfy their cooking requirements, of which half comes from forested areas (Hong 1997). This figure is based on an estimated wood fuel consumption of 0.6 cubic metres per person per year in Phnom Penh, and a survey of firewood transported through check-points into the capital (DoF 1994). It does not consider the amount of fuel wood consumed by the industrial and service sectors, and does not appear to take into account the amount of firewood required to produce charcoal.

A research study conducted in 1997 by the Wood Energy Flow Study Team suggests that 57,226 cubic metres of...
firewood enter the Phnom Penh market annually. If all this wood were to be consumed in Phnom Penh, a per capita consumption of 0.07 cubic metres is indicated. However, some of this amount is distributed to other nearby towns, and some sold to the industrial and service sectors. In addition, 23,802 tons of charcoal is estimated to enter Phnom Penh annually.

**Wood Fuel Collection/Harvesting**

*Natural Resource Base*

The impact of wood fuel collection on the local resource base relates to its richness, and the land ownership or land use rights of the communities. Where households own land around their homes, they have an incentive to cut firewood on a sustainable basis, and to invest in multiple-use tree planting on their land. All forest-land is owned by the State, with no community participation in management, resulting in a lack of incentive for local communities to cut and use wood gathered in the forests in a sustainable manner. Land ownership or land use rights are reflected in the harvesting methods, for example, for local use it is likely that twigs, dead branches and prunings are collected from around the house, whilst to supply markets, often the whole tree is cut from the forest and sold as wood fuel. In areas of high wood fuel production, the trees are cut during conversion from forest to agriculture or settlement land.

*Recovered/Recycled Wood*

Residues from the wood processing industry have a potential to be recovered for energy use. Estimates within the region indicate that 80% of trees in the forest are wasted during the production of sawn wood (RWEDP 1997). Half of this amount is left in the forest as branches and stumps, with the remainder lost during processing. Within Cambodia it is not known how much waste is accessible for wood fuel, although Lao (1993) indicates that off-cuts, sawdust and other waste amount to 40% of wood processing operations.

Within urban areas, old construction wood, pallets and packing crates, furniture, etc are recycled for wood fuel.

*Other Biomass*

Agro-residues are an important source of energy within Asia, although in view of the lack of data for Cambodia it is difficult to determine its importance within the country. Agriculture dominates the economy, therefore suggesting a large amount of agro-residues. However, residues are also important for other uses, such as fertiliser and fodder, and the proportion available as wood fuel is unknown. Energy statistics suggest that the figure is extremely low at less than 2% of the total energy consumption, although the figure was arrived at 'somewhat arbitrarily' (MIME 1996a). Residues are expected to be more important forms of energy in forest-poor areas.

*Conversion Technologies*

Within the wood energy sector, the only type of conversion technology used in Cambodia is the charcoal kiln. Three types of kiln, the brick beehive, earth mound, and flat-bed, have been observed in different parts of the country, and the type used appears to depend on the permanence of the site. The efficiencies of each differ according to the type of kiln and the skills of the charcoal producer. Currently, there is no development or promotion of more efficient technologies.

*Implications for Policy Development*

Gaps in current data related to natural resources remain due to the lack of inventories. Whilst forest cover can be estimated from satellite imagery and aerial photography, there has been no ground-truthing or inventory of trees on different land types since 1969. As it is difficult to estimate the amount of wood available for harvesting on a sustainable basis, so too is it to determine the potential amount available for energy. Whilst such information is essential for forest management, it is evident that a large amount of wood fuel is consumed on an annual basis. However, wood fuels clearly originate from sources other than forests, and the importance of non-forest sources in supplying wood fuels must be recognised by policy makers and planners.

Agro-residues form an important source of energy in some areas of the country. It is therefore, important for the Ministry of Agriculture to develop an overview of potential supply and the different demands on that supply in order to assess the availability of residues for energy.

It is clear that wood fuel will be consumed by the majority of the population for some time to come, and therefore it is necessary for the Department of Forestry to begin planning for future sustainable supply. Given the disparity in wood resources within and between provinces, a relevant level of planning must be identified to allow appropriate resource management options to be considered to ensure the optimal system for sustained wood energy supply.
Through agreements between communities and the government, some communities are managing their resources through community forestry, thereby securing incentives for the sustainable management of resources, including wood fuels.

Research of the marketing and distribution system will be necessary in order to determine ways to ensure that changes to the patterns of wood fuel supply will be feasible without adversely impacting on the present supply and distribution systems. In considering options for wood fuel supply, such research will indicate areas which obtain wood freely, and therefore where commercial production will be unfeasible.

**Distribution**

The marketing and distribution system for wood fuels is more applicable to urban than rural users. Generally within rural areas, firewood is collected freely by individual families, whereas within urban areas, they are obtained through commercial markets. Between forest-rich and forest-poor areas, the transport of wood fuels, like other forest products, is restricted by the limited markets and infrastructure.

The only information regarding the marketing and distribution of wood fuels in Cambodia comes from a wood fuel flow study of Phnom Penh, and whilst this section is extracted from that report, it should be noted that within other urban centres, the distribution system may vary.

**Rural Traders**

Within the supply areas, firewood collectors cut wood from areas undergoing agricultural conversion, or from forested areas. Firewood is also supplied as off-cuts from sawmills. Some firewood collectors also make charcoal on a small scale, whilst others sell to larger scale charcoal producers, or enter the firewood directly into the distribution system. Charcoal is produced either close to the forest, or around the village in small earthen kilns, or large brick built kilns. Most firewood collectors and charcoal producers trade independently, selling to traders or transporters along the roadside or railway line. In the case of river transport, boats transport large amounts to Phnom Penh, whose owners act as middle-men. Either way, transporters act as the link between the suppliers and consumers. Generally, the transporters are from the supply areas, but some urban traders buy directly from the suppliers.

**Urban Traders**

Wood fuels are distributed through a highly complex system of transporters and traders. Firewood is split and bundled within the urban areas to the request of the customer, and as with charcoal, are sold to the consumer in small quantities, or in bulk. Purchasers of wood fuels include households, restaurants, and small industries, whilst larger industrial users such as brick and tile kilns purchase their firewood as off-cuts from sawmills, or directly from suppliers in the rural areas.

**Trading Relationships**

Trading relationships exist between rural and urban areas, an example of this is that charcoal producers borrow from urban traders to build kilns, with the loan repaid through charcoal deliveries. Wood fuels are usually traded through cash transactions, although in some cases, payment is made after they are resold.

**Wood Fuel Prices**

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 each level of trader. Prices differ in the wet and dry seasons, with lower prices 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. Within the market system, prices vary according to whether the trader is a transporter, wholesaler, or retailer, and therefore reflects the number of traders the wood fuel has passed through. Prices also vary according to the distance of transportation, species of firewood, or quality of charcoal.

**Employment and Income Generation**

For many people involved in the collection, distribution and trade of wood fuels, this occupation represents the largest part, if not all of their income, particularly for those in rural areas, where alternate income generating opportunities are few, and the majority of the people have no other skills or experience. Due to the informality of the system, the number of people involved in the trade is unknown, although it is expected to be high.

Within the energy sector, the estimated employment per terajoule of firewood consumed averages 140 person
days, in comparison to 15 for LPG and 95 for electricity (World Bank/ESMAP 1991, cited in RWEDP 1997), although RWEDP estimates that the figure for firewood could be 10 times higher.

Gender Roles in the Distribution System

Gender roles within the distribution are not clearly understood. Limited studies indicate men to be the collectors of firewood and producers of charcoal to supply the urban area, whilst men and women chop and stack firewood, and stack or bag charcoal. Men and women (and children) collect firewood for use in rural areas, and therefore the gender roles reflect the harvesting techniques. Women participate in the marketing systems, particularly in urban areas, where the wood fuel trade is often a supplementary form of income.

Implications for Policy Development

Whilst gaps exist in the available information related to wood fuel distribution, the wood fuel flow study of Phnom Penh gives a fairly good overview of the complexity of the system and its operation. The distribution system plays an essential role in supplying a variety of consumers with their main energy source, but what is missing is an idea of the number of people reliant on this trade for their income. This would provide an indication of the importance of the trade, especially in rural areas, where there are few forms of alternate employment.

During policy development, the informal distribution needs further study to assess the amount of employment it generates, and therefore, the number of people affected by changes. Within forest policy, the development of sustainable wood fuel production systems could enhance rural employment. Plans for future wood fuel distribution need to consider transfers of wood from areas of abundance to those of scarcity, which are currently constrained by transportation costs.

3. NATIONAL AND SECTORAL DEVELOPMENT PLANS AND POLICIES

National

Development plans and policies are based on the National Programme to Rehabilitate and Develop Cambodia of 1994. Economic development is at the heart of national policy to enable the country’s transition to a market economy, and to raise the living standards of the population, although growth is concentrated in Phnom Penh. Social development is also a major focus of national policy, particularly in rural areas, which support the majority of the population, and through the agricultural sector contribute significantly to GDP. Rural development is therefore considered crucial in achieving "sustainable growth with equity and social justice".

The present government, installed in 1998, is committed to continuing along this path of development, and has begun the implementation of a series of structural and sectoral reforms necessary to "maintain macro-economic stability and attain a broad-based, sustainable development with equity and alleviate poverty" (RCG 1999). An integrated rural development structure has been established, resulting in the formation of rural development committees at provincial, district, commune and village levels, to promote decentralisation of activities and community involvement in decision making and planning.

The development objectives of the Royal Government are reflected in sectoral policies and plans. Priorities include energy, rural development, and the rational and sustainable exploitation of the country's forest resources. The importance of fuel wood is recognised by the Prime Minister who, in relation to the forestry sector, notes "Another problem is people chopping trees to make charcoal. Before we can [save wood], we need to find other substances for people to use to cook. We also have to find new jobs for people who used to chop trees for firewood and charcoal. Otherwise stopping them would be like destroying their rice bowls" (Asiaweek, May 21, 1999, p28). Such recognition illustrates gaps in information that must be filled, and misconceptions that must be addressed, before the statement can be acted upon.

The RGC (1999) state wood fuels to account for nearly half of total wood demand in 1997, providing almost 90% of rural energy supply, yet sustainable wood fuel production is not addressed within development plans. This is perhaps a reflection of the cross-sectoral nature of wood energy development, and the associated problems in the identification of a 'home' for the sub-sector. Wood energy falls within the scope of the Departments of Energy and Forestry, but also influences and is influenced by other sectors and sub-sectors. Therefore, wood energy policies and plans require a multi-sectoral approach. Wood energy development is a complex issue, it is dynamic, and must therefore be an interactive and on-going process.

The development of wood energy provides an opportunity to meet the above priorities in terms of the development of an indigenous and renewable energy supply, community development through the enhancement of rural employment and income generating opportunities, and environmental benefits associated with sustainable tree
management systems.

Sectoral

Energy

Energy policy remains in its 1995 draft form. The principle objectives 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. Focus continues to be directed towards electricity development, reflecting the importance of economic growth within national policy. Electricity supplies are concentrated in urban areas, there are no rural electricity services although plans are in place for rural electrification.

As all conventional energy is imported, energy policy encourages the development of renewable, indigenous energy supply systems. Renewable energy development efforts focus on hydro and solar energy, yet wood energy is renewable, and provides the most important energy source for the majority of the population within Cambodia, and the largest share of the total consumed energy.

The improvement of energy efficiency is an objective of the Department of Energy, although to date, this has focused on increasing the efficiency of electric lighting in 12 factories in Phnom Penh.

The Department of Energy has recently undergone reorganisation, and it is expected that a Wood Energy Unit will be established.

Forestry

The Department of Forestry is striving to manage and develop the country's forests on a sustained-yield basis. Forest management is addressed through concession management, reforestation and firewood coupes. Forest law and policy are currently under review, and a 5-year plan (2001 – 2005) is being prepared. The extent to which wood energy is addressed within these documents is unknown at present.

Forestry reform is central to the future of the country in terms of international support, and following the installation of the present government the Department of Forestry embarked on a series of measures. Priority areas for reform are concession management and illegal logging, and include a cessation of investments in wood processing, review of forest concession contracts, and a review of forest management law. A forest crime monitoring and reporting project will assist in the implementation of the reforms, with support from FAO. The measures have lead to a crackdown on illegal cutting, and whilst not intended to effect the supply of wood fuels, it is indirectly adversely impacting on aspects of wood fuel supply, trade and use.

The ongoing demand for wood fuel is recognised and firewood for rural use is planned to be met through community forests, a small number of which have already been successfully established on a small-scale in some areas of the country. Urban/commercial demand will be met through an improved firewood coupe system, which will require a thorough review. In the past the system has proven to be unfeasible, as the costs incurred by the operator mean that wood fuels from such areas are not competitive in markets supplied with freely exploited wood. Rational plans for wood fuel supplies will contribute greatly to a sustainable forest management system.

Agriculture

Within Asia, most wood fuels are found to originate on non-forest land, but in Cambodia, wood fuels are not currently addressed in agricultural development policies. The promotion of tree planting on agricultural land, and as part of agro-forestry systems, will enhance wood fuel supply in addition to providing other environmental benefits.

Wood fuel supply is the responsibility of the forestry sub-sector (as outlined above), but the flooded forests are also wood resources under the responsibility of the fisheries sub-sector. Examination of wood resources in other agricultural sectors is also likely to reveal their contribution to energy supplies. For example, rubber trees at the end of their productive life are sold to brick factories around Phnom Penh. In addition, coconut and sugar palm trees provide wood fuels, as will the growing oil palm plantations.

Recognition of the role of crop residues as a source of energy in some parts of the country is required. Whilst there are other demands on this resource such as for use as fertiliser, and animal fodder, the amount available for fuel can be consumed in its primary form, or can be converted into briquettes to provide a more attractive energy form.

Education
It is essential to include wood energy within agricultural and forestry curricula in order to promote its importance for planners and policy makers. Forestry curriculum of the Royal University of Agriculture, includes a module on Non-Timber Forest Products, whose objective is "to study the importance of wood as a fuel, and the characteristics and properties of NTFP" (MAFF/FAO 1999). Students within the Forestry Faculty often undertake wood energy studies for their thesis, but with little or no interaction with other relevant sectors.

**Economy**

The recent switch to a market economy required a new approach to economic development. The private sector has come to play a major role in the national economy, and as such, the supply of energy is increasingly outside governmental control. The supply and trade of wood energy is entirely within the informal sector.

A move has been made to end the taxation of LPG in order to lower its price, and to encourage a switch away from wood fuels within the commercial markets. However, an assessment of the value of wood fuels will highlight their important contribution to the national economy, and indicate therefore, the impact on the economy of encouraging switches to imported fuels.

**Transport**

Road building is given high priority in rural development plans to provide access to urban markets. In addition, access roads have been built into forest concession areas, providing greater access to wood fuel collectors. Combined with the increase in motor vehicles, these points are likely to greatly affect the wood energy trade.

**Cross-Sectoral**

**Land Ownership and Use**

Forest lands are owned by the State. The majority of the rural population has no land title, and therefore, no incentive to protect or replant trees.

Families were allocated land within their village under the 1989 agrarian reforms, although families immigrating after that time were not provided for. In 1992, a new land law was enacted, although it is ambiguous, the land titling offices poorly resourced, and the land registration processes slow and constrained by numerous land conflicts, all resulting in a large backlog of applications, and a growing landless population. The need to address these issues is recognised, the land law has recently been reviewed, and a new draft submitted to the Council of Ministers for consideration.

Land allocation and forest access are serious issues for indigenous people, as their land areas have been allocated for logging concessions and protected areas, in greater quantities than the actual land area, especially in Rattanakiri and Mondulkiri.

**Environment**

National development is expected to impact on the environment, recognised by the Royal Government through its commitment to "ensure that the pattern of development is sustainable socially, politically, fiscally and environmentally" and to "optimise the sustainable utilisation of the natural resource base" (RGC 1994). Therefore environmental sustainability is an overarching aspect in achieving policy objectives, and should be integrated into sectoral development plans. Environmental impact assessment is required for all development projects in Cambodia, but the Ministry of Environment is reliant on cooperation from other government departments and organisations to undertake this task. Environmental Units are established within some government ministries, which will develop cross-sectoral programmes for natural resource management.

There is no evidence of studies related to the environmental implications of energy systems having been conducted in Cambodia. However, the Ministry of Environment is currently preparing an inventory of greenhouse gas emissions as part of its Climate Change Project, and in preparation for the country's first National Communication in response to the UNFCCC. Concerns related to the impacts of future conventional energy production focuses on hydropower, and its potential to disturb the country's unique hydrological system, which controls flooding and irrigation in the country, and is central to the agricultural sector within the national economy.

The benefits of wood fuel production systems include savings made in avoidance or recapture of carbon dioxide from the atmosphere, enhanced agricultural production through soil and watershed preservation, and reclamation of degraded or deforested land. The impacts of fuel wood collection depends on the method of extraction. In the absence of information, it is thought that areas of adverse impact may include those supplying commercial markets, and those of high population density with limited local resources. These would be appropriate areas to
commence studies to feed into the process of planning for future energy development.

Rural Development

The key strategies of rural development are to embrace social and economic dimensions, pay special attention to disadvantaged and vulnerable groups, be participatory, be locally based, and to require decentralisation of organisation and management (MRD 1999). The change of direction has required a re-structuring of the sub-sector, and has lead to the establishment of an Integrated Rural Development Structure at provincial and local levels.

At the lowest level, the Village Development Committee is responsible for securing the participation of rural households, for planning, organisation and management of village development, and for providing a focal point for interaction with government departments, development agencies, and funding sources. As such, the Village Development Committee could be the focal point for wood energy development at the local level.

Energy sources are not specifically addressed within the current rural development plan, although improved cook-stoves are promoted by NGOs in certain areas. The National Plan of Action for Nutrition includes the “planting of trees for firewood and prevention of flooding”, within its rural development component. However, it contains no reference to the fact that in many areas of the country, availability of wood fuel is essential to ensure basic levels of nutrition and food security.

Urban Development

Policies for urban development are yet to be developed. Urban areas account for about 15% of the total population, but are the areas of most rapid growth. As the urban population grows, it becomes increasingly likely that they will live in areas without access to services, and therefore be more reliant on wood fuels.

Employment

The provision of wood fuels is a major source of employment and income generation within the rural areas, and for some urban households. A survey of employment in rural areas would highlight the important role of wood fuels and illustrate ways in which appropriately managed wood resources can contribute to community and rural development, through poverty alleviation.

Gender

Government development plans recognise the dominant number of women in Cambodian society, and their difficulties in accessing land, education and basic services. Therefore, priority is given to the preparation of a gender focus in each of the sectoral plans, and female-headed households feature highly in poverty alleviation strategies. The majority of women work in the agricultural sector, and some are involved in the collection and marketing of wood fuels.

Generally, women have less opportunity to participate in decision-making processes than men, due to their heavy workload involving economic activities, agricultural production, and household duties. However, women are active at the grassroots level, and within the newly formed Village Development Committees must constitute 40% of the membership.

The proposed National Policy on Women promotes their role in agricultural and rural development and their potential to influence sustainable development (Ministry of Women's Affairs 1998, cited in MoP 1998). As society’s most experienced resource managers, the participation of women must be encouraged in wood energy development at the local level.

4. OUTLINE OF POLICY OPTIONS FOR WOOD ENERGY

The above sections indicate an ongoing, and increasing demand for wood fuels, and their important role must be recognised by policy-makers.

Opportunities for Wood Energy Development

Renewability
Wood fuels are renewable and indigenous, in comparison to convention fuels which are finite, and imported.

**Value**

Wood fuels are often undervalued, partly because a large proportion of the fuels are non-monetised, and there are no powerful stakeholders. The estimated value of recorded wood fuel use within the RWEDP member countries in 1994 was US$29 billion, although this figure is expected to be higher due to the amount of under-reporting, and at that time Cambodia was not a member (RWEDP 1997). A comparison of the value of wood fuels with the export earnings of the country is likely to illustrate the difficulties of substituting wood fuels with LPG.

**Employment**

The wood fuel business provides the main source of income for a large number of people. Per unit of energy consumed, the labour involved in the wood fuel business is about 15 times larger than that for LPG. Strategies to encourage sustainable production of wood fuels would therefore help to alleviate poverty.

**Environment**

An area of increasing global concern is that of climate change due to the emissions of greenhouse gasses from the use of fossil fuels. Throughout the world, this concern is resulting in the development of renewable sources of energy, and a reduction of anthropogenic emissions through the sectors of energy, transport, agriculture and forestry.

The importance of sustainable wood fuel production and utilisation is acknowledged as this implies that it is carbon neutral, that is to say that the same amount of carbon dioxide emitted during wood fuel consumption is recaptured from the atmosphere by the regrowth of wood. In combination the increased use of energy efficient technologies, wood energy development can contribute to the achievement of Cambodia's national development priorities of economic growth, social development, and sustainable use of resources.

It is estimated that in 1994, wood fuel use in member countries of RWEDP avoided the emission of approximately 277,683 kton of carbon dioxide, in comparison to hypothetical LPG use. In economic terms, this implies a saving of US$14 billion, based on IPCC estimates of US$50 per ton (RWEDP 1997). Reforestation, afforestation and forest rehabilitation are considered essential within global environmental policies for carbon sequestration. The sustainable production and use of wood fuels will contribute to an enhanced forest resource base, and will therefore become increasingly more economically feasible.

**Policy Options**

To allow effective wood energy development and management, an understanding of policy options is essential, on which informed decisions can be based. Wood energy policies cannot be allocated to one sector due its cross-sectoral characteristics. The following options relate mainly to the forestry and energy sectors, although linkages to other sectors must not be overlooked. The validity of the options must be considered in relation to current national policies, and capabilities of relevant staff to research, design and implement appropriate strategies. Sustainable wood fuel production and use requires a mix of policy options, to reflect the different wood fuel situations within and between provinces, and its changing nature. Options should be selected to optimise economic efficiency, equity, ecological sustainability and financial viability. Development of appropriate legislation and the securing of political will be necessary for the implementation and enforcement of the relevant policy options. A list of options follows, which are detailed in Appendix 1.

**Wood Energy Supply Enhancement Policies**

- Integration of wood fuel production into community forestry
- Sustainable forest management for wood fuel production
- Wood fuel production in agro-forestry systems
- Charcoal production and marketing

**Wood Energy Utilisation Policies**

- Improved stoves dissemination
- Efficient wood energy use in traditional industries and enterprises
- Modern wood energy technology application
- Fuel substitution – use of agricultural wastes
- Fuel substitution – use of fossil fuels
Policies to Build up and Strengthen Local Capacities in Wood Energy Development

- Improving local data and information base
- Developing local planning, policy analysis and programme formulation capabilities
- Developing local capabilities for programme and project formulation

5. CONCLUSIONS

Traditional fuels contribute about 85% to the total annual energy consumption within Cambodia. The majority of this energy is wood fuel, although agri-residues form important sources of energy for some areas of the country, especially in forest-poor regions. Conventional forms of energy are mainly imported into the country, and the majority of households are denied access to such fuels through costs and availability. In urban areas, wealthier households use LPG to complement wood fuel, which remains popular for certain dishes and ceremonies. Energy consumption projections indicate a continued and increased demand for wood fuels, and its planning must be part of a broader energy plan, encompassing the full mix of possible energy sources to satisfy the end users.

Within the country, there is a general assumption that wood fuel supply contributes to deforestation, yet there is no information available to indicate the sources of wood fuels, nor to estimate how much wood can be sustainably harvested from different land types. It is apparent that in addition to forests, wood fuels originate from other sources, and the importance of non-forest sources in supplying wood fuels must be recognised. In view of present global concerns related to climate change, a sustainable cycle of wood fuel production and consumption is highly important because the net emission of carbon dioxide from such a system is zero. Plans for future wood fuel supply include a mix of community and government production systems, but in order to attain sustainability of production, a review of land use rights will be required.

Wood energy is distributed entirely within the informal sector. The distribution system is highly complex and dynamic. It provides a large proportion of family income, especially in rural areas, where alternate income generating opportunities are few, and the majority of people have no other skills or experience. Interventions in the supply of wood fuels could affect the present distribution system, and their potential impacts must be examined.

In Cambodia, the ongoing demand for wood fuels is acknowledged, but not considered within national development policies and plans, and therefore its importance continues to be unrecognised, and relevant sectoral policies remain weak. Central institutions are responsible for policy formulation and planning, but studies have shown that the wood energy situation varies greatly between areas, which illustrate the need for the coordination of central, provincial and local levels. At the local level, the Village Development Committee could become a partner for maintaining wood fuel supply, through its integration into village development plans.

Misconceptions about wood fuel supply and use are prevalent, especially in relation to deforestation and energy switching. It is essential that these misconceptions be addressed in order to enhance the understanding of wood energy issues, leading to an appropriate selection and prioritisation of policy options. Relevant legislation requires development to enable implementation and enforcement of the appropriate policy mix.

National development plans prioritise economic growth, social development, and the sustainable use of resources. Wood energy development will have positive impacts on such objectives, which are evident in terms of the development of an indigenous and renewable energy supply, community development through the enhancement of rural employment, poverty alleviation and income generating opportunities, and environmental benefits associated with sustainable tree management systems.

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APPENDIX 1

Detailed Policy Options
Wood Energy Supply Enhancement Policies

Integration of woodfuel production into community forestry

- **Relevance** – community forests have been established in Cambodia since 1994, with some measure of success, mainly through the NGO sector, and its importance as a forest management strategy has recently been recognised by the government.
- **Validity** – the Department of Forestry will address wood fuel requirements of rural communities through community forests. A sub-decree is currently being prepared for the implementation of community forests. Within the Departments of Forestry and Environment, staff have undergone training programmes with RECOFTC, and gained experience of community forestry implementation with relevant NGOs, particularly CONCERN Worldwide and MCC, and have conducted training sessions for provincial staff. Community forests have illustrated community commitment to managing their natural resources.
- **Implementation** - little is known about wood fuel production from community forests. A study of a community in Kampong Chhnang suggests that a large amount of wood fuel is collected from outside the community forest area. It is thought that community forestry schemes would be beneficial to communities in forest poor areas. Forest law and legislation for land use rights, and training in forestry management techniques and options for community leaders is required.

Sustainable forest management for wood fuel production

- **Relevance** – sustainable forest management is essential for the future of natural resource management. It is also a main condition for future ODA.
- **Validity** – the Department of Forestry plan to develop firewood coupes to meet the demands of urban households, and industrial users. Firewood coupes are a remnant of former forest policy, whereby areas of forested land were auctioned annually to companies for the provision of fuel wood and charcoal to urban areas. Firewood coupes are no longer economically viable due to competition in the market from freely produced wood fuels, and will require a detailed review and revision before implementation. Staff capacity exists in forest management.
- **Implementation** - the Department of Forestry want to revive the coupe system within forested areas, but have yet to define management plans. Information is required to assess the feasibility of such a management system. Appropriate sites need to be identified (ie avoid watersheds, primary forests, protected areas, etc), and tree species need to be investigated. Further research regarding the amount of firewood supplied from forests (in relation to that supplied from non-forested areas) is required, along with reasons for tree cutting in forested areas, and the amount of wood currently available on a sustainable basis taking into account demands from other users of wood. Inventories should be conducted to provide reliable stock and yield tables for different land use types. A forest law is also required, a means of enforcement, and improved security in forested areas. Firewood coupes should be established in areas with access to markets.

Wood fuel production in agro-forestry systems

- **Relevance** – large areas of agricultural and forested land are allocated to private developers for plantation schemes.
- **Validity** – a large amount of fuel wood is currently being produced from areas cleared in preparation for the establishment of plantations and agro-forestry systems. In the future fuel wood could be produced from prunings and from trees having reached the end of their production cycle. Within forest concession areas, waste wood in the form of branches should be cleared from the forest and could be used as fuel wood, but generally the branches are left in the forest.
- **Implementation** – agro-forestry systems are likely to fall within the private sector, and would require some regulation by the Department of Forestry or Ministry of Agriculture to assess the amount of wood fuel that could be produced. The amount of wood fuel currently produced from such areas is unknown. Further information of current and proposed agro-forestry schemes, and enforcement of concession management plans is required. Some capacity exists within the Department of Forestry, as staff conduct reviews and monitoring of some concession areas. Wood fuel production is only likely to be feasible in areas with easy access to markets.

Charcoal production and marketing

- **Relevance** – a proportion of urban households, and the service sector rely heavily on charcoal.
- **Validity** – the Department of Energy would consider this option to be valid in terms of increasing the efficiency of charcoal production.
- **Implementation** – information is required to assess the local impacts of charcoal production, to determine the sources of the wood used to produce the charcoal, and the marketing systems. If adopted this option would require staff training in charcoal production, efficient techniques, appropriate species, etc, and would need to be covered in relevant legislation.
Wood Energy Utilisation Policies

**Improved stoves dissemination**

- **Relevance** – the dissemination of improved cook-stoves would improve cooking efficiency and therefore reduce household wood energy use. Improved cook-stoves could also reduce the health impacts of fuel wood use in the kitchen.
- **Validity** – the Department of Energy is mandated to address energy efficiency. The Cambodian Fuelwood Saving Project has been working on the production of ICS in the province of Kampong Chhnang, during which time information has been collected and analysed, stoves developed and staff trained. The project has demonstrated ICS potential to reduce household wood fuel use.
- **Implementation** - improved cook-stoves could be introduced to urban areas, where users will attain benefits in terms of financial savings through reduced wood fuel use. The option requires further information of urban household cooking practices, and amounts of fuel wood used.

**Efficient wood energy use in traditional industries and enterprises**

- **Relevance** – traditional industries rely heavily on wood fuels, and therefore increased efficiency of use will reduce the amount of wood energy required.
- **Validity** – the Department of Energy are mandated to address energy efficiency. CFSP has increased the efficiency of sugar palm stoves, and successfully disseminated them throughout the province of Kampong Chhnang.
- **Implementation** - other traditional industries heavily reliant on wood fuels include brick and tile manufacturers, bakers, potters, sandalwood oil producers, fish drying, etc. In considering this option, information related to industrial users of wood energy is required.

**Modern wood energy technology application**

- **Relevance** – not relevant at present for Cambodia, which is still at the very early stages of wood energy development.
- **Validity** – not suitable for development at this stage.
- **Implementation** – not appropriate technology at present, but should still be included in training materials for energy planners.

**Fuel substitution – use of agricultural wastes**

- **Relevance** – Cambodia is primarily a rice producing country, with cattle as the main means of agricultural production.
- **Validity** – the use of agricultural wastes as a fuel will lessen the amount of wood fuels required.
- **Implementation** – assessment of current uses of agricultural wastes will be necessary to determine the amount available for energy. Appropriate technologies from external sources would be required for transformation processes and cooking, and training would be required for local staff in their operation.

**Fuel substitution – use of fossil fuels**

- **Relevance** – economic development of the country is reliant on reliable supplies of electricity, which is presently generated using diesel oil. Higher income urban households are complementing wood fuels with LPG for cooking.
- **Validity** – plans within the Department of Energy focus on the development of the electricity sector, but as all petroleum fuels are imported, it is not practical to pursue this option. In the future electricity will be generated from hydro.
- **Implementation** – unlikely over the long term unless reserves of oil and gas are found offshore or below the Tonle Sap Lake. Nevertheless, issues surrounding fuel substitutions to fossil fuels should be included in training materials for the staff of the Department of Energy.

Policies to Build up and Strengthen Local Capacities in Wood Energy Development

**Improving local data and information base**

- **Relevance** – to develop polices for wood energy it is essential to have a strong information base, which should be at provincial/district level to highlight local variations, and which can be continuously updated.
- **Validity** – an improved information base will be invaluable in advocating wood energy development at levels of government responsible for policy development. An improved information base is necessary to challenge the present misconceptions related to wood energy use.
- **Implementation** – requires capacity building of staff in research methodologies, data collection techniques,
and analysis. Research to improve the current data base will require external funding. This element will require co-operation between the Departments of Energy and Forestry.

**Developing local planning, policy analysis and programme formulation capabilities**

- **Relevance** – policies and plans are largely lacking in the sectors related to wood energy.
- **Validity** – until now, planning, policy analysis and programme formulation have been conducted by external consultants with little involvement of local staff. Unless local staff are trained in these areas, they will remain reliant on external consultants.
- **Implementation** – much of this work is expected to be at central level. As wood energy development is a multi-sectoral issue, staff from different sectors should be included in the training. Training could be at different levels, with those involved with policy development within the energy, forestry and agricultural sectors gaining more thorough training in wood energy issues. Those involved in other sectors should be aware of the ways in which wood energy can affect and be affected by their policies and plans.

**Developing local capabilities for programme and project formulation**

- **Relevance** – programmes and projects related to wood energy development are largely lacking in Cambodia.
- **Validity** – many programmes and projects are initiated by external organisations, through expatriate advisors.
- **Implementation** – provincial staff should be involved in this training as the wood energy situation varies within and between regions and it is at this level that local land use decisions should be made. This requires recognition of the importance of wood energy issues, and the decentralisation of some decision making.