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REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
GCP/RAS/154/NET

TROPICAL FORESTRY ACTION PROGRAMME
VIETNAM
FUELWOOD AND ENERGY SECTORAL REVIEW

Ministry of Forestry
Socialist Republic of Vietnam
Hanoi, Vietnam

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For copies write to: Regional Wood Energy Development Programme in Asia
c/o FAO Regional Offcie for Asia and the Pacific
Maliwan Mansion, Phra Atit Road,
Bangkok, Thailand
Tel: 66-2-280 2760
Fax: 66-2-280 0760
E-mail: rwedp@fao.org

FOREWORD

The study on “Fuelwood and Energy”, as a component of the Tropical Forestry Action Programme, a Forestry Sectoral Review in Vietnam, supported by UNDP/FAO, was conceived in 1989 during an early phase of this exercise.

Due to its limited resources, the Government of Vietnam, Ministry of Forestry, requested FAO to provide additional support for the fielding of experts to conduct a comprehensive review on fuelwood demand and supply situation in Vietnam. FAO responded promptly by fielding Messrs. Auke Koopmans and Keith M. Gray to Vietnam in December 1990 and February 1991, respectively. Originally, the experts were to be fielded together in one mission to carry out the study, but this did not materialize due to practical reasons. Consequently, the experts had only limited time to interact and consolidate field information during their missions.

Nevertheless, both consultancy reports, field in March – April 1991, contained a great deal of valuable information. Though major findings of these reports have been incorporated very relevant to publish the findings in more details so that the pursuing on policy and planning on wood energy development in the near future in Vietnam and perhaps in other countries could be facilitated.

This consolidated report was prepared for three main reasons: to make the information available, to maintain the consistency of presentation, and finally, for the convenience of reference. While mainly relying on the information of the two original consultancy reports, some improvements have been based on verified information obtained later.

Wood energy – or as many people often simply refer to it, “fuelwood” – is not that simple or straight forward concept as it would seem on the surface, as is to be seen in this report. Wood energy embraces a wide scope of development efforts, both in institutional arrangements and the implementation. With regard to wood energy, many production, distribution and end-use systems exist, cutting across most socio-economic strata of both rural and urban people.

It is no surprise to energy and forestry planners to see vast majorities of people in developing countries to heavily depend on this civilization-old energy source. However, it is always amazing to note that in most of these countries, wood energy development has not been accorded with sufficient attention, let alone investment. The words **“wood in energy”** (sector) and **“fuel in forestry”** (sector) may perhaps better reflect a future strategy for investment planning in both sectors.

It is sincerely hoped that this report will be useful to interested readers, especially those two are actively involved in forestry and energy planning and development.

This project wishes to acknowledge with thanks to both experts whose names were mentioned above for their initial contributions and especially to Mr. A. Koopmans, who painstakingly synthesized the two reports into this final one. Secretarial services of Ms. L. Navaporn, I. Panpicha and M. Pimpa were also highly appreciated.

Aroon Chomcharn
Officer-in-Charge
May 1992

EXECUTIVE SUMMARY

This report is a synthesis of two reports, one on fuelwood demand and the other on fuelwood supplies, which were separately prepared within the framework of the Tropical Forestry Action Programme (TFAP) for Vietnam. The report describes the energy situation in Vietnam, with the emphasis on biomass energy. The introduction describes how the work was carried out, and gives answers to the question why the report covers, together with fuelwood, also other biomass fuels, e.g. agricultural residues.

The first chapter gives general information on Vietnam, its population, climate, land use, forest areas, the economy and the current energy situation. A provisional energy balance shows that biomass energy accounts for about 74% of the total energy consumption in the country. In the domestic sector, biomass energy accounts for about 97% of the total energy consumed. Out of the total amount of biomass energy, fuelwood supplies about 46%, while "residues", which partly consists of wood, supply the remaining 54%. The natural forests of Vietnam presently cover about 7.3 million ha of the land area; of these 5.4 million ha are categorized as productive forests. About 4.2 million ha of this area consists of hardwood type forests. The natural forests are rapidly decreasing in area. The rate of forest loss is quoted to be between 100,000 to 300,000 ha per year. Realistically, however, the forest loss could be estimated at 100,000 ha per year, based on a comparison of satellite imageries of 1983 and 1987. The present area that is still classed as forest land, but in reality is more or less bare, is about 9.1 million ha.

An energy balance drawn up by the consultant indicates that biomass energy supplies about 74% of Vietnam's energy needs. The domestic sector, which accounts for about 66% of the energy consumption in the country, relies heavily on biomass energy.

The second chapter, which forms the main part of the report, is devoted to the quantification of fuelwood demand and supplies. Using existing information sources, which are unfortunately inadequate, an estimate of the total biomass energy consumption in the domestic and the industrial sectors has been made. With regard to the industrial sector, the emphasis has been placed on rural-based industrial activities, such as brick and tile making, agro-processing, food processing, to name a few. Although a large number of industries were identified, only a few could be discussed in-depth, due to lacking information on most industrial activities. In the same way, estimates of the sustainable supplies of fuelwood and other biomass energy sources were made.

It is estimated that overall, the domestic sector and the industrial activities covered in this study, consume about 45-46 million tons of energy annually, expressed in wood equivalent or WE, of which about 4 million tons consist of commercial energy sources (coal, kerosene and electricity) with the remaining 41-42 million tons WE derived from wood and residues. The term "residues", as used in the reviewed Vietnamese literature, is ambiguous and poses several problems. It apparently covers both agricultural residues from crops, such as straw, husks and stalks, but also residues from saw milling, perennial crops (e.g. coconut and rubber), wood from home gardens, scattered trees, etc. Out of the 41-42 million tons WE, approximately 22-23 million tons WE is estimated to come from the forests and concentrated plantations and 18-19 million tons WE from residues. Out of this latter amount, an estimated 10-11 million tons WE could possibly be wood (saw dust, off cuts, rubber wood, wood from home gardens and scattered trees). The remaining 8 million tons WE are thought to be agricultural residues, weeds and grass, among others.

With regard to the fuelwood supplies, it has been estimated that annually about 20 million tons can be supplied on a sustainable basis from forests, plantations, bare forest lands and residues (forest industries, scattered trees, etc.). Comparing this with the demand for wood as fuel, it appears that there is an apparent gap of about 13 million tons fuelwood in the demand/supply balance. A major part of this gap may be filled by agricultural residues, which presently may have been underestimated at about 13-14 million tons. There seems to be a surplus of residues of about 6 million tons, even after taking into account alternative uses, such as animal bedding and composts. However, no doubt a part of the gap in the fuelwood demand/supply balance will be filled by overcutting forests beyond the sustainable limit.

Remedial measures for this apparent gap in the demand and supply balance must be found. These may involve both demand reduction and supply increase. Demand reduction will require: (1) a substantially increased acceptance and installation of improved appliances and practices with e.g. stoves and furnaces, improving their production methods, the introduction of alternative fuels like liquified petroleum gas (LPG) and natural gas, and (2) energy substitution. A supply increase would involve raising the annual plantation establishment levels up to 300,000 ha/year for five years from the present, and thereafter a proposed level of 100,000 ha per year. In addition, it would require increasing the present level of scattered tree planting from 400 million up 1,200 million trees annually.

Chapters 3 and 4 cover energy conversion technologies and equipment used in the country, as well as energy substitution, conservation and pricing. It is shown that due to the costs involved in commercial energy sources (with the exception of coal dust), the options for energy substitution are limited, in particular in rural areas, where biomass energy is considered to be a non-monetized commodity. With regard to energy conservation, there is good potential, that could have considerable impact on energy consumption in the country. Even slight improvements in the end-use efficiencies of the domestic stoves, from the present 12-17% to 14-19%, could reduce the total annual energy consumption with an estimated 3-4 million tons. However, experience with the introduction of improved stoves has shown that still a lot of work has to be done in developing efficient and user-friendly stoves, which can compete with the flexible (multi-fuel and multi-pot) tripod or metal-rack stoves. Where stove development has been simultaneously linked with income-generating activities, the experiences have been positive. For instance, in Thai Binh province mushroom growing activities have been initiated using straw for growing. This was possible as excess straw became available due to the introduction of improved stoves, of which about 10,000 were installed within a one-year period. However, unless concerted and massive efforts in the field of energy conservation will be undertaken, it may be assumed that the effects will be limited. This will result in an increase in the total biomass energy demand in the future due to the population growth.

Chapters 5 and 6 cover some environmental and institutional aspects. It is argued that although biomass energy may play a role in forest area loss and degradation, not enough is known to draw definite conclusions. The need for more agricultural land *vis-a-vis* wood energy needs, the use of agricultural residues and the farmers' perception towards this use and other relevant matters will need further in-depth studies. However, it can be stated that biomass energy has not received sufficient attention in the national energy planning, although biomass energy supplies an estimated 74% of the total energy consumption in the country. In the recent past, some activities have been undertaken, such as the collection of biomass energy consumption data. However, this still remains on an ad-hoc basis. There exists only little co-ordination between institutes and organizations involved in energy, and biomass energy issues in particular. This may lead to insufficient information exchange and to the duplication of activities.

It is concluded, that as existing data are inadequate, much more work on data gathering (on for instance consumption, availability, pricing, flow mechanisms) will have to be done. To achieve this, the institutional expertise from concerned agencies will need upgrading. This process should be continuous to provide energy planners with a reliable database to help direct energy policies. At the same time, this continuous process of upgrading the database and expertise could lead to a better understanding of the importance of biomass energy in the national economy, as well as identifying problem areas for which solutions will have to be developed.

It appears that there is a large gap in the fuelwood demand and supply balance. The proposed plantation and scattered tree planting programmes would not produce sufficient amounts of fuelwood to meet the national fuelwood shortfall. Major increases in the tree planting targets, necessary to bridge this gap, will require major investments and may present a marketing dilemma as it is not known if the markets will be able to absorb the additional amount of higher-value products, such as pulpwood and poles, generated under such a programme. Land allocation programmes may provide another key to increase the production of fuelwood. The data on the forest lands classed as bare forest lands appears to be insufficient for the planning of land allocation and settlement programmes. Therefore, a land capability survey should be carried out. More emphasis may be given to the development of agro-forestry models as part of the settlement and plantation programmes in land allocation schemes.

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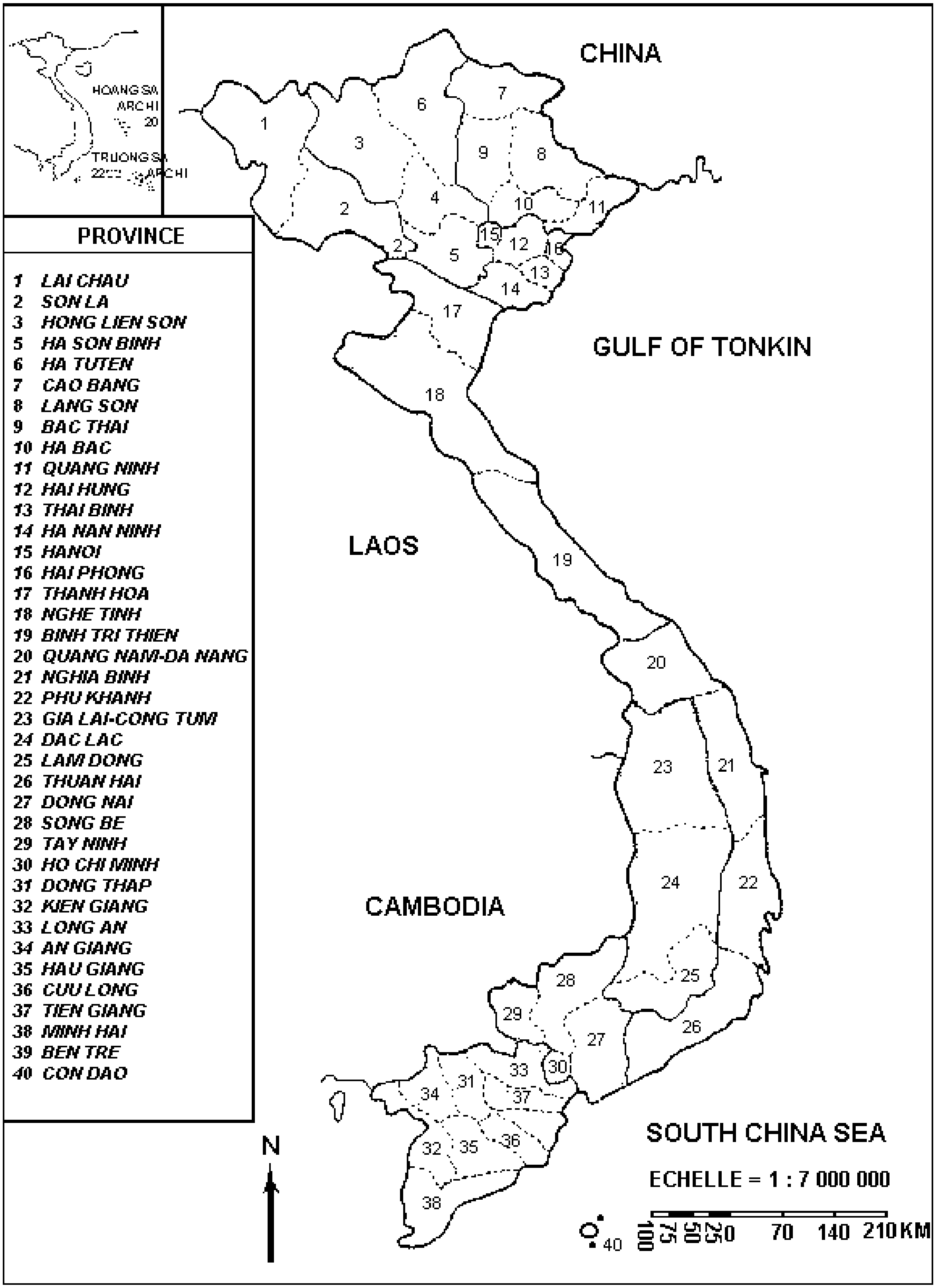
ABBREVIATIONS AND TERMS USED

BPD	Barrels oil per day
cm	Centimetre
CTA	Chief Technical Advisor
DBH	Diameter at breast height
Dep.	Department
Dong	Vietnamese currency unit. 1US$ equaled Dong 7,000 (1990-1991). 1US$= Dong 11,500 in Feb 1992.
EI	Institute of Energy
ENERPLAN	Computer-based energy planning programme
FAO	Food and Agriculture Organization of the United Nations
Filao	Local name for Casuarina equisetifolia
FIPI	Forest Inventory and Planning Institute
FODO	Forest Operations Division of FAO, Rome
FORTECH	Forestry Technical Services Pty Ltd, Canberra, Australia
FSIV	Forest Science Institute of Vietnam
FTP	Food, Tree, People forestry programme
FW	Fuelwood
GBV	Gross Bole Volume
GDP	Gross Domestic Product
GNP	Gross National Product
ha	Hectare
HAI	Hanoi Architectural Institute
HCM	Ho Chi Minh City
IIED	International Institute for Environmental Development
IRR	Internal Rate of Return
IUCN	International Union for the Conservation of Nature
KJ	Kilojoule
KWh	Kilowatt hour
LEAP	Computer-based energy planning programme
LPG	Liquified Petroleum Gas
m.a.i.	Mean annual increment
MC	Moisture Content
MCWB	Moisture Content Wet Basis
MD	Man-day
MEDEE	Computer-based energy planning programme
MJ	Megajoule (1,000 kJ)
MoA	Ministry of Agriculture
MoC	Ministry of Construction

MoE	Ministry of Energy
MoF	Ministry of Forestry
MW	Megawatt
m^3	Cubic Metres
NPV	Net Present Value
OB	Over Bark
PJ	Peta Joule (10^15 joules)
RWEDP	Regional Wood Energy Development Program
Scove	Practice of applying a clay layer on kiln walls to make it more airtight
SEV	Soil Expectation Value
SIDA	Swedish International Development Agency
SPC	State Planning Committee
SPH	Statistical Publishing House
Spp.	Species
SSC	State Science Committee
Stere	Measure of stacked roundwood measuring 1 x 1 x 1 metre
T	Ton
TCE	Ton Coal Equivalent
TFAP	Tropical Forestry Action Plan
TKM	Ton Kilometre
TOE	Ton Oil Equivalent
TWE	Ton Wood Equivalent (see also WE)
UB	Under bark
UNDP	United Nations Development Programme
UNITAS	University of Tasmania
VPSU	Vinh Phu Service Union
WB	World Bank
WE	Wood Equivalent. For calculation purposes some fuels, notably residues have been converted to Wood Equivalent (WE) using appropriate conversion factors and calorific values as shown in annex 15.
WFP	World Food Programme (known in Vietnam as PAM)

ADMINISTRATIVE MAP OF VIETNAM



INTRODUCTION

Vietnam was once heavily forested and had a forest cover of about 57%. However, during the past 50 years, war, widespread selective logging, the need for more agricultural land under population pressure, shifting cultivation and fuelwood collection have considerably depleted the wealthy forest resources of Vietnam. It has been estimated that presently forests cover only about 28% of Vietnam's land area.

Fuelwood is one of the factors, which are thought to have negatively affect the forest cover. Fuelwood is, nevertheless, an important source of energy in Vietnam, and often the only one accessible to the poor. Although accurate figures are not available, a very large proportion of the population, probably around 90%, depend on fuelwood to satisfy their energy needs. Besides, fuelwood is also an important source of energy for several industries, located mainly in rural areas, where the industries provide off-farm employment for many people, including women. The dependency on fuelwood is likely to continue for some time, even with accelerated economic development, because alternative sources will be either too costly or not widely available (Contreras-Hermosilla, 1990).

However, no satisfactory assessments of the fuelwood demand situation are available as may be judged from demand estimates quoted in the literature. The estimates range from 30-60 million cubic metres (solid) per year, and may rise to 40-100 million cubic metres by the year 2000. With regard to the fuelwood supply situation, even less is known. However, simple observations indicate that many places already suffer from acute fuelwood shortages that may have far-reaching implications. Widespread illegal logging and the fact that immature trees are cut down reduce the standing stock; branches may be lopped off reducing the growth rate of trees; the increased use of agricultural residues may affect soil fertility, are but a few of these implications. Fuelwood scarcity may also imply that less time and energy can be dedicated to agriculture and/or other productive activities as more and more time is needed to collect fuelwood. Moreover, fuelwood scarcity may affect health, because people resort to faster cooking food, which is often less nutritious. Fuelwood scarcity can also increase the use of unboiled water.

Given the lack of assessment on the fuelwood demand and supply, and without insight of pricing mechanisms, geographical origins of fuelwood, types of fuelwood used and available, it is unlikely that valid conclusions on the fuelwood issue can be drawn. Therefore, in order to better understand the issues related to fuelwood in Vietnam, an in-depth study was deemed necessary. It was decided to carry out a fuelwood demand and supply study as part of the review of the forestry sector in Vietnam, funded by UNDP/FAO and SIDA within the framework of the "Tropical Forestry Action Programme".

The study, which was carried out in late 1990 (fuelwood demand) and early 1991 (fuelwood supply), each over a period of two months, started with literature reviews (see Chapter 8 for a list of the cited literature), followed by meetings and discussions with a large number of personnel from ministries, government institutions, provincial authorities and international organizations, who are involved with forestry, industry, agriculture and energy matters. Extensive field visits were made to several provinces in the northern, central and southern parts of the country in order to observe the biomass energy demand and supply situation.

While reviewing the literature, it soon became clear that in addition to fuelwood, other fuels, such as residues, were widely used. Unfortunately, the term "residues" used in most of the literature reviewed, includes also fuelwood, e.g. from scattered trees and home gardens and wood processing waste. In order to prepare a complete overview of fuelwood use in Vietnam, it was decided to cover both fuelwood and residues. Where possible, a distinction has been made between "actual fuelwood" and "actual residues" (straw, husks, cobs, stalks, dung, leaves, etc.) but, due to a lack of sufficient information, this could not in all cases be adhered to. Therefore the term "residues" may cover, unless otherwise specified, all types of residues ranging from agricultural residues to residues from saw mills (saw dust, slabs and off-cuts), residues from coconut palms (husks, shells, fronds), scattered trees along roads and canal banks, and trees in home gardens.

Fuelwood is available in Vietnam in a variety of forms, which tend to reflect its usage. For domestic cooking, it is normally sold in small bundles consisting of some 30-60 cm long pieces of wood, some 3-6 cm in diameter. A common practice is that urban retailers purchase fuelwood from fuelwood harvesters close to forest lands. Fuelwood is sold by the stere or stacked cubic metre, which is normally regarded as 0.6 m^3 solid. This is then split by the retailer normally in an urban location. All these forms of fuelwood are found in the markets. For industrial use, such as brick or tile making, the wood is normally retained in larger dimensions perhaps one or more metres long and often more than 10 cm diameter.

In Vietnam as well as in many other countries, fuelwood is regarded as a free commodity, which may be gathered without cost other than that associated with the gatherer's own personal efforts. It applies particularly to the public domain, where forest resources are state-owned and where there are no specific rights attached to individuals, families or kinship groups. This free commodity concept is strongly based in the society. In a recent national fuelwood study prepared in Australia, it was found that up to 50% of urban residents gathered their own fuelwood for domestic heating from a range of public and private sources at no more than personal cost (personal communication Mr. K. Gray).

Because the fuelwood from natural forests is basically valued at zero, this will have an impact on prices of woodfuel from tree plantations. Unlike plantation-grown wood, the fuelwood gathered from natural forests does not have a tree production cost, although it must have a replacement cost. Therefore there is little incentive to the farmer to grow it as a dedicated fuelwood cash crop.

This dilemma of fuelwood as a "free commodity" is discussed in some detail in a technical and economic appraisal of a proposed project of World Food Programme entitled *"Re-afforestation of Coastal Areas - Vietnam 4304"* (Christophersen, 1991). This project will establish 125,000 ha of fast-growing tree plantations in 12 coastal provinces suffering from chronic food deficit and fuelwood shortages. A large part of the population in these areas have non-agricultural occupations. These people are working for e.g. coastal fisheries or industries, and do not have access to agricultural land to grow food crops, nor access to residues as fuel, which may contribute to the deficit.

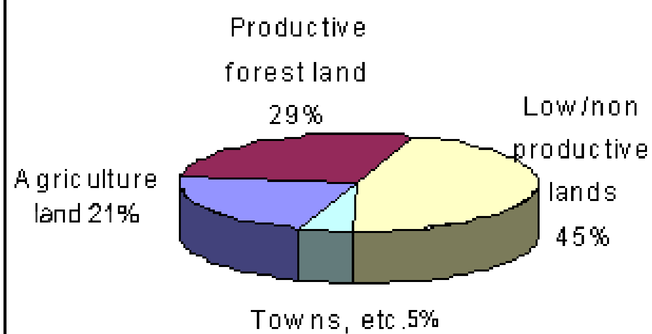
Vietnam faces fuelwood shortages equalling about 10 million tons, as confirmed by this study. The shortages, in the context of present socio-economic situation of the country, imply that fuelwood from natural forests will remain an important source of energy, especially in rural areas, adversely affecting the forest cover. Fortunately there appears to be a significant interest in growing trees for higher-value products, such as construction timber, poles, forest products for medicines, fruit trees, etc. Thus some fuelwood (tops, branches) could be generated as a by-product of the plantation activities, simultaneously reducing the pressure on natural forests.

1. COUNTRY PROFILE

1.1 Geo-climatic conditions

Vietnam forms the eastern edge of South-East Asia. It has common borders with China in the north and with Laos and Cambodia in the west. The eastern and southern border is formed by a 3,300 km long coastline, along the Gulf of Tonkin, the South-China Sea and the Gulf of Thailand. Vietnam has a surface area of about 330,000 sq km, which stretches over a length of 1,600 km between the northern latitudes of 8° and 23°. The country is mountainous with the highest peaks in the northwest reaching over 3,000 metres above sea level.

Figire 1.1 Land use in Vietnam



100% is 33 million ha.

Several plains extend over the length of Vietnam. The dominant plain in the north is the Red River Delta stretching for more than 200 km from the coast to the north-western mountain ranges. The fertile delta is intensively cultivated and has the highest average population density of Vietnam with 784 people per sq km. To the south, the delta merges with fertile coastal plains, which are the main rice growing areas of Central Vietnam. The mountain ranges of north-western Vietnam, being the southern end of the high plateaux of eastern Tibet and Yunnan province of China, extend up to the eastern coastline and continue southward becoming narrow and rugged. Further south, the mountain ranges widen into sparsely populated high plains, covering an area of about 50,000 sq km, where coffee, tea and rubber are grown. Extending further southward, the highlands descend into an enormous delta formed by the Mekong river and the smaller Vam Co, Sai Gon and Dong Nai rivers. The Mekong delta is the most important agricultural area of Vietnam measuring about 65,000 sq km. It is nowhere more than 3.5 m above sea level. The country is administratively divided into 40 provinces, as shown in the map.

National statistics[1] show that out of the total area of about 330,000 sq km (excluding islands) or 33 million ha, about 50% or 16.7 million ha is in productive use. Of this, 21%, about 6.9 million ha, is in the use of agriculture. The remaining 9.8 million ha (29%) are productive forest lands. Towns and areas for special use, occupy 1.7 million ha (5%), while the remaining 14.7 million ha (45%) is land of little or no productivity (see figure 1.2). Annex 10 gives an overview of these areas at the provincial level and shows land areas per capita. In addition to productive forests, there are also other areas considered as forests. This is shown in table 1.1 and figure 1.2, which show a total forest area of about 18.9 million ha, equal to about 57% of the total land area.

[1] Statistical Data of the Socialist Republic of Vietnam, 1976-1989. Statistical Publishing House (SPH), Hanoi, 1990. The data provided is sometimes inconsistent. For instance, table 55 of the statistics, which is used to compile this report, gives a figure of 6.9 million ha for agricultural land. Table 25 of the statistics gives a figure of 8.9 million ha for agricultural land (used to compile table 1.2 of this report). No explanations are given for discrepancies, presumably they base on differences in the interpretation of terms.

Statistical data of the Ministry of Forestry indicate, however, that 10.7 million ha is considered productive forest land, of which only 5.7 million ha still has forest cover. The remaining 5 million ha. are de-forested. The discrepancy between these major statistical sources has not become clear, but has probably been created by differences in the interpretation of the forest data. Moreover, the data, as published by the Ministry of Forestry, do not always cover all provinces. Table 1.1 gives an overview of forest areas in Vietnam, and annex 11 shows the data on the provincial level.

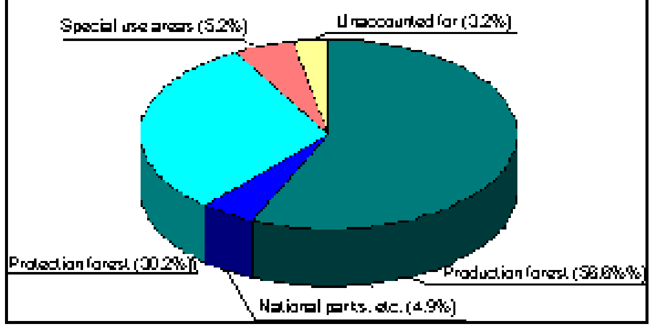


Figure 1.2 Forest land use in Vietnam
Total forest area 18.954 million ha.

Table 1.1 Forests areas and forest use in Vietnam (* 1,000 ha.)

Forest type and forest use	Total forest area	%	With forest	%	Without forest	%
Forest area	18,967	100.0	9,308	49.1	9,658	50.9
consisting of:						
Production forest *	10,721	56.6	5,746	30.3	4,975	26.1
Protection forest **						
- Water shed area	5.567	29.4	2,461	13.0	3,106	16.4
- Dune/sea protection	153	0.8	61	0.3	92	0.5
Special use area *	992	5.2	476	2.5	516	2.7
National parks, etc. **	936	4.9	?	?	?	?
Unaccounted for ***	605	3.2	564	6.1	969	10.0

Source: Forestry Statistics 1986-1988, MoF-SPH, 1989 and Ha, undated

Note: * Figure given covers only 21 provinces. No data are given for the other 19 provinces
** Includes all 40 provinces
*** These figures may indicate forest areas of the 19 provinces for which no data are available.

As shown in table 1.1, there are large areas, which are considered forest areas, but actually no longer have forest cover, e.g. bare forest lands and shrub lands. Some available data show changes in forest cover over a period of time. Armitage (1990) reviewed most of these data and concluded that the only meaningful measure was that obtained from a comparison of the 1983 to have occurred in some areas the aggregated national data indicate a loss about 45,000 ha per year for "rich"[2] and "medium" forest areas. The "poor" forest area have been increased marginally, reflecting the degradation process. and 1987 inventories, which were based on satellite imagery. Although large losses are reported However, these indicated losses are probably conservative. Some sources suggest that the annual decrease in forest area may reach 80,000-100,000 ha per year (Armitage, 1990). With regard to changes in agricultural land, more or less the same but opposite changes are found as shown in table 1.2 and figure 1.2. Available statistics indicate an increase in agricultural land from about 8.2 million ha in 1980 to about 8.9 million ha in 1989, equal to an average annual increase of about 70,000-80,000 ha. Although no doubt other shifts in land use patterns have also taken place, these figures may indicate the negative influence of agriculture, i.e. the need for more agricultural land for diverse purposes on forest areas.

Bare forest land.

Table 1.2 Changes in agricultural land use (*1,000 ha.) from 1980 to 1989

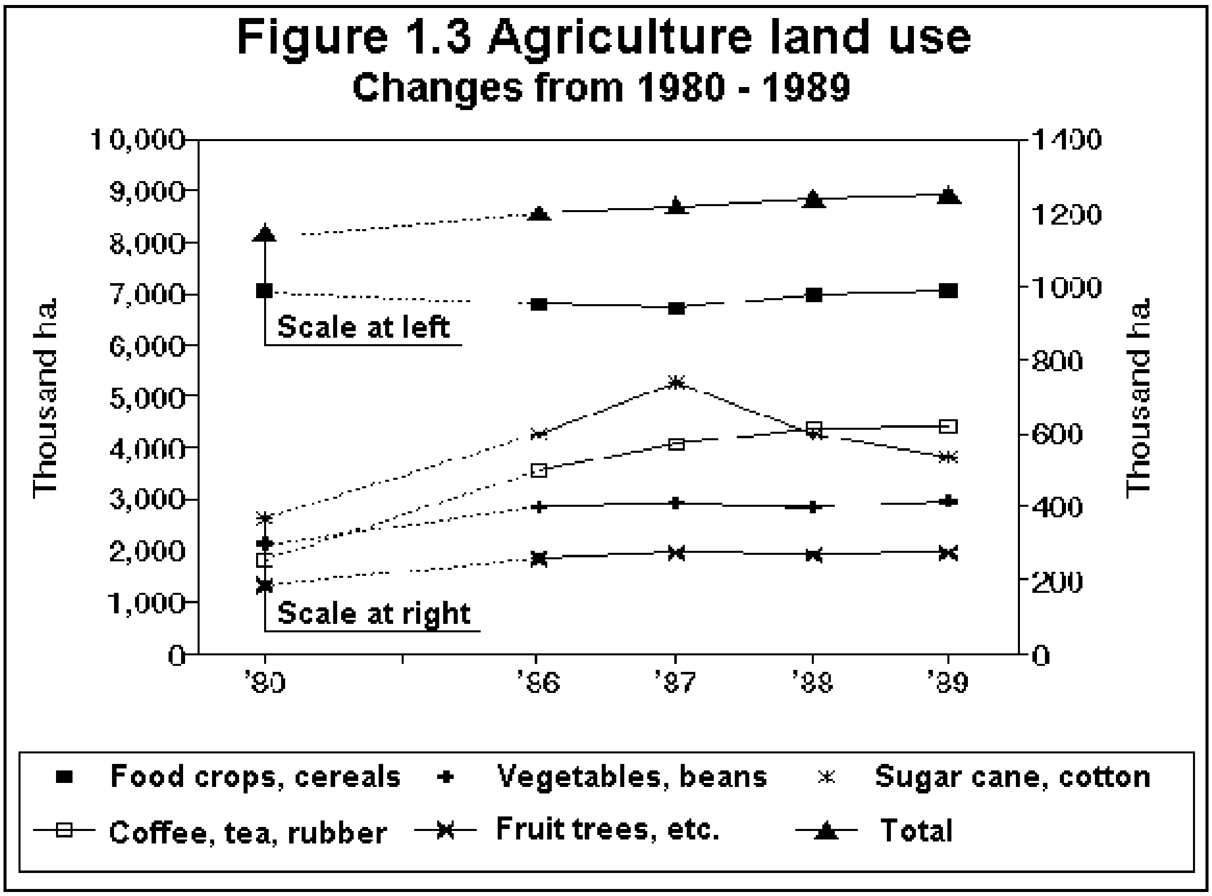
Crop type	1980	1986	1987	1988	1989
All crops	8,251.0	8,606.1	8,641.7	8,883.5	8,935.8
Annual crops:	7,772.8	7,846.0	7,789.0	7,999.4	8,045.3
- Food crops (cereals, etc.)	7,049.0	6,812.3	6,709.9	6,967.8	7,072.6
- Vegetables, beans, etc.	299.6	400.5	409.8	401.2	416.7
- Others (sugar cane, cotton, peanuts, tobacco, etc.)	371.7	601.0	637.6	601.0	535.4
Perennial crops consisting of:	478.2	760.1	852.7	884.1	890.5
- Coffee, tea, Rubber, etc.	256.0	498.9	574.7	611.9	616.7
- Fruit trees, etc.	185.6	261.2	278.0	272.2	273.8

Source: Statistical data of the Socialist Republic of Vietnam, 1976-1989.

Of the agricultural area, about one third is irrigated with the remainder depending on rainwater. The Mekong delta accounts for about 38% of Vietnam's cultivated area as well as for food production. However, it accounts for only 24% of the rural population, while the Red River delta, with 22% of the rural population covers 13% of the cultivated land and accounts for 18% of the food production (FAO, 1989).

[2] The Ministry of Forestry stratifies natural forests into three qualities according to commercial timber volume. "Rich" forest has over 150 m^3/ha gross bole volume (GBV), "medium" has from 80 - 150 m^3/ha, and "poor" under 80 m^3/ha. "Young" forest has no commercial wood.

Vietnam's climate varies greatly: in the **north** the influence of Central Asia and the Yellow Sea are felt with large differences in temperatures between summer and winter and sudden temperature changes. The winter season - from November to April - shows average temperatures of around 16°C with frequent light drizzle from February onwards. The summer (from May to October) is very hot and humid with frequent rains and typhoons. In the **south**, the monsoons from the Pacific and Indian Oceans influence the climate with temperatures from 25° to 30°C and a regular rainy season. The year here has three seasons: the summer (from May to October) is very wet, the second period (November to February) is relatively dry and cool, and the remaining season (February to April) dry and hot. In the central part of the country, the northern and southern climates mix; the area is generally cooler than the southern part, and the dry and rainy seasons are less pronounced.



1.2 Population

The population of Vietnam has been steadily growing from about 52.7 million in 1979 to about 63.7 million in 1988. In April 1989, it had reached 64.4 million, equalling an average annual growth rate of 2.1%. The official statistics indicate a steady decline in the population growth rate, from 3.2% in 1976 to 2.1% in 1989. This reflects a fall in the birth rate from 39.5 to 31.3 per thousand. The natural population growth, however, is about 2.3%, but due to emigration, the actual population growth rate is 2.1%. Assuming that the growth rate of 2.1% does not drastically change, it can be estimated that by the year 2000 Vietnam will have a population of about 81 million (WB, 1990). Of the total population, about 80% live in rural areas and the remaining 20% in urban areas (see also annex 3). These figures have over the last 15 years stayed rather stable. Therefore, it might be expected that by the year 2000, about 65 million people will live in rural areas with the remaining 16 million in urban areas.

In 1988, the social labor force totalled 28.9 million, of which 4.1 million were state-employed, 21 million were employed by the co-operatives sector, and 3.8 million by the private sector. Some 26.9 million people out of the 28.9 million people belonged to the material-producing sector (e.g. industry, construction, agriculture and forestry). The rest, some 2 million people active in the non-material productive sector including science, education, art, public health and government management, among others.

1.3 National economy

Vietnam is endowed with rich natural resources. It has vast reserves of anthracite coal with deposits in Quang Ninh province in the north-east of Vietnam, estimated at more than 3 billion tons. Oil has been found offshore, in the Bach Ho or White Tiger field, producing about 50,000 barrels per day (bpd). The production was expected to increase from 2.2 to 2.5 million tons in 1990. Accompanying natural gas is flared but could, if a pipeline was laid to the coast, be used onshore for industrial and domestic purposes. A small gas field in Thai Binh province in the Red River Delta is used for electric power generation by means of two gas turbines, while part of the gas is said to be used for ceramic production units.

Most of the country's considerable mineral wealth (iron, zinc, tin, nickel, gold, bauxite, titanium, chromium, wolfram, manganese, apatite, rare earth, precious and semi-precious stones, etc.) are located in the north. In the central part of the country and the central highlands, additional mineral deposits are found. Unfortunately, most of the mineral deposits are located in mountainous areas without adequate communication systems and far from harbours making exploitation economically difficult.

The Gross Domestic Product (GDP) has shown steady increase over the years. It has been estimated that the per capita Gross National Product (GNP) is around 175 US$, with a GDP growth in 1990 estimated at 8.2%[3]. The national income data (in 1982 prices), as reported in the statistics[4], which are shown in table 1.3, show lower growth rates and lower values for GNP data. It should be noted that, due to the complex dual economy in the recent past (state and free market) using different exchange levels, accurate GNP data are difficult to calculate.

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3 Asiaweek, Nov. 30, 1990

4 Statistical data of the Socialist Republic of Vietnam, 1976-1989.

Table 1.3 National income in billion Dong at 1982 prices (1980-1989)

Sector	1980	1986	1987	1988	1989*
Agriculture	61.3	84.6	81.7	84.5	91.3
Industry	31.3	48.4	53.9	56.0	54.0
Commerce	18.4	23.4	24.3	25.8	27.2
Transport and Communications	2.2	3.1	3.5	3.5	3.4
Forestry	0.2	1.4	1.5	3.0	3.2
Construction	4.4	5.0	5.3	5.1	4.9
Other	2.3	3.6	3.7	3.9	4.2
	-----	-----	-----	-----	-----
National Income	120.1	169.6	173.9	183.9	188.3
Non-mat. services and depreciation (1)	43.2	61.1	62.6	66.2	67.8
	-----	-----	-----	-----	-----
GDP at 1982 prices	163.3	230.7	236.4	250.1	256.1
% change of national income (at 1982 price)		3.2	2.4	5.9	1.5

Source: World Bank 1990
* Preliminary data
(1) Estimated at 36% of the National Income Estimate includes unreported informal sector economic activities.

In early 1989, the Government introduced bold reforms of the economy to stimulate the economy by liberalizing prices, exchange rates and foreign trade and by decentralizing the management of productive units. The initial response of this reform and stabilization programme has been encouraging with inflation rates[5] moving downward from 400% in 1988 to about 19% for the 12-month period ending in March 1989. Exports to convertible areas doubled and output of the agricultural and private sector (concentrated in light industries and services) increased considerably during the same period.

1.4 Current Energy Situation

Vietnam is a small producer and a small consumer of energy. Energy consumption per capita, and in particular the consumption of conventional energy sources like oil is estimated to be one of the lowest in the world. The major source of energy is biomass (wood and agricultural residues), which is used by the vast majority of the rural and semi-urban population with electricity (from hydropower, coal and oil) and coal, used in urban areas. Coal is the dominant source of energy for the industrial sector, which is mainly urban-based. Since 1975, electricity generation has received a high priority resulting in high levels of investment in the recent past as well as in the near future. Vietnam's energy reserves consist of the extensive coal deposits in Quang Ninh province in the

[5] There are some uncertainties with regard to the inflation rates. For example, a rate of 800% is mentioned in Asiaweek of May 1989 as valid for 1988.

north-east, of the off-shore Bach Ho field and other oil and gas fields, located approximately 200 km off the south-east coast, a small gas field in Thai Binh province in the north, extensive peat deposits in Minh Hai province in the south, and small peat deposits near Hanoi, considerable and widespread hydropower sources and biomass (SPC/UNDP, 1990).

1.4.1 Coal

Coal production has fallen from 8-10 million tons a year in the late 1970's to about 4.5 million tons in 1989 due to several reasons, such as a lack of and use of obsolete mining equipment and a slump in the domestic market. The domestic market has suffered, because the economic reforms have forced the local companies to pay market prices instead of subsidized ones[6]. Attempts to attract foreign investment in coal mining for export have been hampered by a lack of mining laws and infrastructure problems. Inadequate port facilities are apparently the main bottleneck; as ports are often to shallow for coal-carrying large vessels.

1.4.2 Oil

Crude oil production has risen sharply from about 40,000 tons in 1986 to about 2.5 million tons by 1992 (expected to rise to 5 million tons by 1993). Crude oil is exported to Japan, Hong Kong and Singapore, since Vietnam does not have refineries. Refined oil products like diesel, gasoline, kerosene and fueloil have been imported mainly from the former Soviet Union. Refinery capacities of about 5 million tons per year are on the drawing board with initial work already started at a site between Ho Chi Minh City and Vung Tau, with the aim to fill the current annual need for about 3 million tons of gasoline with the remaining two million tons expected to be exported[7].

1.4.3 Electricity

Electricity is generated by three separate companies using coal, oil and hydropower as energy source with the total installed capacity amounting to over 2,000 megawatt (MW), however with availability averaging slightly over 50%. It is expected that by 1995, the installed capacity will reach 4,500 MW mainly from hydropower with the Hoa Binh power station (1,920 MW) accounting for the major part of the expansion. There is no national grid and the existing local transmission and distribution networks are limited and in poor condition. Considerable losses occur in generating, transmission and distribution, amounting to some 25% of the generated power. Siltation of hydropower reservoirs, environmental problems with coal-using power stations (REC, 1990), lack of capital resources and others are problems that the electric power sector faces.

Power company No. 1 is responsible for the northern part of Vietnam. It has a generating capacity of 1,200 MW with per capita consumption of about 134 kWh per year. Hanoi City uses 250 kWh per capita. South Vietnam is served by Power company No. 2, with a present installed capacity of 990 MW and annual per capita consumption of only 100 kWh. Ho Chi Minh City

[6] Far Eastern Economic Review, 11 October, 1990.

[7] Bangkok Post, 6 December 1990.

consumes about 50% of the total amount generated. The central region of the country, served by the Power company No. 3, is the most poorly served with installed capacity between 160 MW and 200 MW. It mainly consists of unconnected local systems using diesel engines. Annual per capita consumption is only 40 kWh. In Vietnam, about 700 sub-districts, out of a total of 4,000, have been electrified; an estimated 6% of the households have electricity. The electricity consumption in the rural areas is very low with a share of about 8% of the total consumption.

1.4.4 Biomass

It has been estimated that approximately 90% of the domestic energy consumption is derived from biomass like fuelwood, agricultural residues (rice straw and husks, maize stalks, etc.) and charcoal. Industries, agricultural processing and the construction materials industry, for instance brick, roof tile and lime kilns, use also considerable amounts of biomass, amounting approximately 400,000-500,000 tons annually (MoE-EI, 1987). The extraction of firewood in recent years has been estimated at 30 million tons per year, of which two-thirds in the northern Vietnam.

An energy balance compiled by the consultant (as no official energy balance had been supplied) by using various information sources (MoE-EI 1987, MoF undated, Hoang 1988, Khoa 1990, Thuy 1988), statistics and estimates, confirm these figures, although there are some differences, in particular in the amount of energy used by the industrial and other sectors such as agro-processing. Table 1.4 and figure 1.3 give an overview of the energy balance. These clearly show the heavy reliance on biomass energy sources. The detailed energy balance appears in Annex 1.

The total amount of energy consumed in the country, expressed as <u>per capita energy consumption</u>, assuming that the energy balance resembles reasonably well the actual situation, would amount to about 15,000 MJ, equal to about 1 ton wood equivalent (TWE) or 0.71 ton coal equivalent (TCE) or 0.35 ton oil equivalent (TOE). **It should be noted, that the energy balance was drawn up using available data and should be revised and updated, preferably on a continuous basis, as more reliable and more recent data becomes available[8].**

So far, no overall inventory has been made to assess the amount of biomass available for energy supply. It appears that, in a paper by Dr. H Thomasius, an assessment of the theoretical potential supply has been made. Unfortunately, this paper on *"Climatic Features and Productivity Assessment for Various Vegetation Types in Vietnam" (undated)* could not be located. Nevertheless, his estimates are quoted by several authors, who indicate a potential annual supply of over 80 million tons, with "shrub lands" (contributing 16 million tons), "savannas" (20 million tons) and "open forests" (32 million tons). These, in addition to forests and agricultural residues, are major potential suppliers of biomass energy (Thuy, 1988; Hoang, 1988). In case this assessment is correct, the supplies, in principle, would be sufficient to satisfy the demand.

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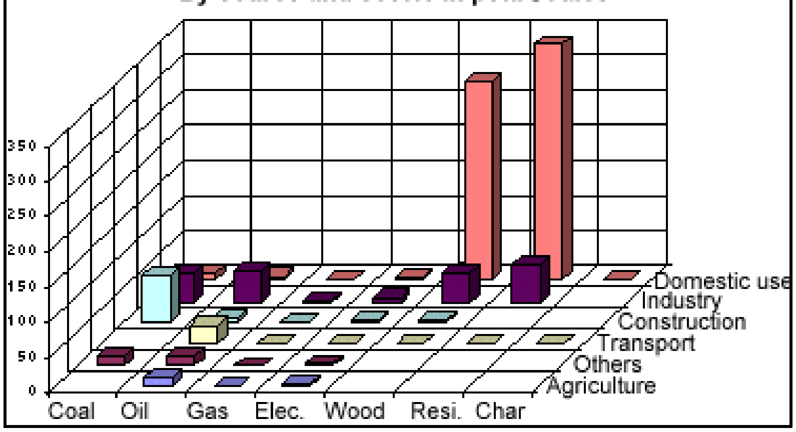
[8] The Institute of Energy and Electric Power, a specialized institute of the Ministry of Energy was contacted, but declined to supply data as they considered their data not reliable enough to make estimates on a national basis. An energy balance showing commercial energy sources, compiled by the same institute, but obtained outside Vietnam (MoE-EI, 1990), shows small variations to the extent of 1-2% on the total amount as calculated by the consultant. The total amount includes large quantities of energy used internally and losses in transfer and distribution (about 46% of the total primary energy supply), for which no explanation is given.

Table 1.4 Energy Consumption by Source and Sector in Petajoules (PJ) per year

Energy Sources	Industry	Agriculture	Construct.	Transport	Other	Domestic	Total	In % of total
Conventional								
Coal	38.9	(1)	67.0	(1)	13.5	9.5	128.8	13.4
Oil Products	41.4	10.7	5.8	25.6	13.9	5.1	102.4	10.6
Natural Gas	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.1
Electricity	6.2	1.6	3.1	0.1	2.3	4.8	18.2	1.9
Sub-Total	87.5	12.3	75.9	25.8	29.8	19.3	250.5	26.0
Biomass								
Fuelwood	39.0	(2)	3.2	0.0	(2)	284.3	326.4	33.9
Residues	50.8	(2)	(2)	0.0	(2)	334.8	385.6	40.0
Charcoal	(3)	(3)	(3)	0.0	(3)	1.3	1.4	0.1
Sub-Total	89.8		3.2	0.0		620.4	713.4	74.0
Total	177.3	12.3	79.1	25.8	29.8	639.7	963.9	100.0

Note: (1) Included in "Other" (2) Included in "Industry" (3) Not known Figures may not add up due to rounding

Figure 1.4 Energy Consumption
By source and sector in peta Joules



However, these amounts appear to be indicative of the potential productivity of different land types perhaps not taking into account long-term sustainability and accessibility. With proper management, the sustainable amounts might be far lower than indicated. Moreover, supplies could be in excess in certain areas, while other areas may suffer from shortages. Since large scale fuel-wood collection can contribute to deforestation, careful assessment, planning and monitoring of this important energy source are required.

2. BIOMASS ENERGY DEMAND AND SUPPLY SITUATION

The energy balance (annex 1) shows that biomass fuels play a very important role in the national economy with approximately 74% of the total energy consumption contributed by it. The remaining 26% is supplied by coal, oil and electricity. If the amounts of energy transformed and lost are included, these figures become 72.5% and 27.5%, respectively. Despite biomass fuels' importance in the national economy, up to a few years ago they were given no attention in the mainstream energy planning on the national level, which up to about 1975-1985 was only concerned with conventional energy[1] sources. This is probably one of the main reasons, why so little information on biomass energy consumption and supplies in Vietnam is available or accessible.

The Ministry of Energy, realizing that biomass energy does have a very important role, has taken action and formed inter-sectoral working groups to look into this problem. This has resulted in the preparation of at least two major reports on energy use in Vietnam, in which biomass energy is included. Further work, often on an *ad-hoc* basis depending on data needs, has been or is undertaken or planned. In the future, the Government of Vietnam intends to make its decisions on energy use, including biomass energy, on the basis of integrated energy planning at the national level[2]. Of these two main reports, only the *"Report on Daily Life Fuel at National Level, June 1987"* (MoE-EI, 1987, available in Vietnamese only) could be obtained. From the other report (also in Vietnamese), entitled *"Forecast and Strategies for Energy in Vietnam up to the year 2010, February, 1985"*, only copies of some tables were supplied.

In addition to these two major information sources, other information was acquired, although most of it outside Vietnam. Apparently, as the same tables and fuel consumption figures are quoted, the two reports have been used as information sources to compile the other reports. The information presented here is therefore mainly based on the first report (MoE-EI, 1987), in addition to statistics, field visits and discussions.

However, in almost all reports consulted, no specifications are given on how the data were obtained, what has been considered as residues, nor how or if residues were converted to fuelwood or coal or vice versa (calorific values, end-use efficiencies used, etc.). Therefore, the energy consumption data presented in this report have to be treated with care.

With regard to the supply situation, the picture is even more unclear with almost no written information available. One paper, which unfortunately could not be obtained, appears to give some information on potential supplies of biomass energy in Vietnam, but, although total amounts are quoted in other papers, it has not been possible to establish how these amounts were derived at. Estimates of biomass energy supply, specifically fuelwood and wood residues, are therefore based on the information on Vietnam's forest resources (UNDP, 1986; Ha, 1989; World Bank, 1990; Armitage, 1990; Filipchuk, 1990; Bergman, 1990; Sidabutar, 1990) and selected national statistics.

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1 In this report, conventional energy refers only to non-renewable energy sources such as coal, oil, gas and electricity.

2 Source: *Regional Survey of Energy Planning Practices and Methodologies in the Socialist Republic of Vietnam.* Country report presented by the Institute of Energy and Electricity at the APDC Energy Planning training course held in Hanoi in November 1990 (obtained in March 1991 after the mission had been completed).

The potential supply of agricultural residues was obtained from several sources. In most cases, the amount had to be estimated by using, if not indicated, average conversion factors from crops to residues. It should be noted that the picture given here is based on totals (wood as well as residues). Although, where possible, regional variations have been taken into account, local variations in the demand and supply may occur. Furthermore, socio-economic considerations may influence the use of biomass energy sources.

2.1 The biomass energy demand situation

2.1.1 Biomass energy demand in the domestic sector

The energy balance shows that rural and urban domestic sector accounts for about 66% of the total consumption, with biomass supplying over 95% of its requirements. The domestic consumption was calculated from data published in 1987 (MoE-EI, 1987). Although the figures might no longer be applicable, only these data were available. For that reason, they have been used to calculate the annual per capita energy consumption on provincial level.

The above-mentioned report indicates that during sample surveys, the average per capita consumption was found to be 2.5 kg of WE per day in mountainous areas, while in the Red River delta, the coastal, central and South-Eastern areas and the Mekong River delta, about 1.5 kg WE per day was reported to be consumed. These areas include 80 mountainous districts in several provinces. No specifications, such as location or population, on the districts concerned could be obtained, which made the assessment of the per capita consumption in these provinces necessary. In urban areas, the fuel consumption was reported to be 1.35 kg WE per day. The latter include, in addition to the urban areas of Hanoi, Ho Chi Minh City and Haiphong, 80 cities in various provinces. By using other data (Hoang, 1988) and correlating them with the per capita consumption and adjusting them for the use of coal, electricity and kerosene in urban areas, the total amounts of fuel used in the different provinces were established. However, this adjustment was done roughly as no data was available on the use and distribution of conventional energy sources.

The results are presented in annex 2, which shows that in 1989, an estimated 19 million tons of fuelwood, 27 million tons of residues and small amounts of charcoal and conventional energy sources were consumed by the domestic sector (for conversion factors, see annex 15).

The reviewed literature and information sources do not make a clear differentiation between fuelwood and residues. The main source of information (MoE-EI, 1987) estimates that in 1986, about 31.7 million tons of biomass (expressed in wood equivalent or WE) were used as fuel. In addition to this, an amount of 4.4 million tons wood equivalent (WE) was required to prepare pigfeed[3]. The composition of the total amount of 35.6 million tons wood equivalent consumed in 1986 was given, as shown in table 2.1. It should be noted, that it is not known, which conversion factors were used, nor how the conversions were made from fuels to wood or wood to fuels.

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[3] In Vietnam, it is customary to cook almost all pigfeed, which requires considerable amounts of fuel, often more than for domestic cooking.

Table 2.1 Breakdown of fuel used in the domestic sector in 1986

Total amount (incl. pigfeed prep.)	35.60 million tons WE	100.0%
Fuelwood:		75.0%
Natural forests and plantations	18.97 million tons WE	53.3%
Homegardens and scattered trees	7.19 million tons WE	20.2%
Sawdust and other wood waste	0.53 million tons WE	1.5%
Residues:		15.5%
Agricultural residues	4.70 million tons WE	13.2%
Rice husks	0.82 million tons WE	2.3%
Conventional energy sources		7.8%
Electricity	0.36 million tons WE	1.0%
Kerosene	0.53 million tons WE	1.5%
Coal dust	1.89 million tons WE	5.3%

Source: MoE-EI. Percentages, as quoted in this reference, do not add up to 100 with 1.7% being unspecified.

The 1986 amounts (as given in MoE-EI, 1987), consisting of 75% wood, 15.5% residues and 7.8% conventional energy sources, after taking into account population growth, compare reasonably well with the present calculations, despite slightly altered assumptions. The present (1989) results, as calculated by the consultant, are presented in table 2.2. For comparison, the amount of fuel used to prepare pigfeed, estimated at 4.06 million tons WE and consisting of 50% wood and 50% residues (see section 2.1.2), has been added.

Both tables 2.1 and 2.2 show amounts including the fuel used for pigfeed preparation. In case these amounts are excluded (4.4 million tons WE in 1986 and 4.06 million tons WE in 1989), and assuming that 50% consists of fuelwood and the remaining 50% of residues, it appears that the per capita energy consumption for domestic purposes has increased from 0.527 ton WE in 1986 to 0.580 ton WE in 1989. Such an increase is high, but it is not known, whether this is due to real increase or caused by different conversion factors.

However, a real increase in the average per capita energy consumption possibly could have taken place as the population in districts with a high per capita energy consumption has disproportionally increased, when compared with the population in districts with a low per capita energy consumption. Annex 3 shows the overall population growth rate, rural population as well as proportion of the rural population in the total population in each province. This disproportionate increase of population is probably caused by the Government's policy to relocate people from densely populated areas to new economic zones, often in districts with a lower population density. The policy calls for the relocation of 10 million people by the year 2000 (Western, 1986).

Table 2.2 Estimated amount of fuel used in the domestic sector (1989)

	Incl. pigfeed prep. Million tons WE	%	Excl. pigfeed prep. Million tons WE	%
Total amount consumed	41.67	100.0	37.61	100.0
Consisting of:				
Wood	20.98	50.3	18.95	50.4
Charcoal	0.11	0.3	0.11	0.3
Residues	17.78	42.6	15.75	41.8
Electricity	0.74	1.8	0.74	2.0
Kerosene	1.24	3.0	1.24	3.3
Coal	0.82	2.0	0.82	2.2

Source: Consultant's estimate, see annex 2 and annex 6.

With regard to the present (1989) amounts of wood and residues used by the domestic sector (excluding pigfeed preparation), amounting to 34.7 million tons WE, not much is known about the composition. The literature does not clearly specify, what has been considered as residues, but it appears that it includes, in addition to agricultural residues such as rice straw, rice husks and cassava stalks, also saw mill waste, for instance off-cuts, slabs, bark and saw dust, together with wood obtained from scattered trees in home gardens, along roads and river banks. Residues from perennial crops (coconut, tea, coffee and rubber) also have been considered as residues, although it could be argued that a part of these, notably coconut palm fronds, prunings of tea bushes, unproductive rubber trees are fuelwood and should be considered as such. However, in this study, these have been considered residues, while fuelwood has been considered being derived only from the natural forests and concentrated plantations.

Assuming that the 1986 ratio between fuelwood and other fuel sources still stands, an estimate of the composition of the total amount of energy consumption in 1989 was made, shown in table 2.3 and figure 2.1.

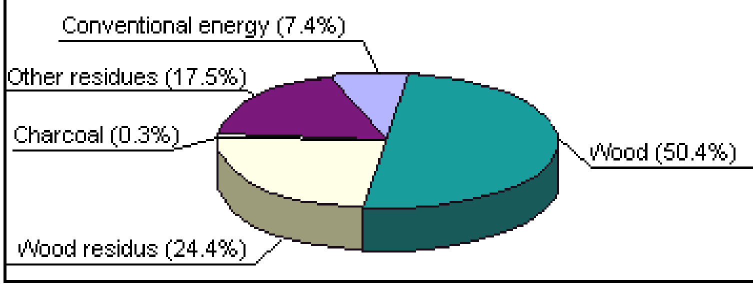
Table 2.3 Composition of domestic energy consumption

Total amount consumed in million tons WE consisting of:	37.61	100.0%
Wood (from forests and plantations)	18.95	50.4%
Wood - Residues (from home gardens, scattered trees, sawdust, perennial crops, etc.)	9.18	24.4%
Charcoal	0.11	0.3%
	-----	----
Sub-total woody biomass	28.24	75.1%
Agro-residues (ricestraw, husks, maize cobs, etc.)	6.57	17.5%
Conventional energy sources	2.80	7.4%

Source: Estimated by the consultant using the most recent data.

Figure 2.1 Energy demand by the domestic sector

Total 37.61 million tons W.E. (see table 2.3)



The 9.18 million tons wood residues in addition to the 18.95 million tons of fuelwood from plantations and forest and 0.11 million ton charcoal (WE) would result in a per capita consumption of wood energy of about 437 kg per year. This figure will naturally show variations from area to area, in particular if urban and rural areas are compared. Unfortunately, no reliable breakdown in rural and urban consumption can be given other than some indications. Annex 2 gives an estimate of the shares of the different fuels used. These are only valid for the province as a whole, including rural population. The Institute of Energy and Electric Power has just finalized a study concerning Hanoi City, which covers about one third of the population of Hanoi, the remainder of the sample population living in rural areas. The final results were not yet available, but the preliminary results show that only a small amounts of fuelwood are used in the city itself. This is confirmed by surveys of general markets coupled with the fact that no specific fuelwood markets exist. Also, transport of fuelwood in large quantities is not, unlike in and around Ho Chi Minh City, a common sight.

2.1.2 Biomass energy demand in the non-domestic sectors

The energy balance shows that the non-domestic sector including for example industry, agriculture and construction, accounts for about 34% of the total energy consumption. The construction sector (basically the building materials) account for about 27%. In addition to conventional energy sources, biomass energy is used, accounting for about 28% of the total energy consumption in these non-domestic sectors.

As mentioned above, biomass energy is used in industrial, agricultural and village activities. Although no doubt there will be countless different industrial or other related activities, which use energy during one or more stages in the processing, not all will be using fuelwood or residues. Attempts have been made to identify as many different biomass energy using industries as possible with a preference for large consumers. This has resulted in a number of identified industries. The list, however, may not be exhaustive as no information on all industries could be acquired. The industries have been subdivided into six major groups as follows:

Food processing. This group includes, for example, bakeries, noodle making, restaurants, beancurd (tofu) making, confectionery, fruit preservation, fish smoking and drying, etc.

Mineral-based industries or building materials production. This covers brick making, roof tile making, lime burning, refractories, porcelain, pottery, ceramic liner stoves etc.

Agro-processing. This basically concerns the processing of agricultural crops like sugarcane to sugar, tea leaf curing and drying, rubber smoking, copra and coconut oil production, tobacco curing, coffee drying and roasting, etc.

Textile-based industries. This covers textile printing, yarn dyeing, silk yarn reeling, other yarn making, etc.

Other activities, e.g. road construction (tar melting and asphalt preparation), soap making, paper making, salt making, among others. Pigfeed preparation is included here, although it could also be categorized under domestic activities.

Metal-based industries. This group covers foundries (iron, brass, etc.), blacksmiths and jewelry making. This latter group, although probably using certain amounts of charcoal, has not been further considered as no information on this sector was available.

Based on information gathered during field visits and earlier visits to Vietnam as well as statistics, an estimate was made on the quantity of fuel used by these industries. The specific energy consumption for the industries considered and other relevant data are given in the annexes 4, 5, 6 and 7. The amount of fuel used for the different sectors have been calculated using several assumptions. This is also the case for the type of fuel used but here, based on observations and discussions with concerned institutions and local people, an estimate on the respective shares was made. It should be noted that the information provided here are estimates. The information provided here should therefore be treated with care.

presumed that the activities in bakeries and restaurants, noodle making, and the like, are evenly spread over the population. Therefore, fuel use has been allocated according to the size of the population. For restaurants, it has been assumed, that 40% use fuelwood, 30% use residues and the remaining 30% use other energy sources, mainly coal. For beancurd and noodle making, the shares of the fuel types have been taken as 50%, 30% and 20% respectively for fuelwood, residues and coal. In the case of bakeries, it has been assumed, that 80% use fuelwood with the other 20% using other energy sources like coal.

A wood-fired bakery oven.

The Ministry of Construction has provided statistical data on energy use within the **mineral-based industries**. However, it appears that the figures on fuelwood consumption are considerably underestimated. It is known that in the southern part of the country almost no coal is used by the brick, tile and lime burning factories, but only fuelwood. Therefore, within this study, it has been assumed that in the northern and the north-central parts (up to Binh Trie Thien province), fuelwood and coal are used, while in the south-central (from Quang Nam Da Nang province) and the south only fuelwood is used. In the northern half of the country, it has been estimated that 75% of the bricks and tile are fired with coal, and 25% with wood, while quick lime (QL) is produced using only coal.

For **agro-processing** the following assumptions were made: Sugar is processed using residues (basically bagasse and some ricehusks) as fuel; tobacco is cured with 90% wood and about 10% residues; rubber is cured using only wood (non-productive rubber trees). Tea drying and processing is done with fuelwood and residues. Coffee is dried with fuelwood (40%), some residues (20%) with the remaining energy supplied by other energy sources like oil. Coconut oil is processed using mainly coconut residues (estimated at 80%), with a small amount of fuelwood (about 20%).

Within the **textile-based industries** only silk yarn reeling has been considered. The fuel used has been assumed to be coal and oil, since almost all of the processing is done in large factories, unlike in other countries in the region, where silk yarn reeling often is a cottage industry with wood the preferred fuel.

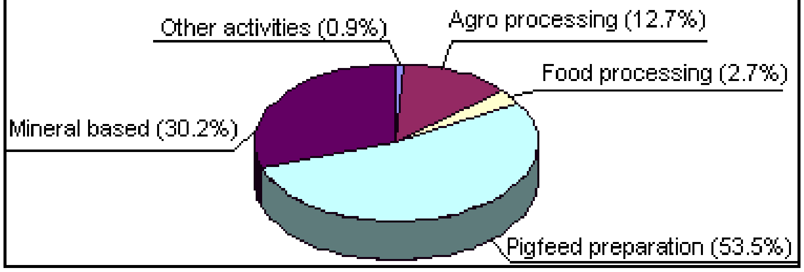
The remaining **other activities** and industries, probably cover many more industries than have been described in this study. Tanning of hides, candle making, gum/resin processing and alcohol distillation are a few of those activities, about which no information was received. From those few that were identified, it has been assumed that tar melting for road construction (mainly repair work) is done with fuelwood. This also applies for soap making. Pigfeed preparation is a very energy-intensive operation with an estimated 350 kg of fuelwood equivalent required per pig per year, resulting in a total amount of over 4 million tons of fuelwood (WE). It has been assumed that 50% of this amount is made up by fuelwood and the other 50% by residues. With regard to pigfeed preparation, stoves are similar to (or even the same as) the ones used for domestic cooking, the

Alcohol distillation is one of the other activities for which no information could be obtained

end-use efficiencies valid for domestic stoves have been taken into account, unlike other industrial processing, where for fuelwood and residues, the same end-use efficiency has been used for calculations.

The total amount used by these industrial and other sectors is illustrated in table 2.4 On the followin page), and is shown in graphic from in the figures 2.2 and 2.3. This table, without considering the amount of fuel used for pigfeed preparation, shows that about 2.5 million tons WE fuelwood and residues are consumed annually. Comparing this with the data given for the same sector for 1986 (0.5 million tons WE), it is apparent that either industrial activity has increased notably, or that the consumption was underestimated in 1986.

Figure 2.2 Energy use by the non-domestic sector Share of each sub-sector (total 7.61 million tons)



Although the amount arrived at in this study has been based on many assumptions, with the exception of statistical data on the quantity of goods produced in the country, it is believed that the amount of about 4 million tons of fuelwood and 2.6 million tons WE of residues (approximately 4 million tons physical residues) used by the industries, which have been described in this study, resembles reasonably well the actual situation for these industries. The amount of conventional energy used is a very rough estimate. The amount of coal used by the mineral-based industries is low (lower than stated by the Ministry of Construction), caused by the assumption that in the south only fuelwood is used for brick and tile making.

Figure 2.3 Energy use by the non-domestic sector Total 7.61 million tons (see table 2.4)

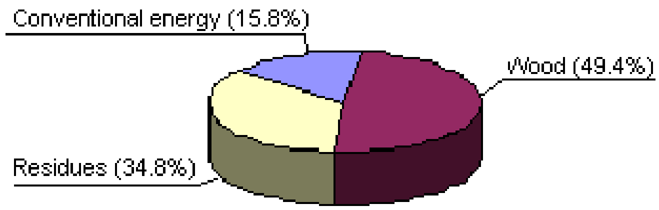


Table 2.4 Estimated amount of fuel used by the non-domestic sector (1989)

	Amount of fuel used in tons wood equivalent Activity		
	Wood	Residues	Conventional
Food processing	96,735	74,027	38,000
Agro-processing	424,584	541,084	---
Mineral based industries	1,149,627	---	1,150,000
Other activities	51,750	---	15,000
Pigfeed preparation	2,037,455	2,037,455	---
	---------	---------	---------
	3,760,151	2,652,566	1,203,000

2.1.3 Aggregated biomass energy demand in Vietnam

By combining the domestic sector with the non-domestic, i.e. industrial sector, the total amount of biomass energy used in the country can be calculated. Using the data as shown in table 2.2 and table 2.4, the total adds up to about 22-23 million tons wood, while the amount of residues adds up to about 18-19 million tons WE. Since residues not only comprise of crop residues, like rice straw and husks, but also of residues from perennial crops (e.g. coconut and rubber), trees in home gardens, and so forth, the total amount of wood used as fuel within the country can be estimated. Using the same ratio as valid in 1986 (MoE-EI, 1987), it is estimated that 32-34 million tons of wood, consisting of about 22-23 million tons from natural and plantation forests, and about 10-11 million tons from home gardens and scattered trees, are consumed. The amount of residues used as energy source comes to about 8 million tons wood equivalent, equal to an estimated 14 million tons of residues (physical), taking into account the end-use efficiency.

Table 2.5 and figure 2.4 show the amounts of biomass and conventional energy sources used by the domestic sector and the non-domestic sector. Annex 12 provides an overview of the biomass energy consumption data at the provincial level. It is shown that on an average, the consumption of biomass energy reaches about 640 kg WE per capita per year. It has to be stressed, that the non-domestic sector covers only the applications as mentioned, and therefore does not necessarily represent an accurate picture of all industrial activities.

Figure 2.4 Energy use by all sectors covered in this report
Total 45.23 million tons W.E. (see table 2.5)

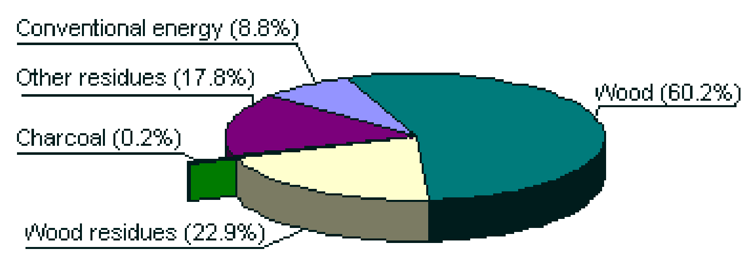


Table 2.5 Estimate of the total amount of fuel used by all sectors (1989)

Activity	Total amount of fuel used in million tons wood equivalent (WE)			
	Domestic	Pigfeed preparation	Non-domestic	Total
Total amount consumed consisting of:	**37.61**	**4.06**	**3.56**	**45.23**
Wood (forest and plantations)	18.95	2.03	1.73	22.71
Charcoal	0.11	--	--	0.11
Residues (as wood) from home gardens, scattered trees, sawdust, etc.	9.18	1.18	--	10.36
	-----	-----	-----	-----
Sub-total as wood biomass	**28.24**	**3.21**	**1.73**	**33.18**
Residues as "physical/actual" residues	6.57	0.85	0.62	8.04
Conventional energy sources	2.80	--	1.20	4.00

Source: Estimated by the consultant, see annexes 2, 4, 5, 6 and 7.

2.2 The biomass energy supply situation

The natural forests, tree plantations and scattered trees in home gardens and along roads, canals and other locations, together with residues from perennial crops, such as coconut and rubber, have the physical potential to produce a given amount of fuelwood under sustainable management systems. This does not mean that this physical amount would be economically available. Fuelwood is a low-value product, and is generally regarded as a free commodity - the only cost recognized by society are gathering and transport.

Accordingly, fuelwood is generally unable to bear the costs of long transport distances. Cursory estimates indicate that distances, over which fuelwood can be transported economically, are around 100 km. This estimate bases on practices around Ho Chi Minh City, where in forested areas piles of fuelwood for sale are a common sight along the roads within a radius of about 100 km. At larger distances from the city they are no longer seen. Drawing a circle with a radius of 100 km around Hanoi shows that there is very little forested area, which may probably be the main reason why so little fuelwood is used in Hanoi.

This also implies that fuelwood may be available in forest areas, such as in the interior and mountain regions. However, this will mainly serve the needs of local communities and is not an economic supply for the more densely populated areas of the coast and foothills, where shortages often occur. Nevertheless, it is useful to begin by presenting an overview of the national physical potential for fuelwood supply.

2.2.1 An overview of the natural forest situation

The total land area of Vietnam is about 33 million ha, and almost 19 million ha, or 57%, is classed as forest land[4]. However, only 9.3 million ha is estimated to have forest cover and about 9.6 million ha is essentially deforested and is subject to varying intensities of shifting cultivation and gathering of woody biomass for woodfuel. Statistics give the total forested area of both production and protection forest as 7.282 million ha. Areas on a national basis are shown in Table 2.6.

Table 2.6 Forest Land by Production and Protection Class (in million ha)

Forest Types	Forest Classes		
	Production	Protection	Prod. and Prot.
Evergreen/Semi-Deciduous/Deciduous	4.245	1.466	5.711
Bamboo Types			
a) Bamboo	0.775	0.235	1.010
b) Bamboo/Wood	0.255	0.059	0.314
Conifer Types	0.089	0.029	0.116
Tidal Forests/Mangrove	0.123	0.008	0.131
	------	------	------
Total Forested	5.485	1.797	7.282
Total Non-Forested/Degraded	5.873	3.253	9.126
	------	------	------
Total Forest Land	11.358	5.050	16.408

Source: MOF-SPH, 1989

Note : Table excludes: special use forests, special multipurpose forests etc.

The productive and protected forests consist mainly of a mixture of hardwood species dominated by dipterocarps, with some upland pine and mixed pine-hardwood associations. Pure stands of bamboo and mixed bamboo-hardwood occupy the second largest forest area, while tidal forests, mainly mangroves, cover only a small area.

[4] In this report, some discrepancies may be found in figures relating to forest areas. This is caused by that the statistics in some cases refer to the total forest area, while other data are valid for a limited area (in many cases 21 out of the 40 provinces.

The natural forest has been stratified into three qualities according to commercial timber volume with rich forest having more than 150 m^3/ha gross bole volume (GBV), medium 80 - 150 m^3/ha and poor under 80 m^3/ha. Young forest has no commercial wood. The rich-medium forest totals 1.688 million ha or about 40% of the production forest with the balance in poor and young productivity as shown in Table 2.7.

Table 2.7 Evergreen/Semi-Deciduous/Deciduous forest areas (in million ha)

Forest Productivity Class	Forest Class (area)			Forest Class (in %)		
	Product.	Protect.	Prod./Prot.	Product.	Protect.	Prod./Prot.
Rich	0.365	0.113	0.478	8.6	11.1	9.9
Medium	1.323	0.300	1.623	31.2	29.4	30.0
Poor	1.590	0.391	1.981	37.5	38.4	37.4
Young	0.966	0.214	1.180	22.8	21.0	22.7
Total	4.244	1.018	5.262	100.0	100.0	100.0

Source: MoF-SPH, 1989
Note : Volumes are overbark to 10 cm dbh.

Data, presented by Armitage (1990), from the Ministry of Forestry, indicate that the mean Gross Bole Volumes (GBV) for rich, medium, poor and young productivity groups of the hardwood forests are respectively 189, 124, 62 and 34 m^3/ha. The biomass usable as fuelwood from commercial trees would make up about 50% of the GBV, plus an additional, approximately 30%, or in total about 120 m^3/ha in the case of rich forest and about 80 m^3/ha for medium productive forest types.

2.2.2 Fuelwood production from forests

2.2.2.1 Natural forest

With sustained yield management and tight control over harvesting practices to minimize damage, as well as maximum timber utilization and marketing of lesser known species, a merchantable annual gross bole volume increment of up to 2 m^3/ha per year appears achievable for the dipterocarp forests of South-East Asia (Armitage, 1990).

Assuming that the 2 m^3/ha/year also applies to the rich and medium productivity forests in Vietnam, and assuming the same amount for the mangrove and coniferous forests, 1 m^3/ha/year for young, and 0.5 m^3/ha/year for poor forests and bamboo/wood forests, the total gross increment is estimated to be 5.7 million m^3/year. Of this, a total of 2.6 million tons per year of fuelwood could be potentially available on a sustainable basis, supposing that the established management practices are followed. This quantity, for which the details are shown in table 2.8, is available from both harvesting and silvicultural residues in the forest.

Table 2.8 Sustainable fuelwood production from production forests

Forest Type	Productivity M^3/ha/year	Area in million ha.	Annual Sustainable Production		
			Million M^3GBV	Million Tons GBV	Million tons Fuelwood
<u>Hardwood Forests</u>					
Rich/Medium	2.0	1.688	3.376	2.363	1.536
Young	1.0	0.966	0.966	0.676	0.440
Poor	0.5	1.590	0.795	0.557	0.362
<u>Other Forests</u>					
Coniferous	2.0	0.087	0.174	0.122	0.079
Mangrove[5/]	2.0	0.123	0.246	0.172	0.112
Bamboo	?	0.775	?	?	?
Bamboo/wood	0.5	0.256	0.128	0.090	0.058
TOTAL		5.486	5.685	3.980	2.587

Source: Armitage, 1990, Annexes 4,5,7,8 (For area data); MoF-SPH, 1989

Note: The following assumptions were made:
Fuelwood supplies = 50% GBV plus 30% for top/branches
Wood density assumed as 700 kg/m^3 at 20 – 25% mcwb (see annex 14)

The national fuelwood production overview presented above must be treated with care, due to considerable variations in forest and tree resources, population densities and accessibility between various provinces and regions. In addition, the non-GBV as assumed to be around 30%, may need field verifications.

2.2.2.2 Plantations

According to the Ministry of Forestry (MoF, 1991) the forest plantation area established between 1961 – 1990 is 1.99 million ha, of which 1.41 million ha is planted by the state and 0.57 million ha by the non-state sector. However, other data (Armitage, 1990 and Bergman, 1990) indicate, that as of 1987 only 0.58 million ha can be considered as plantation area, of which 0.54 million ha is productive. An overview of these plantation areas is given in table 2.9.

[5/] The data used here for forest productivity may in some cases be too low. For example, mangrove forests in South Vietnam have a growth rate of about 10 m^3/ha/year (Chong, 1989), while in Thailand growth rates are about 8 m^3/ha/year (personal communication, Dr. Chomcharn). The same is true for bamboo forests which may attain growth rates at least as high as “rich forests”. With field verification, figures in table 2.8 may appropriately be revised later.

Table 2.9 Area of Forest Plantations by Forest Districts (in ha).

No.	Forest District	Area
I - IV	Northern District	237,721
V	North-Central District	143,964
VI	Central Coastal District	30,475
VII	Western High Plateau District	38,129
VIII	South East District	30,499
IX	Mekong River Delta District	100,610
I - IX	All Districts	583,348

Source: Bergman (1990)

During the period 1975-85, about 35% of the planted areas consisted of three Pinus species - Pinus merkusii, Pinus kesiya and Pinus massoniana. Since then Eucalyptus (mainly Eucalyptus camaldulensis) has increased its share to nearly 50% by 1990, followed by Pinus merkusii with 20%, Pinus kesiya and Pinus massoniana making up 10% and Casuarina equisetifolia with 5%. Acacia mangium, Acacia auriculiformis and Acacia aulacocarpa) are beginning to become important plantation species and will represent nearly 30% of the proposed WFP plantation of 125,000 ha in coastal Zones V and VI. An estimate of the surviving plantations was made (Sidabutar, 1990), which is shown in table 2.10.

The plantations now being established are of fast growing species of especially Eucalyptus, Acacia and Pinus, as well as Casuarina, on short rotations of 8-15 years. An estimate was made of the yield of these plantation and by assuming a M.A.I. of 10 m^3/ha/year, the annual yields on a national basis are projected to be 1.125 million m^3 in 1990, increasing to about 1.406 million m^3 in 1995, and in the year 2000 and 4.343 million m^3 in 2005 (Sidabutar, 1990). However, these projections can, at best, be regarded as broadly indicative. To produce precise projections, plantation inventory should be carried out.

The main end-use of the fast-growing species will be for timber as poles for rural building, plus other roundwood for domestic use, pulpwood for the paper industry and for fuelwood. Under the new large WFP project in Vietnam (project 4304), the proportions of end products from Eucalypti, Acacias and Casuarina have been estimated as follows: 60% poles and 40% fuelwood for the first two species, and 25% poles and 75% fuelwood for Casuarina. The VPSU at Bai Bang, Vinh Phu Province, regards plantation grown wood within an economic range of the pulpmill (about 60 km) as providing approximately 70% pulpwood and 30% fuelwood.

Table 2.10 Areas Planted, Survival Rate and Species Planted from 1975-89 (ha)

Period	Area in hectares		Dominant Species
	Planted	Survived	
1975-79	214,069	100,000	Pines
1980-85	310,065	150,000	Pines, Eucalypti, Mangletia, Melaleuca, Styrax
1986-89	499,294	250,000	Pines, Eucalypti, Acacias, Aleurites
1990	94,000	75,000	Pines, Eucalypti, Acacias, Casuarina
TOTAL	1,117,428	575,000	

Source: Sidabutar, 1990 and MoF-SPH 1991

To estimate the fuelwood yield from plantations, a yield of 50% as fuelwood has been presumed to be valid for the whole country, realizing however that this will vary with location. The total yield is assumed at 10 m3/ha/year m.a.i. gross, which seems to be a commonly used national figure. This should, however, be subject to review following the proposed national forest inventory.

The latest statistics (MoF-SPH, 1991) show a slightly higher national total of productive plantations of about 603,000 ha. These areas, assumed to be successful and well stocked, have been taken to calculate the potential fuelwood supplies from plantation areas. Assuming further a fuelwood yield of 50% of m.a.i. and a density of 0.7 ton/m3, it is apparent that plantations could potentially provide about 3.5 t/ha/year. This figure will be lower in some areas, depending on competition for higher-value uses, such as pulp wood. The areas and fuelwood yield estimates on this basis are presented by province in annex 13, and indicate a present fuelwood potential of about 2.2 million ton/yr. However, this estimate is not made according to age-class distribution and yield scheduling may alter this figure.

2.2.2.3 Bare forest lands

This is a broad category of forest land, which formerly carried high forests of various productivity classes and a range of original forest types. No classification was available and the assumption has been made that these lands, covering over 9 million ha (see table 2.6), are generally covered by low woody vegetation, which will range from herbaceous cover through shrublands to lands with scattered trees and is in various stages of degradation. Some of these bare forest lands, for instance in Lang Son Province to the north and on the hills of the midlands south of Hanoi, have reached the stage of serious erosion.

Most of this development has resulted from a combination of shifting cultivation, fuelwood gathering and uncontrolled logging in some places. Fire damages contribute to this process. It is a complex and varied situation with different pieces of land being subject to different activities and pressures at different times. Fuelwood gathering is said to be on increase. At some locations, literally streams of people can be seen emerging from these bare forest lands, carrying fuelwood to the roadside for their own use or for cash income by selling it to urban markets.

It is the aspiration of the Ministry of Forestry, as well as the provincial governments, to reforest these bare forest lands. This is now being carried out to the limit of available finances. However, it is important to realize that these lands will eventually return to high forest given protection from peoples' interference and time. They are capable of producing fuelwood and eventually other higher-value products such as poles, according to the decided management objectives. Under this management option of protection, these areas may produce 0.5 ton/ha/year of fuelwood on a sustained yield basis, which may reach up to 2.0 ton/ha/year on former rich/medium productivity sites, in case they are not significantly degraded.

However, in accordance with the Government's policy and its programme for land allocation, these bare forest lands will be reforested through plantation establishment, as far as it is economically and socially feasible. Nevertheless, it is unlikely that 100% of the land will ever be covered with plantations, and in any case, the plantation programme will take many years to complete. Meanwhile, it would be prudent to protect unplanted areas from further degradation. The management objective should be to achieve a level of fuelwood removal, which will provide an improvement in density of the stand, leading to sustained yield production. This should be carried out where ever possible, even as an interim measure in suitable areas, in view of plantation establishment.

Assuming conservatively, that these bare forest lands can supply about 0.5 ton/ha/year of fuelwood on a sustainable basis, it appears that they may supply about 4-4.5 million tons of fuelwood per year.

2.2.3 Residue production from various sources

As mentioned in previous sections, residues consist of two main groups. The first group comprises of wood residues, such as those derived from saw milling - slabs, offcuts, sawdust and bark; wood from scattered trees in home gardens, agricultural lands, along roads and canal banks; and wood from perennial crops like rubber trees and coconut palms. The second group of residues comprises non-wood residues such as rice husks, rice straw, maize cobs, stalks and leaves. However, no clear distinction can be made in all cases and the following should be seen as being indicative. In many cases, only limited data is available, which makes the use of estimates necessary.

2.2.3.1 Scattered trees

The reviewed information sources place scattered trees in the "residues" sector. However, scattered trees can also be considered as forest resource, as shown in the forest statistics, where they are described as "dispersive trees" (MoF-SPH, 1991). This includes plantings of individual trees, mainly on non-state lands in home gardens, in crop lands especially as agroforestry, along farm boundaries, roadsides, canal banks and other similar areas. The data show these to be a major tree resource, planted for a wide variety of uses, which include the growing of fruit, production of timber (mainly poles and other on-farm utility materials), fuelwood, fodder, for shade and for soil protection.

In 1990, 400 million trees were reported to have been planted, which is equal to 0.4 million ha at 1,000 trees/ha equivalent. During 1961-90, an area equivalent to 5.7 billion trees was planted. However, to consider losses, an area equivalent to only 4.0 million ha, was used for the analysis as presented in Annex 13. To estimate the sustainable fuelwood supply, it has been assumed that the m.a.i. would be the same as valid for forest plantations (10 m^3/ha/year), but would yield a lower amount of 2 t/ha/year on an area equivalent basis. On the basis of the above conservative assumptions, the contribution of scattered trees has been estimated to be about 8.0 million tons per year, which is expected to increase in response to the Government's programmes. Inventory data are urgently needed to provide a more reliable estimate of this major contributor to the fuelwood supplies.

2.2.3.2 Residues from forest industries

A main source of fuelwood are residues from sawmills, which Davies (1991) has reported produce about 1.0 million m3/year of sawn timber. Sawmills are of two main types: (1) those with conventional mechanical sawing systems, which number at least over 300 throughout Vietnam, and to which the above production statement appears to apply, and (2) small workshops with manual sawing methods and no record of production.

Assuming a recovery rate of 40% of sawn wood, there would be 60% residues (10% sawdust and 50% wood waste) available as fuelwood, totalling about 1.5 million m^3 per year. It can be fur-ther assumed that there will be many informal sawmilling activities as well, which may add an additional 50% to this figure. Overall, it can be estimated that these activities supply, on a sustain-able basis, about 1.575 million tons residues per year to be used as fuel, assuming a density of 700 kg/m^3.

2.2.3.3 Other wood waste

A significant amount of fuelwood is derived from material from the replacement of old and defective woody construction materials. The sources are numerous and include parts of all kinds of buildings, fences and other structures. Supposing that 50% of these replacement materials are used as fuel (Christophersen, 1990), it can be roughly estimated, that the amount of fuelwood would reach about 0.60 million tons per year. This amount is a very rough approximate and needs detailed survey for verification.

2.2.3.4 Perennial crops

The main tree crops of interest for production of biomass are rubber, tea and coconut. They occupied 216,000 ha, 58,000 ha and 206,000 ha respectively in 1989 (SPH, 1990). In addition, there are about 17,000 ha of citrus trees with a relatively small fuelwood potential, and 100,000 ha cashews (proposed 150,000 ha by 1995) that offer significant fuelwood potential, when re-placed in the end of their productive life. However, as plantations are relatively young, this is a distant prospect.

(i) Rubber

In 1976, the area planted with rubber trees was about 76,000 ha producing approximately 40,000 tons of dry rubber. In 1986, these figures were 202,000 ha and 50,000 tons. It has been estimated that in 1989 out of a reported 216,000 ha only some 67,000 ha were productive with the remaining acreage in need of replanting. In the recent past, replanting has been carried out to the tune of about 5,000 ha per year. Biomass yields, at a very conservative estimate of 100 m^3/ha[5] of stem and branch wood, could amount to some 0.5 million m^3 or 0.35 million tons, being available annually over a period of 10-20 years. However, rubberwood, when properly treated, is also suitable for furniture, and acceptable paper pulp raw material either for local use or export as wood chips. If so, the fuelwood component would be markedly lower, but, as no information is available on alternative uses, it has been assumed that this amount of about 0.35 million tons will be available on a sustainable basis. Additional amounts may become available as replanting is planned to be increased, while existing trees also will become available, once they reach the end of their productive lives of about 25-30 years. In addition to the fuelwood obtained through replanting, considerable but unknown amounts of dead branches and storm-damaged trees are suitable fuelwood, and often collected by the local population.

(ii) Coconut

In the southern regions, coconut palm is an important component of the home garden and a significant biomass energy producer (husks, shells and fronds), plus potential trunkwood. The Energy Institute (1987) has reported that 189,000 ha of coconut palm resources are part of the home gardens. It has been assumed that these trees would be additional to the "dispersed trees" recorded by the Ministry of Forestry, since coconut palms are mostly not supplied through the forestry sector and therefore will <u>not</u> appear in forestry statistics.

The 1989 area devoted to coconut was 206,000 ha, of which about 112,000 ha were productive (informal communication, Dep. of General Statistics). Stemwood could be a significant supplier of fuelwood, but it is thought that most of it is used for other purposes, such as sawn timber, poles for house and bridge construction. However, the fronds are used as fuel. As each palm produces in an average 13 fronds per year, weighing about 1 kg, with about 160 palms per ha, this represents a sustainable supply of about 0.4 million tons per year of wood for use as fuel.

Together with woody biomass, coconuts produce a considerable amount of biomass from husk and shells, which are used as fuel in most households that have access to these residues. With about 5,500 nuts per ha per year at 1.5 kg/nut, and with the husk accounting for 37% and the shell for 14% (m.c. as received), 4.21 tons per ha per year of wet biomass is generated, equal to about 0.47 million tons per year from the productive area of 112,000 ha. However, the moisture content is high and after drying and taking into account alternative uses as charcoal and ropes, it is estimated that the available amount for fuel may reach only 0.14 million tons per year.

(iii) Other perennial crops

Although not much is known about fuelwood supplies from perennial crops other than rubber and coconuts, some estimates have been made. This mainly concerns tea. Prunings of the bushes are estimated to supply on an annual and sustainable basis about 17,000 tons WE per year. No sufficient information is available about other perennials like citrus trees, cashew trees and areca palms. Annex 9 presents an overview of the estimated amounts of wood as well as other residues available from perennial trees/crops.

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[5] In Thailand, about 140 m^3 per ha becomes available during replanting (personal communication Dr. Chomcharn).

2.2.3.5 Agricultural residues

The amount of residues used as energy source within the country has been estimated at about 18 million tons per year expressed in wood equivalent (WE), equal to about 31 million tons residues. However, as described earlier, part of these residues are wood (scattered trees, home gardens, processing waste, etc.) and the remaining part, estimated at 8 million tons WE or about 13 million tons of residues, consist of non-wood residues from e.g. agricultural crops (rice, maize) and perennial crops (coffee and coconut husks).

Some estimates of the amounts of these non-wood residues generated in the country have been calculated. About 35 million tons of non-wood residues are produced annually. These consist largely of rice straw and husks (respectively 23.8 and 5.4 million tons per year), which together make up 84% of the total amount of non-wood residues. Other significant residues are sugar cane (bagasse, tops) with a share of 6%, maize (stalks and cobs, 5%), potato stalks (2%) and cassava stalks (1%). Annexes 8 and 9 give an overview of the amount of residues produced by agricultural activities as well as from perennial crops. Table 2.11 shows the amounts of wood and other residues generated in the country. However, not all of the residues are available as energy sources, because there are some competing uses such as for animal feed, animal bedding, fertilizer, etc.

Sugar cane tops, rice and other straws are widely used as animal feed and litter for cows and buffaloes. It has been estimated, based on an average requirement of 1.85 tons per year for a buffalo, and 1.30 ton for a cow (MoE-EI, 1987), that about 9-10 million tons are used annually for that purpose.

Straw, together with dung and other farm waste forms a part of organic fertilizer, which is applied on the fields at a rate of about 6 tons per ha (FADINAP, 1990). The organic fertilizer consists of dung, straw, leaves, farm yard waste and ashes from fuel burned (mainly from straw and husks). It is estimated, based on the assumption that straw contributes 1 ton of the total of 6 tons of organic fertilizer per hectare of agricultural land, that annually about 5-6 millions tons of straw, leaves, etc. are used for this purpose. Another, but unknown part of the residues will not be available for use as fuel, partly because it is generated seasonally, partly because it is burnt in the field as fertilizer. This is the case with rice straw, which is not very suitable as domestic fuel. Part of it is produced in areas with a low population density resulting in a local surplus. The overall conclusion, which may be drawn, is that out of the 35 million tons of agricultural residues generated probably less than 50% is available as a source of energy.

Table 2.11 Estimated amount of residues generated in Vietnam

Type of residue	Amount generated ('000 tons)	
	Actual amount	As W.E. (1)
<u>Wood residues</u>		
Scattered trees	8,096	8,096
Forest industries	1,575	1,575
Other wood waste	600	600
Perennials (rubber wood, palm fronds, etc.)	781	781
Sub-total	11,052	11,052
<u>Other residues</u>		
Rice straw/husks	29,191	17,164
Maize stalks/cobs	1,741	1,024
Sugar cane tops and bagasse	2,218	1,304
Other agricultural residues	1,685	991
Perennial crops	162	93
Sub-total	34,997	20,576
<u>TOTAL</u>	46,049	31,628

Source : See Annex 8, 9 and 13
(1) : Amount in WE has been calculated taking into account average heat values and using efficiencies of domestic stoves (see annex 14).

In addition to agricultural residues, it was found during surveys that ferns, weeds, grass and leaves - in fact anything, which will burn, including cowdung, were used as fuel. It has been estimated by the consultant that these sources may supply 1-2 million tons annually. These types of fuels are predominantly used in areas with a severe fuel deficit, such as areas without forests, or with low agricultural productivity; in areas whre occupations other than agriculture are common, e.g. coastal fishing communities, industries, or in semi-urban areas and large villages.

2.3 National overview of fuelwood supply-demand

The amount and reliability of the available data is thought to be only sufficient to provide a broad indication of the supply of and demand for energy in the form of fuelwood as well as other biomass energy sources. However, despite the limitations of the data, it is possible to draw some useful conclusions. The national overview of fuelwood supply in relation to demand by major sources is presented in table 2.12, and a more detailed overview is given in annex 14. The figures

2.5, 2.6 and 2.7 show respectively the supply and demand balance and the regional situation using forestry regions as a basis. The supply is specified as to total supply per forestry region and the supply per capita for each forestry region.

Table 2.12 shows that on a national basis, with regard to fuelwood, there is a deficit of about 13.8 million tons, while residues show a surplus of 6.4 million tons, even when taking into account the use of it for other purposes. However, when converting the surplus amount of residues to "Wood Equivalent" by applying appropriate conversion factors as valid for domestic stoves (see annex 15), there is a deficit of about 10 million tons of biomass energy in the form of wood.

Table 2.12 Biomass energy supply and demand situation * 1,000 physical tons

Biomass energy source		Supply	Demand		Balance
			As fuel	Other	
Fuelwood Supply		**20,080**	**32,934**	**(1)**	**- 12,854**
from forest lands					
- natural forests	2,588				
- plantations	2,209				
- bare lands	4,232				
from residues as wood					
- scattered trees	8,096				
- forest industries	1,575				
- other wood waste	600				
- perennial crop trees	781				
Supply from Residues		**34,997**	**13,484**	**15,067 (2)**	**+ 6,446**
- agricultural residues	34,835				
- perennial crop residues	0,152				

Source: Annex 13 and 14

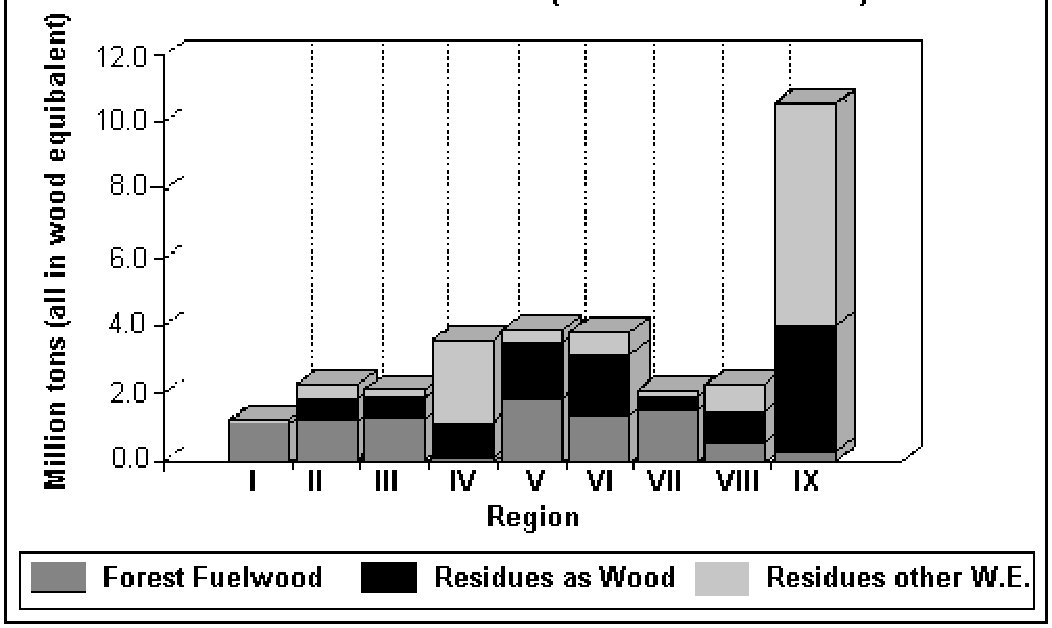
(1) Possible demand for wood for pulp, chip board, etc.

(2) This consists of 9.34 million tons as animal feed and 5.76 tons for organic fertilizer

Weeds being dried for fuel.

Litter from casuarina plantations (coastal protection) collected for fuel.

Figure 2.5 Total Biomass Energy Supply Amount and Source (based on annex 13)



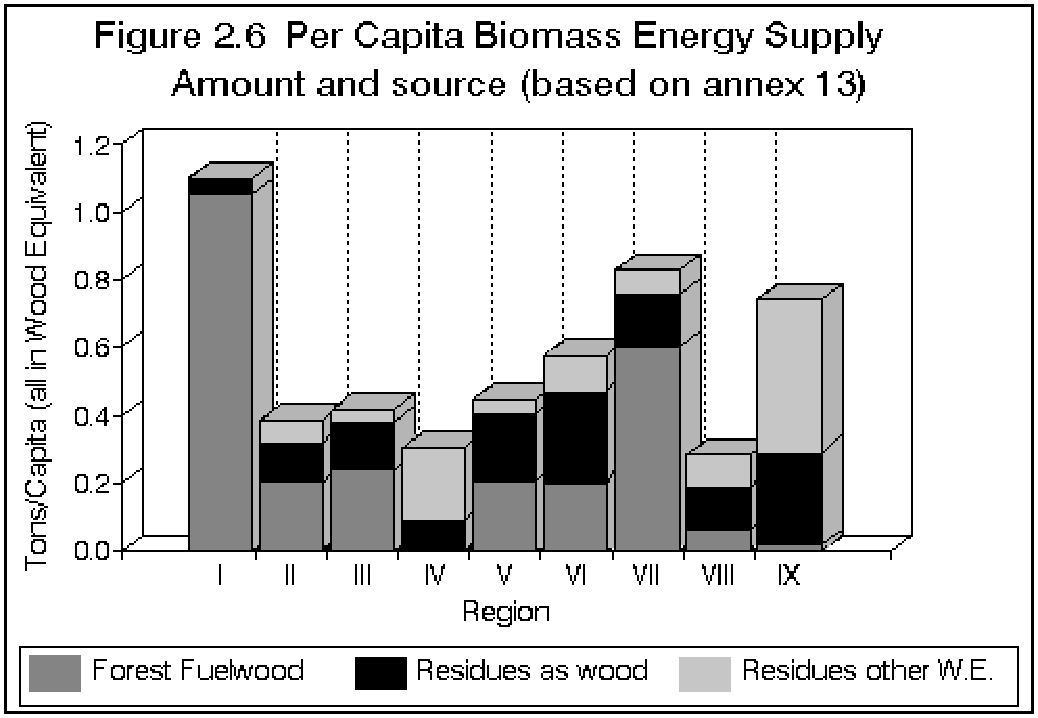


Figure 2.6 Per Capita Biomass Energy Supply
Amount and source (based on annex 13)
Tons/Capita (all in Wood Equivalent)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
I
II
III
IV
V
VI
VII
VIII
IX
Region
Forest Fuelwood
Residues as wood
Residues other W.E.

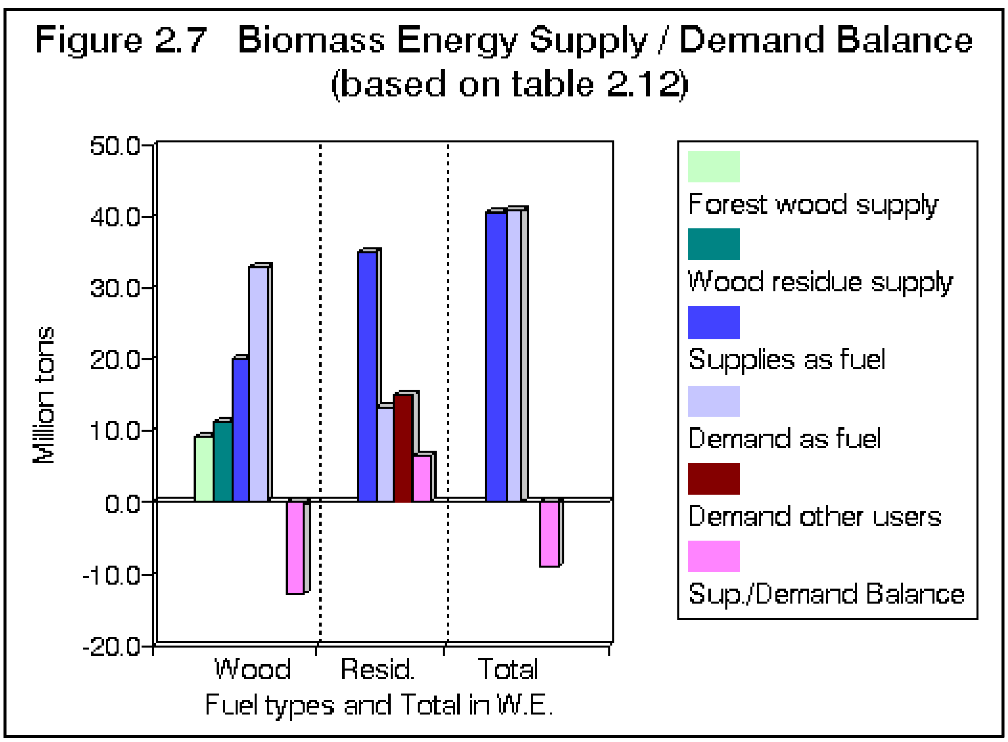


Figure 2.7 Biomass Energy Supply / Demand Balance
(based on table 2.12)
Million tons
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
Wood
Resid.
Total
Fuel types and Total in W.E.
Forest wood supply
Wood residue supply
Supplies as fuel
Demand as fuel
Demand other users
Sup./Demand Balance

On a regional basis, shown in table 2.13, more or less the same picture emerges, with most of the regions having a large deficit, while others appear to have a surplus. Overall, the following comments on the tables 2.12 and 2.13, as well as the annexes 12, 13 and 14 can be made.

- **By drawing up the tables and annexes, it has been assumed that the fuelwood supply is based on sustainable production from all sources. With agricultural residues, this statement of sustainability is not necessarily valid and, where the use of it as fuel will lead to soil degradation, may have to be replaced by other energy sources (see also the discussion in Chapter 5).**

- **Most regions show fuelwood and residue (as fuel) deficits, when comparing present demand with the estimated supply, and will need additional supplies.**

- **Only one region, the north-western mountain area (region 1), shows a fuelwood surplus.**

- **Three regions, the Red River Delta (IV), the Central High Plateau (VII) and the Mekong River Delta (IX) show a surplus of residues for use as fuel.**

- **Two regions, the North-Western mountain area (I) and the Mekong River Delta (IX,) show an overall surplus of biomass energy sources.**

- **Region VI, the central coast area, has the lowest per capita deficit (0.08 tons per capita per year).**

- **In most areas, there is a dependency on residues as energy source, which may have implications on soil fertility and farm productivity. Additional energy sources like conventional energy may have to be supplied or more wood production will be required.**

Table 2.13 Regional supply and demand balance for biomass energy sources

No. Region	Demand			Supply			Balance			Balance ton/cap.		
	1	2	3	1	2	3	1	2	3	4	5	6
I North West	1.0	0.1	1.0	1.2	-0.0	1.2	0.3	-0.1	0.2	0.22	-0.13	0.15
II North Central	4.0	0.8	4.4	1.8	0.7	2.2	-2.2	-0.1	-2.2	-0.38	-0.02	-0.39
III North East	3.6	0.7	4.1	1.9	0.3	2.1	-1.7	-0.4	-1.9	-0.34	-0.07	-0.38
IV Red River Delta	4.7	1.8	5.8	1.1	4.3	3.6	-3.7	2.5	-2.2	-0.31	0.21	-0.19
V Central North	5.7	1.3	6.4	3.5	0.7	3.9	-2.2	-0.7	-2.6	-0.25	-0.08	-0.30
VI Central Coastal Zone	3.2	2.0	4.4	3.1	1.3	3.9	-0.1	-0.7	-0.5	-0.02	-0.11	-0.08
VII Central High Plateau	2.4	0.1	2.5	1.9	0.3	2.1	-0.5	0.2	-0.4	-0.22	0.09	-0.17
VIII South East	2.9	1.4	3.7	1.5	1.3	2.2	-1.4	-0.1	-1.5	-0.18	-0.02	-0.19
IX Mekong River Delta	5.4	5.2	8.5	4.1	11.1	10.6	-1.3	5.9	2.1	-0.09	0.41	0.15
ALL VIETNAM	32.9	13.5	40.9	20.1	19.9	31.8	-12.9	6.4	-9.1	-0.20	0.10	-0.14

Source: See Annex 14

Note : 1 = Demand, Supply and Balance for wood as energy source in million physical tons
2 = Demand, Supply and Balance for residues as energy source in million physical tons
3 = Demand, Supply and Balance as total biomass energy in million tons "Wood Equivalent"
4 = Demand, Supply and Balance for wood as energy source in tons per capita
5 = Demand, Supply and Balance for residues as energy source in physical tons per capita
6 = Demand, Supply and Balance as total biomass energy in tons "Wood Equivalent" per cap.

Figure 2.8 Biomass Energy Supply / Demand Balance
Regional basis (see table 2.13)

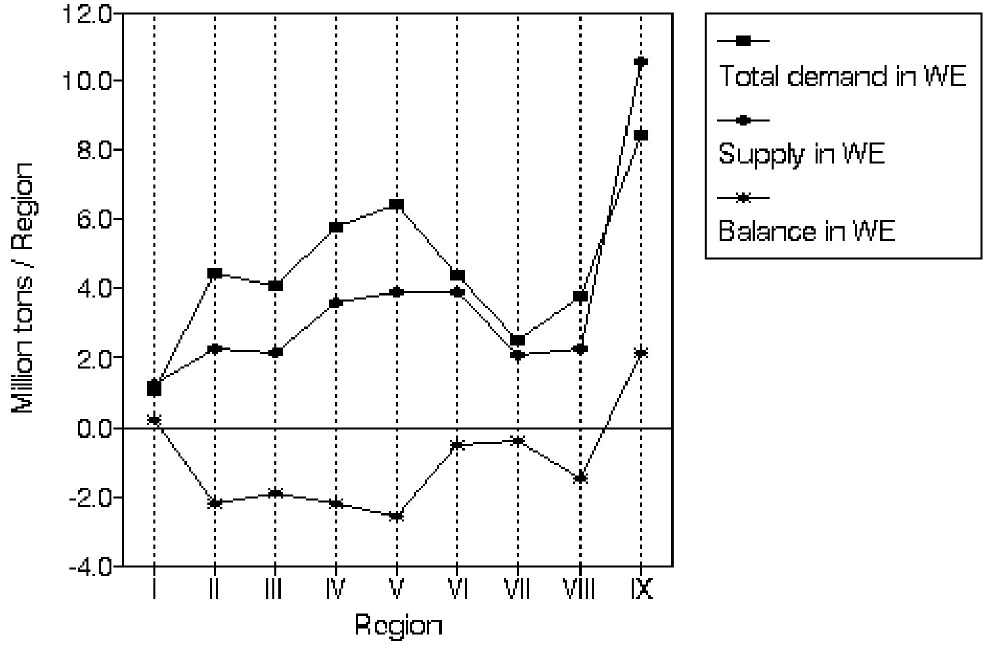
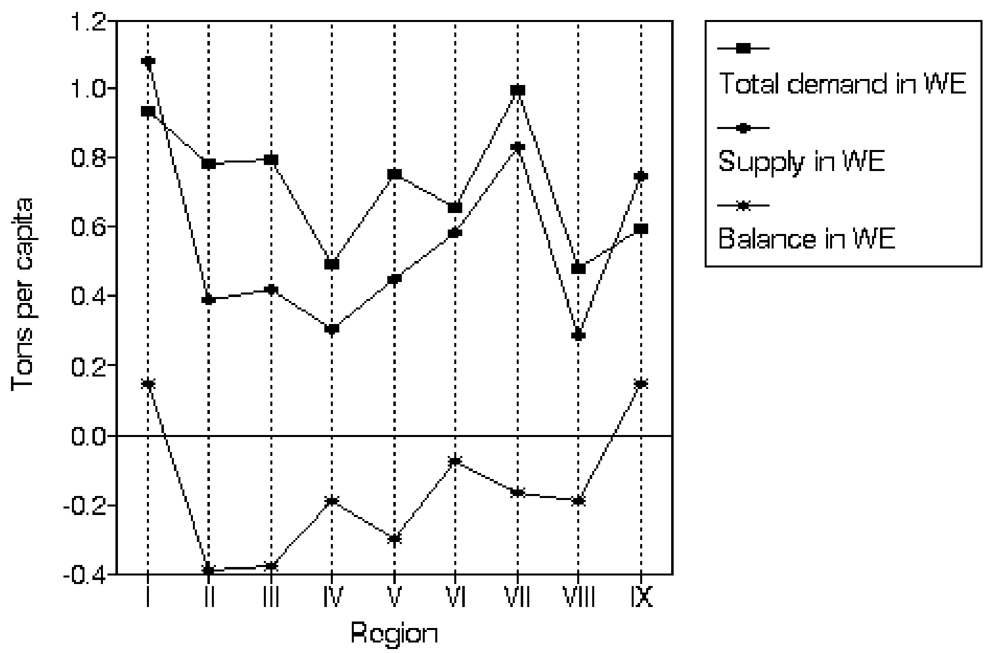


Figure 2.9 Biomass Energy Supply / Demand Balance
Per capita regional basis (see table 2.13)



2.4 National policies, objectives and strategies for supply of fuelwood

Apparently, there exists a Government document entitled *"Energy Planning Practices and Methodologies in the Socialist Republic of Vietnam"*, compiled by the Institute of Energy of the Ministry of Energy, presented at the APDC Energy Planning Workshop in Hanoi in November 1990. This document only briefly mentions biomass energy. It is apparent that no national policies, objectives and strategies presently exist for biomass utilization and production.

Normally, each country produces a 5-Year Development Plan for each of the major sectors including forestry and energy, but it appears that such a plan is not produced for Vietnam. However, the Planning Department of the Ministry of Forestry produced a policy statement in a document released in November 1988, which is entitled *"Forestry Development Strategy Toward 2005."*

In this document, the Ministry of Forestry states its intention to build up the forest resource base over a 50-year period to 18.965 million ha, which equals the area presently classified as forest lands and would include 12.175 million ha of production forests. It states that the area will include 3.795 million ha for the production of household fuelwood, and forecasts the production of fuelwood to rise to 20 million m^3/year up to the year 2010, excluding the production of scattered trees. Some details are provided on the application of this strategy for all kinds of forest production by Zones.

A more recent (January 1991) draft document from the Planning Department of the Ministry of Forestry has proposed a programme for the period of 1991-1995, which includes the establishment of 500,000 ha of timber plantations, which is about the level achieved during 1986-1990. In addition, there would be an annual planting of 400 million seedlings for household wood production (equating to about 400,000 ha/year as in the previous five years). This programme is expected to produce fuelwood, but the document does not specifically address the fuelwood problem in Vietnam. Also, there appears to be little policy guidance nor focus by way of specific objectives and strategies.

Several organizations are involved in various aspects of biomass energy, including the Institute of Energy, the Ministry of Forestry and others. The institutional involvement and requirements are discussed in Chapter 6.

2.5 National programmes related to fuelwood production

2.5.1 Basic requirements

Tables 2.12 and 2.13 show the broad national pattern of biomass energy supply, which meets the present demand of 40.9 million tons WE per year. The same tables show a deficit of 12.9 million tons as fuelwood. The shortage could partly be offset by the surplus of residues available for fuel. However, the use of agricultural residues as energy sources may have a negative influence on soil fertility and agricultural productivity. Hence, it is the objective of the Government of Vietnam to reduce the dependency on residues as a source of energy. Accordingly, Government intervention is required consisting of major increases in plantation establishment through the land allocation and settlement programme on the bare forest lands.

2.5.2 National tree planting programmes

The programmes of tree planting through plantations and scattered trees, which have been carried out, and even those, which are proposed by the Ministry of Forestry and by international donor agencies, have been largely notional without adequate planning to meet specific, quantified national and provincial needs. An important outcome of the TFAP (Tropical Forestry Action Programme) should therefore be to assist the Government of Vietnam to focus on policies needed to provide basic forest and tree products to the people in a rational manner. This should be carefully planned in accordance with the available financial support, manpower, technical and institutional support and suitable land.

The main features of the national programmes are as follows:

1. *Over the period 1986-1990, the average rate of plantation establishment has been 125,000 ha/year (gross). For the period 1991-1995, the Planning Department of the Ministry of Forestry has advised (January 1991) that the Government proposes to establish 650,000 ha of plantations, of which 500,000 ha or 100,000 ha/year will be for timber production and 150,000 ha for non-wood production.*

2. *In addition to this, the Government proposes to distribute 2,000 million trees including 1,300 million trees for wood production for households and 700 million for other uses. This is about the same as for 1986-1990, and equals timber tree potential of around 260,000 ha/year.*

3. *The proposed WFP 4304 project will establish 125,000 ha of fast-growing species on 31,000 ha/year over the next four years in 12 provinces that suffer from fuelwood shortages along the coast and midlands.*

4. *There has been some support from FAO, especially through the UNDP/FAO-funded Project VIE/86/027 "Fuelwood Afforestation in Different Ecological Zones."*

5. *There is a preliminary proposal by the World Bank for 291,000 ha over 6 years for 48,500 ha/year in 12 provinces facing fuelwood shortages. Of these 12 provinces, six are in common with the WFP 4304 project.*

2.5.3 Fuelwood production from national tree planting programmes

Assuming that the WFP and WB programmes are included in the national planning target, about 0.82 million tons additional fuelwood supplies per year may be achieved, assuming that plantations supply 3 tons per year per ha, and scattered trees about 2 tons per hectare per year. Table 2.14 (on the following page) provides an overview of the incremental fuelwood production from this programme on a national basis.

Table 2.14 Fuelwood Production from New Plantings * 1,000 tons expressed in Mean Annual Increment or M.A.I.

Year	Planting activities '000 hectares				Fuelwood production '000 tons		
	Plantations		Scattered Trees		Plantat.	Scat. Trees	Total
	Per year	Total	Per year	Total	Per year	Per year	Per Year
1991	100	100	260	260	300	520	820
1992	100	200	260	520	600	1,040	1,640
1993	100	300	260	780	900	1,560	2,460
1994	100	400	260	1,040	1,200	2,080	3,280
1995	100	500	260	1,300	1,500	2,600	4,100

Note: The WFP project is expected to end around 1995, but the WB project may start in 1992 and is expected to continue for six years. It is assumed that the national planned programme of 100,000 ha/year will continue with a range of donor support with the government making up the shortfall in area.

Even though a substantial amount of fuelwood will be generated by these programmes, unless some policy changes are implemented, much of this new fuelwood could end up in the urban cash markets, and the farmers would continue to gather wood from the degraded forest lands for their own use, as well as competing on the market with the plantation-grown fuelwood.

It appears that plantation development is expected to be established through co-operatives and farmers' participation under the land allocation programme with a varying degree of Government support (food aid in the case of WFP programmes) and an agreed sharing of the forest product output.

The degree of success of the plantations or the land allocation programme, and in particular the settlement component of it, is not known. During visits to a number of settlements under the land allocation programmes, however, these generally appeared satisfactory. The main constraint, according to the provincial staff, was in securing funding to continue the programmes. In all visited provinces, there appeared to be no shortage of staff to administer the programmes nor for the provision of extension officers to advise on land use and plantation development.

The World Food Programme (WFP) also maintains that there are no staffing constraints to implement its new programme (project 4304), which will establish 125,000 ha of plantations on allocated bare forest lands. This programme will start after the completion of the present programme (Project 3352) covering 81,000 ha. In Vietnam, the WFP projects are regarded very successful in terms of implementation.

However, while these intensive plantation reforestation programmes are accepted as necessary where socio-economically feasible, it must be recognized, that there are alternative methods, which are less expensive, although probably also less productive. These bare forest lands, given enough time and protection from harvesting for fuelwood and other subsistence needs, as well as from shifting cultivation and from fire, would in many cases eventually return to their original condition of high forest. This option would not require much intervention by the Provincial Forest Services.

Many of these bare forest lands are capable of sustainable production of fuelwood and other products at little more than social costs. This social cost must recognize income, which must be foregone in order to provide time required for protection, even though this income is obtained by the households using the land that may be degraded by their activities. The people must be helped in finding alternative sources of income.

2.5.4 Fuelwood production through land allocation programmes

The alternative offered by the Provincial Forest Services is the allocation of land. The status of the land allocation programme on a national basis, in relation to plantation development as of 1988 is shown in Table 2.15.

Programmes of land allocation are feasible, if the land is:

1. *Suitable for subsistence farming, in addition to tree growing in accordance with the Provincial and District guidelines in case the household does not have own land, or;*

2. *Close enough to the household's present farm to allow non-resident plantation development without additional subsistence farming;*

3. *The land must be suitable for its selected purpose of tree plantations, agroforestry and/or cropping and;*

4. *Adequate land use planning data and extension services must be available.*

From the table 2.15, it appears that nearly half of the bare forest lands have been developed for plantations and cultivation. This leaves the remaining 1.4 million ha apparently available for development. Assuming the land is suitable for settlement, an area of around 1.0 million ha (net of land for subsistence agriculture) might be available for plantation development through farmers' participation. Subtracting the 0.5 million ha proposed for plantation development during 1991-1995, there remains a further 0.5 million ha for future plantation establishment. This area, if suitable, could incrementally yield an m.a.i. for fuelwood only of 1.5 million tons/year. Together with the 4.1 million tons/year m.a.i., as shown in table 2.14 as produced after five years, this amounts to 5.6 million tons/year.

Table 2.15 Status of Land Allocation and Plantation Establishment

Details	Quantities	Area in % of --------------- Allocated Land	Area in % of ---------------- Bare Forest Land
Allocated Land '000 ha.			
- Forested (1)	1,750	39.5 %	
- Bare forest lands	2,684	60.5 %	
	-----	-------	
- TOTAL	4,434	100.0 %	
Areas in Use '000 ha.			
- Home Gardens	323		12.0 %
- Plantations	960		35.8 %
	-----		------
- TOTAL	1,283 (out of 2,684 ha.)		47.8 %
Allocated Units			
- Villages	2,271		
- Cooperatives	5,722		
- Families	349,570		
- Government Offices	610		

Source: World Bank 1990

1. Forest land assumed to be natural forest which would not be planted.

This amount would improve the national fuelwood situation. However, there will be a time lag until fuelwood becomes available from the plantations and scattered trees at the end of the first eight-year rotation (yielding respectively 24 tons and 16 tons per ha) and meanwhile the population will continue to increase at the rate of 2.1% per year.

Taking into account this population growth rate,it can be estimated that in 1995, Vietnam will have a population of about 73 million, rising to about 81 million by the year 2000. This would result in an increased use of fuelwood by the domestic sector only (excluding pigfeed preparation) from about 28 million tons at present to about 31-32 million tons in 1995 and 35-36 million tons in 2000, assuming that the ratio of fuelwood to residues remains about the same. This assumption is based on the fact that the increased population will have to be fed, resulting in increased cropping areas, yields or both. In the first case, increase in areas grown, the availability of residues will probably increase proportionally with area, while in the second case, increased yields, more fertilizers may have to be applied, resulting in that more residues may become available instead of being used as an organic fertilizer. Assuming that the ratio of domestic to industrial use remains also the same, the total amount of fuelwood consumed in the country will be about 37 million tons in 1995 and about 41 million tons by the year 2000.

Table 2.16 Biomass energy Supply and Demand Balance 1990 - 2010

Year/Note	Demand			Supply			Balance			Balance ton/cap.		
	1	2	3	1	2	3	1	2	3	1	2	3
1989 (4)	32.9	13.4	40.9	20.1	19.9	31.8	-12.9	6.4	- 9.1	-0.20	0.10	-0.14
1990	33.6	13.8	41.7	20.1	20.3	32.0	-13.5	6.6	- 9.7	-0.21	0.10	-0.15
1995	37.3	15.3	46.3	20.1	22.6	33.4	-17.2	7.3	-12.9	-0.24	0.10	-0.18
1999 (5)	40.5	16.6	50.3	25.7	24.5	40.1	-14.9	7.9	-10.2	-0.19	0.10	-0.13
2000	41.4	16.9	51.3	25.7	25.0	40.4	-15.7	8.1	-10.9	-0.19	0.10	-0.14
2005	45.9	18.8	57.0	25.7	27.8	42.0	-20.2	9.0	-15.0	-0.23	0.10	-0.17
2010	51.0	20.9	63.2	25.7	30.8	43.8	-25.3	10.0	-19.4	-0.25	0.10	-0.19

Source : See Annex 2, 4, 5, 6, 7, 13, 15, Table 2.12 and Table 2.13

Note : 1 = Demand, Supply and Balance for wood as energy source in million tons
2 = Demand, Supply and Balance for residues as energy source in million physical tons
3 = Demand, Supply and Balance for biomass energy in million tons "Wood Equivalent"
4 = Present data (see table 2.13)
5 = Wood supply increases with 5.6 million tons per year as a) 1991 plantings of 100,000 ha. and 260,000 ha. as scattered trees are cut down (8 year cycle) supplying 4.1 million tons and b) an estimated 1.5 million tons is obtained from additional plantations (section 2.5.4).

Table 2.16 shows this estimated increase in the national demand and supply, based on the population growth and the increasing supply from the planned programmes of plantation and scattered tree establishment (by households) from 1991 to 1995. It does not, however, include any allowance for increases in supply from tree crop residues, due to increased plantings of rubber, coconut and other woody plants. At the same time, it has been assumed that decreases in the wood supply, as bare forest lands (supplying on a sustainable basis 0.5 ton/ha/year), are converted for other purposes, i.e. tree planting, are offset against the supplies derived from clear cutting of these bare forest lands.

In any case, not enough is known at present to give a reliable estimate about what may happen in the future. The data should be seen as indicative only. Therefore, care should be taken with the interpretation of the data provided, given the many uncertainties underlying the assumptions. However, the following conclusions may be drawn, based on the assumptions of:

* ***Sustained yield of 2.6 million tons per year from natural forests;***
* ***Sustained yield of 4.2 million tons per year from bare forest lands under protection and management;***
* ***Present levels of plantation and scattered tree plantings continue;***
* ***Present levels of use of non-agriculture biomass residues do not change;***
* ***The share of agricultural residues as energy source remains the same.***

- ***There appears to be a shortfall in meeting energy needs (from fuelwood and residues, expressed in WE) of about 9.7 million tons per year WE in 1990, which will rise to about 13-14 million tons per year by 1998. This will fall to about 10 million tons per year, when planned 1991 plantations are felled, and then incrementally rise with the population increase to a roughly estimated 19 million tons per year by the year 2020.***

- ***It has been assumed that the shortfall is made up by fuelwood sources with a sustainable yield, which is not presently so. Hence, at present an unknown portion is being supplied by cutting the natural forests and bare forest lands well beyond their sustained yield capacity.***

- ***Unless the plantation and scattered tree planting programmes are increased, and/or the per capita biomass energy demand decreased, as will be later discussed, the shortfall will continue to increase with the population growth.***

2.6 Requirements in fuelwood supply to meet the forecast demand

As mentioned earlier, the estimates of fuelwood shortfall made above are very approximate. Many of the assumptions need confirmation by more detailed studies. However, they provide a beginning to policy development and the planning process. Two key factors in determining the demand for fuelwood are: 1) the unit cost of alternative energy sources, and 2) the net disposable income per household. Industrial development in Vietnam is expected to raise the net disposable income, and at the same time, draw people away from rural areas. This pattern has been established in most countries as part of the development process, during which dependence on fuelwood may decline. Macro-economic modeling from other countries' experience will readily demonstrate this. Hence, at some future time, fuelwood demand per capita will likely decline in Vietnam.

The use of specialized tools, such as the Long Range Energy Planning model (LEAP), a computer-based energy planning model, in which biomass energy consumption, land use patterns, economic growth, etc. can be included in input data, may be useful. Such an introduction would assist energy and forest planning activities, as the model can cope with the complexibility and uncertainties of the future, in particular with regard to technical, economic and socio-economic changes.

However, supposing that the fuelwood shortfall as forecast in table 2.16 is to be met, in order to balance the supplies with the demand, the following solutions may be considered:

a) By demand modification

- ***The programme of introduction of improved efficiency cooking and heating devices, both for domestic and non-domestic purposes, needs strong support and must be intensified. In addition to improved devices, improved practices, in particular for domestic cooking, should also be introduced, as this may equally result in significant fuel savings.***

- ***The extension of electricity supply in urban areas may reduce fuelwood demand significantly, depending naturally on the price. In pricing electricity, due consideration should be given in the economic analysis of new power projects to the substantial environmental benefits of the reduction of fuelwood demand.***

- ***Other alternative sources of energy such as natural gas (abundantly available off-shore, LPG, etc.) may be promoted, in particular in urban areas.***

- ***Subsidizing the price of kerosene could be considered, at least until there is an adequate extension of electric power and/or other alternative energy sources.***

b) By supply increase

- ***It will be necessary to substantially increase the establishment of plantations and scattered trees well in excess of the proposed level of 100,000 ha/year and 400 million trees/year (for timber/fuelwood). The required levels would be as follows for the period 1991-1995:***

Annual Planting Targets in by:	Plantations ha/year	Scattered trees million per year
- As proposed by the Ministry of Forestry	100,000	400
- Needed to overcome Shortfall	300,000	1,000 - 1,200

The above programme would show a small surplus, when comparing the demand with supply in 1999, when the felling of 1991 plantings occur. It may be possible to reduce the level of tree plantation establishment, depending on the degree of success, which can be achieved from fuelwood demand reduction programmes discussed later. However, before the above policies can be accepted, it is necessary to get more information in order to confirm the many assumptions made. It is therefore necessary to:

- ***Assess the success of the present plantations and scattered tree programmes, in particular where established under the land allocation programme. This can be done through a new national forest inventory.***

- ***Carry out a land capability survey of the bare forest lands, which are the reservoir for the plantations proposed under land allocation.***

- ***Carry out a socio-economic baseline survey of households and co-operatives, which have been involved in the plantation programmes of land allocation. This will assess the critical human factor, which is the other key to success after land capability.***

- ***Last, but not least, it must be remembered that the production of fuelwood is a joint or by-product or residue. With the establishment of 300,000 ha of plantations per year, it has been assumed that there is a ready market for at least 50% and possibly more, of the wood products to be sold as poles or pulpwood at a higher value than fuelwood in order for the plantations to be an economic proposition. This quantity is estimated at an amount to 19.8 million tons per year. In case it is impossible to utilize this amount of wood, then it will be necessary to assume that a higher proportion than 50% of the product will be used as fuelwood. If this is so, then the price of fuelwood must be increased appropriately in order to recover the cost of production.***

3. BIOMASS ENERGY CONVERSION AND PROCESSING TECHNOLOGIES

Biomass energy in the form of fuelwood, charcoal and agro-residues is widely used in the domestic sector and by small industries, which predominantly are located in rural areas. Although agricultural residues are less convenient to use than fuelwood and charcoal with regard to caloric value, ash content, handling and burning characteristics, and often require different combustion devices, the use of them is widespread. The following gives a brief description of energy conversion equipment and technologies used in Vietnam, and prospects for the promotion of more efficient technologies. Specific energy consumption data are not given here, but can be found in annex 4 with data that is based, where available, on actual practices in Vietnam. However, it should be noted that due to time constraints, only a limited number of industries could be visited for on-the-spot collection of information, while information in reviewed literature was found to be very limited.

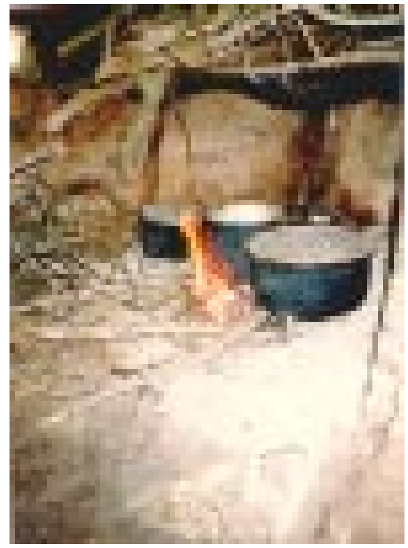
3.1 Stoves Used In The Domestic Sector

The widespread use of agricultural residues in the domestic sector has influenced the use of stove types as many people prefer a stove, which can be used with different fuels. Stoves made of metal bars or cast iron, either round, square or rectangular, the so-called tripod stoves, are widely used, in particular in the rice-growing areas. These stoves are nothing more than a support to keep the pots at a certain distance from the floor, on which the fire is lit, without any provision for protection against air movements. However, as the sides are not closed, quickly accumulating ashes from fuels like straw can be easily removed by pushing them to any side, providing at the same time an insulating shield. Many people use this insulating shield of hot ashes as a kind of haybox by putting dishes, which require a long cooking time (e.g. rice), on the hot ash as the dish has first been brought to boil.

A traditional metal rack "stove" used with wood, but with large quantities of ash around the stove

The efficiencies of these stove types vary, depending on how they are used. The literature gives widely varying figures on the efficiency of these stoves, from about 5% to 16%, but actual measurements in the kitchen environment show an average efficiency of about 12%. These stoves, which are easy to transport, are sometimes made by the owners themselves, but many people buy them in shops at a cost of about Dong 2,000-3,000 (approximately 30-40 US cents at January 1991 exchange rate). The lifespan of the stoves is long; stoves over ten years old are common.

Stoves that are almost exclusively used with fuelwood, are in general more efficient, since the fire is enclosed or partly enclosed by bricks or mud (the horse-shoe type). In the central part of the country, two-pot ceramic stoves, sometimes made of unfired clay, are commercially available and reportedly widely used. Much depends on the way the fire is tended, but as often small pieces of fuelwood - twigs, branches or split firewood - are used, the combustion is quite efficient, and a rate of 17% seems to be common, although also here widely varying figures are found.



A tripod stove using fuelwood

Improved, chimneyed stoves with two or three pots, introduced by several organizations show higher efficiencies from about 18% to 26%. These stoves are made of mud, bricks and other similar materials at a cost of Dong 10,000-20,000. The higher price stands for stoves with chimneys. Field practice has shown, that their efficiency drops after they have been used for a period of time. However, with proper maintenance, these stoves can have a long lifetime without decrease in the efficiency. The stoves are built in-situ by trained stove builders and cannot be moved around, unless they are broken and re-constructed in another place. In general, the traditional as well as the improved <u>wood</u> stoves have a short lifetime of about one year or even less, and much depends on the willingness and skills of the owner to maintain the stove. A drawback mentioned by users is that the improved stove is less flexible with regard to fuel types and, due to its high mass, it takes a longer time to heat up this type of stove.

This makes it difficult and less efficient to use these stoves for short heating tasks such as heating water. The people consider the stove expensive and some form of subsidy (bricks, metal grate) has been required to introduce the stove (with the exception of Thai Binh province, where the stoves are owner-built). In the southern part of the country, the so-called bucket stove is popular both for wood and charcoal. The stoves are produced by small workshops and sold commercially. The stoves are available in different sizes from small to a large restaurant size and are metal-clad. A typical domestic size costs about Dong 3,000-4,000. The efficiency varies from about 15% to 25%, depending on the way the stove is used and the type of fuel - charcoal has the highest efficiency. If fuelwood is used, the efficiency is about 17%, with charcoal the figure is about 22%.

An improved in-situ built stove Left side is the large pothole for pigfeed preparation

Charcoal bucket stoves in a restaurant

A restaurant fuelwood stove

Stoves used in restaurants and for small-scale food processing such as noodle and tofu making, sometimes are similar to ones used by the domestic sector, only the sizes are larger. With regard to efficiencies, nothing is known as no data are available.

3.2 Energy Conversion Technologies In The Non-Domestic Sector

The two largest consumers of biomass energy in this sector are the brick and tile industries, in addition to the **preparation of pigfeed**[1/]. With regard to the latter, as pigfeed is prepared by individual households. In many cases, the domestic stove is used, although the cooking vessel for pigfeed preparation is much bigger. One of the main reasons of using the same stove is that cooking for domestic use and for pigs is often done at the same time employing one fire. Besides, as pigs are kept in or very close to the kitchen, transport distances of heavy cooking vessels are short. As the same type of stove is used, the same efficiency rates are used both domestic and pigfeed cooking.

The other large consumer, **the brick and roof tile industry** uses different types of kilns, depending on the type of fuel used. With coal firing (almost always accompanied by small amounts of fuelwood to ignite the coal), kilns with or without permanent walls are used, both using the updraft principle. If fuelwood is used, almost always permanent updraft kilns are employed. The same applies to rooftile firing. Larger factories use both updraft kilns and multi-chamber cross (or horizontal) draft kilns, often sloping up towards the chimney.

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[1]/ Pig rearing, although in many cases done by households, is described here as a non-domestic activity because pigs are destined for sale (income generating activity).

Where coal is used the coal is mixed with mud (10 up to 40%) into brick-like cakes which, when dry, are stacked in between the dry bricks or tiles. These coal cakes are spaced evenly throughout the setting, starting from the second or third layer from the bottom upwards. In the top part of the kiln, less coal cakes are used. In the case of scove kilns without permanent walls, small channels are constructed in the bottom part of the brick setting, which later are used to ignite the kiln by wood fire. Once the coal starts burning, these channels are partly closed, with scoving moving progressively upwards, depending on the rate of combustion. Elaborate measures are taken to prevent local overheating by shielding the kiln on the windward side. However, overburnt bricks are common with this type of kiln.

Roof tiles being dried side by side with coal cakes used for firing. The coal cakes are stacked in between the tiles (or bricks) in the kiln.

In the case of permanent coal-fired kilns, the same system of using coal in between the setting is used. Permanent combustion chambers are constructed under the floor of the kiln, in which wood or residues set to fire to start the kiln firing. The combustion chambers are closed almost completely, once the coal has started to burn. Kiln sizes vary from about 1.5 m square, and 3 m high and up to 3-4 m square (or rectangular) and 3-4 m high setting.

Wood-fired kilns for bricks and tiles, which are predominantly used in the south and south-central part of the country, often have the combustion chambers on one or both sides of the kiln, but outside the kiln walls. Bricks are set in the bottom part in rows, with channels in between connecting to the combustion chambers. These rows and channels are about 1 m high, same height as the combustion chamber. Thereafter, the channels are bridged over with setting continuing in a 3-on-1 pattern up to the top. Kiln sizes vary, but a common size seems to be about 3 m wide with a setting height of about 4 m, and a length varying from 4 to 12 m (all internal dimensions). The combustion chambers used are large with a size of about 1 m high, about 80 cm wide with a length of 1-1.5 m. In general, the brick and tile kilns can be said to have low to medium efficiencies. The scoved types of kilns have lowest efficiencies, while large kilns have medium efficiencies, due to their high ratio of amount of products fired to the kiln surface (heat loss) area. Improvements can be made, such as the introduction of grates, doors in front of the combustion chamber and the proper control of primary and secondary air. These improvements are inexpensive and can improve the efficiency considerably as is evident from other countries. In Sri Lanka, where doors in front of the fireboxes were introduced in a large brick factory, payback times of the investment were found to be less than one week.

Lime kilns are found in different sizes and shapes. A common type used in the north and north-central part of the country is a vertical shaft kiln with an internal diameter of about 2 m and a height of about 3 m. Limestone is mixed with coal-mud balls and loaded in the kiln intermittently. The kiln is lighted with wood loaded in the bottom and is topped up with limestone once the load starts settling. After the firing stops, the burnt limestone (quick lime) is unloaded and sold as such, since slaking of the quick lime is done on the construction side. Although shaft kilns can be efficient, these typically small kilns operated batchwise have low efficiencies. Other types used are temporary kilns without walls. Limestone mixed with coal-mud balls are spread out in a circular pattern on a flat ground. Small openings are kept in the circumference for ignition with wood. The kiln is lit, once the setting is about 0.5 m high, while limestone and coal balls are added continuously, until the setting reaches a height of about 1.5-2 metres. The kiln is left to burn and cool, whereafter the burnt limestone is removed and sold. These kilns, with a large surface area and no permanent walls, are very inefficient. It is not known, how the small amounts of lime produced in the southern part of the country are produced as no information nor kilns could be found.

A small lime kiln

Ceramic and pottery are fired with coal, oil, electricity and wood. On a small scale, only wood and some coal are used, but if the products are glazed, wood is preferred as sulfur, contained in the coal, can affect the glaze layer. Kilns used vary widely, but a type often seen is the so-called "snake" or "dragon" type, which in fact is a long tunnel, sometimes up to 20-30 m long, semi-cylindrical construction, about 2 m wide and 1.5 m high. The kiln has a small firebox on the lower end (head) with side firing ports along the length of both sides of the kiln and slopes upward to the chimney on the other end (tail). The products are placed inside the kiln. Firing with wood or coal starts at the firebox. When firing progresses sufficiently, thin sticks of firewood are fed through the firing ports on both sides. Air, used for cooling of the lower end of the kiln, is used for combustion as firing takes place progressively closer to the chimney. Once the fire has reached the chimney end of the kiln, the last firing ports are bricked up and the kiln is left to cool. These kilns are quite efficient due to their combustion air preheating and semi-continuous character.

Dragon kiln

With regard to technologies and equipment used by the **food processing sector**, hardly any information could be obtained other than on the small-scale noodle and tofu making. Both are home-based operations using domestic or slightly larger stoves. Processing is manual: grinding of rice into flour for noodles and of soy beans for tofu making. Fuel varies depending on the availability, but in noodle making a well and long-burning fuel, such as fuelwood or coal is preferred, since it is difficult to simultaneously tend the fire while make noodles, which requires continuous attention. In beancurd making, there is no real preference as the beanflour/water mixture has to be stirred only from time to time while boiling, thus giving more time to tend the fire.

Noodle production

Agro-processing is done both on large and small scales. Again, not much information has been available. Most of **the sugar** is processed by small to medium-sized units numbering in the hundreds in the country. Cane is crushed in diesel engine-powered crushers, and the juice collected and concentrated in shallow pans set into a channelleading from the furnace to the chimney. The number of pans, made from steel or cast iron, varies from 2 to 5. The pans are round or rectangular. The juice is poured into the pan closest by the firebox and moved progressively to pans further on, as the juice gets more concentrated. The last pan near the chimney contains syrup with a concentration of about 90%. The syrup is then removed, stirred and cooled to increase its viscosity and poured into moulds to set. Highly skilled operators are required to ensure a good quality brown sugar; during the concentration process, the syrup should not burn. The fuel used is bagasse, which is available on-the-spot, but has to be dried before use. Efficient operations have sufficient bagasse to process the output. Less efficient units need to procure additional fuel, such as ricehusks.

Sugar processing

Tea is an important export crop of Vietnam. The exported qualities are processed in larger factories. Many farmers in the north grow tea for their own consumption and for local sale. They process the tea at home or in small village industries. Unlike black tea, which needs heat for withering of the leaves and heat for drying after the leaves have been cut and twisted, the green tea widely used in Vietnam is only dried. The tea leaves, after picking, are spread out on a thick metal plate measuring about 1.5 by 1.5 m, although other sizes are also found. This metal plate is supported at walls, which enclose at the same time the furnace, at a height of about 70 cm above ground level.

Tea processing

Fuel, which can consist of anything, such as wood but also leaves or weeds, is burnt in this combustion space. Care is taken that the metal plate does not get too hot to avoid the tea leaves from burning. The fresh green leaves are continuously raked for about one hour on this plate, whereafter the leaves are removed and left to cool for about half an hour. During this cooling period, the moisture content equalizes within the leaves. The leaves are then again spread out on the hot metal plate for final drying, which takes 20-30 minutes. Skilled operators are required to get good quality tea.

3.3 Non-Heat Conversion Systems

Systems converting wood to energy other than heat have not been found although no doubt there will be some systems in the country. There are some exceptions, one being charcoal production and the other the use of charcoal to power cars by gasification systems.

Charcoal gasifiers are used on a limited scale; about 20 units were seen in operation on the roads in the southern part of Vietnam. The gasifiers, with a diameter of about 60 cm and 2.5 m high, operate on the updraft principle. A good quality charcoal is needed, which is available locally. About 120-130 kg charcoal is needed for a 100-km trip with a partly loaded truck (load approximately 5 tons). The gasifiers are locally made, but French-designed. They require an investment of about Dong 1-1.2 million (exchange rate unknown but at the January 1991 exchange rate of Dong 7,000 = 1 US$, it costs approximately 150-170 US$) for the materials only, with installation done by the owner of the truck.

A charcoal gasifier mounted on a truck used for fuelwood transport

A superficial calculation showed,that the operating costs with a gasifier, when compared with gasoline, were attractive. However, in this area good quality charcoal is produced which is available at a low cost, around Dong 300/kg (4 US cents). This is probably the reason why gasifiers are used in this particular area.

Charcoal production is efficient with large brick beehive kilns used in the mangrove growing areas. Kilns in the southern most part of the country are in an average about 9 m in diameter with a height of about 3.5-4 m and cost about Dong 2.5 million (US$ 625 at an exchange rate of approximately Dong 4,000 = 1US$ in 1989). However, smaller kilns are also used and kilns with a diameter of about 1.5-2 m have been seen in operation. Mangrove or other wood is used in the form of one metre long billets and with a diameter ranging from 7 to 15 cm. The loading capacity of such kilns is about 27 tons (45 steres, using the conversion factor as given in the literature quoted), and produces about 6-7 tons of charcoal resulting in a yield of 22-25%. Each burning cycle takes about one month including loading and unloading (Chan, 1990 and Chong, 1989).

Small scale charcoal production

3.4 Biomass Energy Conservation Measures

As is clear from the above, there is ample scope for energy conservation measures, such as improvements in equipment and kilns, such as brick and tile kilns and lime kilns, among others. In the domestic and small-scale food processing sectors, the use of more efficient stoves could go a long way in reducing energy consumption. Slight improvements in efficiency, e.g. from 12% to 14% in the case of residue-burning stoves and from 17% to 19% in the case of wood-burning stoves could reduce the amount of biomass energy consumed with about 3-4 million tons per year. Such an increase in efficiency is easily attainable, as shown by the improved stoves introduced in several provinces, which have efficiencies ranging from 18-26%.

3.4.1 The domestic sector

Vietnamese people are aware of the importance of conserving energy, as many of them encounter problems with supplies. Energy conservation can result in savings, such as reduce the time needed for fuelwood collection, or in terms of money - mainly that of the urban and semi-urban population, who buy fuelwood - but also with regard to the environment. The latter concerns not only the surroundings, but also the conditions in kitchens as traditional stoves contribute to dirty and unhealthy surroundings.

The interest in fuel savings is evident from biannual stove competitions, under which ingenious and highly efficient stoves have been developed, unfortunately not always user-friendly. Certain efficient stoves, developed by local people, have been commercialized and their sales run in the ten-thousands, e.g. coal stoves in Bac Thai and in Ha Tuyen province). An efficient biomass stove introduced in Thai Binh province has also taken off well, with an estimated 1,000 stoves produced with assistance from provincial authorities, whereafter the local population have taken over, resulting in the introduction of another 10,000 stoves. The fuel saved, principally straw, is used for other purposes, in this case for growing mushrooms for export (introduced and popularized by the provincial Science and Technology Department), adding considerably to the income of the local people, in particular women.

The increased income could possibly have been the reason, why the stove was so well accepted. Several organizations and institutions have been involved with domestic stoves and have tried to introduce a similar stove as used in Thai Binh province in other provinces with similar conditions, but their experiences have been much less positive (Koopmans, 1989). As the domestic sector, including the cooking of pigfeed, is by far the largest consumer of biomass energy, efforts should be made to introduce improved stoves. As people use many different types of fuel, depending on their availability and season, such improved stoves should be capable of burning such fuels without affecting the efficiency and ease of use.

In the domestic sector, work has been undertaken, as mentioned earlier, and possibilities for substantial energy savings exist. The experiences so far are not very positive, but only a very limited number of improved stoves have been introduced and are in use. Only in these cases, where people see a direct benefit, like in Thai Binh province, such programmes have taken off. The same applies to urban areas, where fuel is monetized, and cheap fuels, such as coal require a special stove. It is therefore difficult to see, unless concerted efforts are made by all organizations and institutions involved with biomass energy and stoves, that the introduction of improved stoves or combustion devices will have a marked effect on the biomass energy consumption. The situation might be better in the southern part of the country, where bucket stoves are used. However, their efficiency can also be improved considerably, as witnessed in Thailand, but the increased price of the stove may hamper the introduction of the improved stove during the first few years.

Together with the introduction of more energy-efficient stoves, improved practices will have also an effect on the amount of energy used for cooking and small-scale food processing. Increased attention to fire, retrieval of all unburnt fuelwood and charcoal remains right after the cooking is finished, having everything ready before the cooking starts (preparation of ingredients, e.g. cutting, slicing, cleaning, having pots ready and so on), selecting proper pot size, using only sufficient amount of water in boiling operations, are some of the measures which need attention. With improved devices and practices, energy savings could be significant.

Improved stoves may have, in addition to the fuel savings aspects, a marked influence on the kitchen conditions, or more importantly, the working conditions of women and children, who spend daily long hours in smoky and dusty surroundings while cooking. Epidemiologic studies have shown that the use of biomass fuels, in combination with poor ventilation of kitchens, increase indoor air pollution, which can lead to acute and chronic lung and respiratory diseases, secondary heart diseases and eye inflammation.

3.4.2 The non-domestic sectors

With regard to the non-domestic sectors, including rural industries, the situation is less clear, as little is known about these sectors, in particular the energy conversion equipment used. Judging from the few field visits to rural industries, it appears that industries, which should receive attention, are the main fuelwood using industries, such as brick and tile industries in the southern part of the country, and tea drying, noodle making and rubber drying. With regard to the latter, as the industry mainly uses the rubberwood for "free", there is least financial incentive to improve the combustion system, unless quality can be improved or productivity increased. The wood could be sold as fuelwood, but as rubber growing areas are located quite far away from population centres, the prospects are not good. Rubberwood can also be used for furniture making. This has not been seen practiced in Vietnam, but in other south-east Asian countries, it is widely practiced.

The information available to the consultant on local rural industries, for instance on the production technologies, costs of production and other relevant information, was not sufficient in order to compare alternative technologies. What has become clear during field visits is that the technical capabilities to construct kilns, stoves and furnaces exist and, in general, people and entrepreneurs are aware of the importance to conserve energy, not only financially but also with regard to the micro environment.

3.5 Prospects For Improvements

Even though only little information is available, it is clear that there is potential for improvements. Such improvements could, besides the advantages for the domestic sector, result in improving the competitiveness of the rural industries versus urban industries, as well as versus cheap imports, which are flooding many local markets.

Efforts made in the industrial sector, if any, have taken place on an *ad-hoc* basis. An example could be fish processing for export, where efficient equipment are used, introduced by Japanese companies. In the rubber-drying industry, more efficient equipment will be introduced. This is done within an overall upgrading of factories and processing, in which drying is only one step. It is not known if in other sectors energy conservation measures have been or will be undertaken.

In general, rural industries have limited access, if any, to information on industries, production technologies or improvements made elsewhere, outside and inside the country. In Vietnam, there are no specialized institutions involved with rural-based industries and activities, such as assistance with energy conservation measures and energy audits. The Finance Department of the Ministry of Energy has been appointed to carry out energy audits (MoE-EI, 1990). However, these will be more likely financial audits on energy consumption and stocks, and will not cover energy audits in the technical sense, e.g. investigating, measuring and quantifying, where in production processes energy is used and how efficiently it is used.

Other vital information on rural industries, e.g. on economic and socio-economic contribution, employment and income generation, support to agricultural production and household/community food security, etc. do not seem to exist. This makes an appropriate analysis and the identification of intervention options even more difficult.

4. MARKETING OF WOOD FUELS

4.1 Structure Of Market

Biomass fuels, especially fuelwood, are used extensively in Vietnam. As in most countries, fuelwood collection is mostly informal with no defined market structure. This is the case particularly in rural areas. The rural population, estimated at about 80% of the total, collect fuelwood for their own use while the majority of urban and semi-urban dwellers has to purchase it.

Fuelwood carried over long distances by adults and children

Hanoi City consumes relatively little fuelwood and only a limited amount is seen on sale in markets or by roadsides. In contrast, Ho Chi Minh City uses a substantial amount of fuelwood and in the adjoining Dong Nai Province, there are substantial roadside stacks of fuelwood in various stages of preparation for urban and industrial markets. Ho Chi Minh City has by far the largest fuelwood market, but even so, the individual retailers are relatively small. Other larger cities have fuelwood markets of varying numbers and sizes, mainly depending on their location with regard to fuelwood supplies and other available energy sources like coaldust, electricity and kerosene. Most towns have a more or less regular supply of conventional energy sources. The commercial availability of fuelwood depends on the price and the reliability of supplies.

In smaller cities, where fuelwood is available and competitive in price, it tends to pass directly from forest harvester to fuelwood trader. Harvesters store their supplies for sale along the main roads. Some rural households collect fuelwood for sale in order to supplement their income. However, this is often an irregular activity for most collectors; it is fit together with other activities depending on the season and economic conditions.

Fuelwood is transported by various means ranging from shoulder and headloads for short distances to the use of draft animals, bicycles and other means for longer distances. For long distances or for larger quantities, trucks are used, though they are avoided where possible due to high costs. In fact, many other types of transport are common, such as buses and logging trucks, carrying often bags of charcoal and bundles of fuelwood.

Fuelwood traders tend to buy supplies where they can, and do not normally have a regular supply source through the same people or from the same forest. Bigger traders tend to buy fuelwood in the form of larger pieces or trunk wood, which they either sell as such to fuelwood retailers or chop into smaller pieces, either for sale to retailers or directly to consumers. Big consumers, e.g. brick and roof tile factories often bypass the system by either buying directly from harvesters or middlemen or by employing their own labour to cut and transport fuelwood to the factory.

Transport by bicycle

The other tree and agricultural residues are not commonly traded and are generally harvested on the households' own land and used domestically for cooking. However, in several areas, in particular in rural fuelwood deficit areas, markets for agricultural residues for use as fuel, such as rice straw and husks, are operating.

Charcoal is used to a relatively small extent. The use of it is mainly limited to southern Vietnam, where it is typically used for cooking. In other parts of the country it is also used, but in small quantities and only for special purposes, such as meat grilling. The national production of charcoal is not known, but is estimated to be around 24,000 tons per year. Ho Chi Minh City is a major market for charcoal producers, as charcoal is made from mangroves and hardwoods growing nearby. It is commonly sold by producers to urban wholesalers in sacks of 25-40 kg, which are transported by trucks and boats to urban areas. There the charcoal stacks are sold first to retailers and vendors, who in turn sell charcoal to households by kilograms.

Very little is known about transport costs, but a cursory inspection indicates that 100 km is about the longest distance, over which fuelwood can be transported economically. This view is based on practices around Ho Chi Minh City, where in forested areas piles of fuelwood for sale are a common sight along the roads within a radius of about 100 km, while with larger distances they are no longer seen. This distance limit may also be the reason why in Hanoi very little fuelwood is available for sale. Drawing a circle with a radius of about 100 km around Hanoi shows that there are only a few forests within this area.

Piggyback transport by bus

Charcoal, having a higher value, can bear higher transport costs and consequently can be transported over longer distances. The maximum transport distance in Vietnam is, due to a lack of information, not known. However, transport economics act against charcoal and the often reported low transport costs, due to its low density, have no base in reality. Transported goods are normally subject to charges by volume, when density drops below

1.0, making charcoal quite an expensive commodity to transport, if normal economics apply. These normal economics may sometimes be ignored, where cheap backloading rates are applied for otherwise empty trucks on the return trip. Charcoal may then benefit, as would other commodities, but would still be subject to the density rule.

Charcoal transport and vending tricycle

4.2 Woodfuel Pricing

4.2.1 Fuelwood

(a) Fuelwood prices

The fuelwood market mainly involves the urban population. A very large part of the rural population either collect fuelwood for their own use or for sale to urban household consumers. They, as discussed earlier, perceive fuelwood as a free commodity, bearing only the cost of gathering, transport and storage.

Fuelwood prices were collected along roadsides in 24 urban and 21 rural locations in 11 provinces from Lang Son in the north to Long An in the south. The results are shown in table 4.1. As domestic use accounts for a major part of the total biomass energy consumption in Vietnam, the prices refer mostly to fuelwood in this sector. Fuelwood prices for rural industrial activities were not collected, but it may be assumed that the cost will be similar to domestic fuelwood, though generally less, because: (1) larger unit deliveries are more cost-effective, and (2) they often do not have to bear the additional cost of size reduction (cross cutting and splitting).

As shown in table 4.1, the mean roadside price for natural forest fuelwood in rural areas was found to be Dong 86,000 per ton and for plantation wood Dong 75,000. As expected, urban prices were about 60% higher, reflecting the costs of transport, storage and distribution. The urban prices were Dong 139,000 per ton and Dong 148,000 per ton for natural forests and plantations, respectively. The sample is small and not statistically designed and must be regarded as indicative only. Good price data should be collected during a proposed national fuelwood survey and a representative sample monitored periodically for changes.

The prices, as mentioned in the table, are quoted selling prices. In case only the buying price was known, this price has been used. Usually, prices were provided on the basis of a stere, the unit normally used in Vietnam. These prices have been converted to a price per ton, taking into account the following conversion factors: 20% mcwb, 0.6 m^3/stere and an average density index[1/] of 0.6 for Eucalyptus, 0.9 for Casuarina, and 0.9 for mangrove wood. If the species was known, the actual density was used by according to MoF data.

[1/] Density index comparing with water as 1 gm/cc or 1 metric ton/m^3.

Table 4.1 Fuelwood selling prices along roadsides by location and source (Dong/ton) "in '000"

Province	Urban			Rural		
	Location	Natural Forest	Plantation	Location	Natural Forest	Plantation
Hanoi	City	125,130	-	-	-	-
Vinh Phu	Bai Bang	50	-	Bai Bang	55	-
	Vinh Yen	208,281,80		Phu Dien	110	-
				Ha Tuyen	38	-
Ha Bac	Bac Ninh	125	-	-	-	-
Lang Son	Lang Son	110	111	Huu Lung	-	74
				Loc Binh	-	56,67
				Dong Ma	78	-
				Huu Lung	117	-
Ha Bac	Bac Giang	125,133	-	-	-	-
Nghe Tinh	Vinh	200,150	250	Vinh area	-	130
				Ky Anh	100,40,92	-
Binh Trie Thien	-	-	-	Sen Thuy	56	-
Quang Nam Da Nang	Da Nang	141	-	Da Nang	181	-
Nghia Binh	-	-	-	F.E.Song Cau	120	-
Phu Khan	Tuy Hoa	100	100	Tuy Hoa area	-	47
Thuan Hai	Phan Thiet	37,81,112	-	Phan Thiet	53	-
Dong Nai	-	-	-	Xuan Hung	124,74	-
Ho Chi Minh	City	162,158,180	130	Duyen Hai	-	70
Long An	-	-	-	Ben Luc	57	-
				Tan An	-	83
Total samples and mean price		20 / 139	4 / 148		15 / 86	7 / 75

Note: 1 US$ equals about 7,000 Dong

(b) Fuelwood cost structure

Information from the same sample (17 fuelwood sellers in 11 provinces) throughout the country showed that the mean cost difference (mark-up) between buying and selling prices was only 15%, and in one case was found to be as low as 4%.

Comparing rural and urban prices, a rough overview of the price structure of fuelwood can be figured out. The overview bases on mean prices, because many assumptions had to be made due to insufficient information acquired from the field. The difference between rural fuelwood (Dong 86,000 per ton based on 15 different prices in 10 provinces) and urban fuelwood (Dong 139,000 per ton based on 20 price samples in 9 provinces) is approximately Dong 53,000 per ton.

The main part of this difference is costs involved with transport, which vary with the distance and mode of transport. Fuelwood is often transported using different means, including trucks, buses, rafts, boats, animal carts, bicycles and mancarry. The costs, using discounted back-loading rates of about Dong 400-450 per ton per kilometre (TKM), compared with the official rate of about Dong 1,000/TKM, vary widely. The most expensive means of transport is a truck dedicated to fuelwood, and the cheapest means is the wood gatherers' own mode, which may vary from mancarry through bicycle to animal-drawn cart. The opportunity cost of the labour-intensive modes will be far lower than that of truck or bus. Taking a distance of 100 km as an example, the transport costs would amount to about Dong 40,000-45,000 per ton, almost equal to the cost difference between the rural and urban price and leaving only a small margin for the fuelwood trader.

Besides these cost additions, before fuelwood reaches domestic users, the wood will have to be cross-cut, split and stacked involving in an average a total of Dong 48,000 per ton (subsequently Dong 17,000, Dong 28,000 or Dong 48,000 per ton at a labor cost of Dong 6,000 per man-day). Assuming Dong 139,000 is valid for Ho Chi Minh City, the cost of fuelwood at the wholesaler/retailer depot would amount to about Dong 190,000 excluding losses during handling, transport, retailing margin, etc. The consumer price for Ho Chi Minh City was quoted as about Dong 290,000 per ton, which would result in a margin of about Dong 100,000 to cover these costs. However, it should be noted that there are many uncertainties involved: conversion factors from stere to ton, moisture content, species, among others. These values should be treated with care and preferably should be checked in the field by following fuelwood down from the forest to consumers.

However, forest management to date in Vietnam has mostly been concerned with productive forests, with the emphasis on the rich and medium productivity classes. Natural forests are not managed for fuelwood production as a principal crop, but - as also elsewhere - mainly for timber production. The normal approach in forest management is that fuelwood is considered as a residue from dead standing or fallen woody material and logging residues. Fuelwood is recognized by Armitage (1990) in his comparative economic analysis of the various practiced management systems. However, it only represents 8-10% of harvested volume and 1% of the value. While the fuelwood price given in his models is Dong 12,000/m^3 as standing trees, in practice there appears to be little recovery of this price by the State, and as a rule fuelwood is collected from the natural forest as a free commodity.

Accordingly, the cost of production of fuelwood does not cover the cost of growing natural forest wood; it only covers financial costs. The cost of growing fuelwood must therefore be regarded as a subsidy to the consumer and an economic cost. The following gives some indications of the financial costs of plantation-grown wood, of which some valuable conclusions can be drawn.

For several years some Eucalyptus species, especially E.camaldulensis, have been the most common fast-growing plantation trees in Vietnam. Some data with regard to the establishment, maintenance and harvesting costs, were obtained from the SIDA-funded forestry project at Bai Bang in Vinh Phu Province. By using a computer programme developed by Interforest, the Swedish consultants' company employed by SIDA in this project, some useful indicative data could be calculated for three appropriate plantation models for this species. The following assumptions were used to calculate the wood production costs in Eucalyptus camaldulensis plantations:

- Mean Annual Increment — 10 m^3/ha/year u.b. volume
- Rotation — On 8-year basis without thinnings
- Planting density — 2,500 seedlings per ha (i.e. 2 x 2 m spacing)

- Soil preparation — Manual
- Weeding — 4 times in the year 1 and 2, 2 times in year 3
- Fertilizer — As indicated

- Labour cost — Dong 3,000 per man-day (financial)
- Interest rate — 9.72% per year
- Tax — 5% on gross sales

- Selling prices on roadsides — Pulpwood 180,000 Dong/m^3; Fuelwood 30,000 Dong/m^3; Poles 300,000 Dong/m^3

The calculations, shown in table 4.2 below, indicate that the Models I and II, which only contain 20% of fuelwood yield, are very profitable on the basis of the above assumptions that are based on good field operational experience. An exception may be made for the price of poles, which was found by Christophersen (1991) to average only about Dong 140,000 per m^3 in the WFP project no. 4304 target provinces. However, even with a significant reduction in the pole price, Model I will remain a very profitable option.

Table 4.2 Financial wood production costs (ha) - VPSU plantation (in 1,000 Dong)

Plantation model	Discounted costs	Discounted income	NPV	IRR %
Model I Pulpwood 62.5%, Fuelwood 20% and Poles 17.5%	3,780.53	6,513.28	2,732.75	23.90
Model II Pulpwood 80% and Fuelwood 20%	3,740.53	5,713.40	1,972.87	20.94
Model III Fuelwood 100%	2,498.82	1,142.68	(1,364.14)	(7.99)

Source: Interforest, Mr. Krekula (1991), personal communication

Note : Exchange rate on the date of analysis, March 6, 1991 1US$ = Dong 7,300

Model III, in which it was assumed that all fuelwood would be sold as fuelwood, was unprofitable with a negative Internal Rate of Return (IRR) of about 8%, estimating a selling price at roadside to be Dong 30,000 per m^3. The price needs to rise more than double to Dong 68,000 per m^3 to give an IRR of about 10%. Alternatively, if the yield at 8 years would rise from the 80 m^3/ha in the model to 220 m^3/ha, the same IRR of about 10% would be reached. This indicates a high sensitivity to price but relatively low to a large productivity increase.

The following conclusions can be drawn from these calculations:

1. ***Fuelwood production is unprofitable when grown as a 100% fuelwood plantation.***

2. ***Plantations with 20% fuelwood production component can be very profitable <u>provided that</u> the major part is marketable as higher value products, such as pulpwood and poles.***

3. ***Fuelwood is presumed to be sold partly to urban markets, especially the larger ones, and will have almost no sale potential to the rural people. Table 4.1 shows that rural sales on roadsides for plantation wood seem to reach Dong 75,000 per ton, which is more than the Dong 30,000 per m^3 proposed in Models I-III above.***

4. ***Pulpwood requires a market within a distance of about 60-100 km. This will restrict sales to the economic catchment area of the few pulpmills and the present export ports for pulpwood (and later as wood chips).***

5. ***Poles are sold to widely dispersed local markets. They seem more viable to support the economics of fuelwood production on plantations. However, their price may remain well below that of pulpwood, where this can be sold profitably.***

More or less the same picture emerges with regard to mangrove plantations, although here only the cost of fuelwood is shown. The data on the costs of establishing mangrove plantations and harvesting were provided by the Department of Agriculture, Forestry, Fisheries and Irrigation of Ho Chi Minh City:

1. ***10,000 propagules per ha at a cost of Dong 1.428 per propagule;***
2. ***Plantation establishment requires 32 man-days per ha;***
3. ***Labour cost in an average Dong 4,458 per man-day;***
4. ***Mean annual increment of 6 m^3 per ha per year;[2/]***
5. ***A 20-year rotation with thinnings at 5-year intervals;***
6. ***Harvesting costs of Dong 13,300 per m^3;***
7. ***Transport of harvested wood to Ho Chi Minh City requires Dong 10,000/m^3;***
8. ***Interest rate charged by the bank of 2.4% per month (commercial rate).***

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[2]/ Please see observation provided in footnote 5 page 22.

The cost of fuelwood delivered to Ho Chi Minh City, using above basic data is shown below, whereby the following should be noted. The interest stated is the current, commercial charge of the bank and is paid by the Duyen Forest Enterprise for borrowing. Even at this high rate, costs are met by the wholesale price in Ho Chi Minh City of about Dong 62,000 per ton (about Dong 55,000 per m^3). Hence, it appears that mangrove plantations may be profitable for fuelwood even at the current, very high interest rates and low productivity (see also discussion in sections 2.2.2.1 and 2.2.2.2).

Cost item in Dong per m^3	**Interest rate of 10%**	**Interest rate of 30%**
Wood production costs	8,100	24,400
Harvesting costs	13,300	13,300
Transport costs	10,000	10,000
	--------	--------
Cost at Ho Chi Minh City depot	31,400	47,000

(c) Fuelwood price trends

Efforts were made to check whether the cost of fuelwood to the consumer has risen over the last few years. Unfortunately, only one time series for fuelwood prices, covering sales prices of mangrove wood in Duyen Hai district, could be obtained. Moreover, the prices are based on memory, since no written accounts were available, and should therefore be treated with care. The price time series shows a significant initial decrease in the real price followed by a very large (999%) increase in 1989, and followed by a relatively small increase closer to the present inflation rate of around 6% per month. The very large increase may be traced back to a drastic devaluation of the Dong, carried out around that time.

Table 4.3 Mangrove fuelwood price - Duyen Hai, Ho Chi Minh Province

Year	Dong/stere	Incremental increase in %	Inflation rate in %	Real increase in %
1985	70			
1986	150	114	487	(373)
1987	350	133	301	(168)
1988	1,100	214	308	(94)
1989	14,000	1,173	174	999
1990	25,000	79	28	51
1991 (to 31/3)	38,000	52	n.a.	

Source: HCM City Department of Agriculture, Forestry, Fisheries & Irrigation

4.2.2 Charcoal

(a) Charcoal price

Charcoal represents a very small - under 1% - of the total biomass used as an energy source on a national level. It is almost entirely used by the domestic sub-sector for cooking. Its consumption is concentrated in southern Vietnam, mainly in Ho Chi Minh City, where, before 1987, it provided a significant 8% of that city's domestic energy consumption (IOE, 1987).

It is likely that the energy consumption pattern will continue to change in Ho Chi Minh City with a greater emphasis on electricity and charcoal, and a corresponding decrease in the per capita use of fuelwood. Charcoal is environmentally more desirable for urban use and there may be some merit in Devitt's (1990) suggestion to convert the apparently large amounts of logging residues to charcoal. An increase in the share of charcoal of the energy market will depend to a large extent on the switch-over price level (depending on actual price, heat value and combustion efficiency), discussed later in this chapter. Besides these factors, increasing net disposable income of households will also exert its influence.

The main source of supply comes from significant areas of natural and plantation mangrove forests in Duyen Hai District of Ho Chi Minh City, and further south in Minh Hai Province. These mangrove resources were substantially reduced by chemical defoliants during the war. However, these resources are being increased by the Provincial Forestry Services of both Ho Chi Minh and Minh Hai provinces and the availability of charcoal should correspondingly increase.

Prices of charcoal, shown in table 4.4, were received from a limited number of sources, three in Thuan Hai Province and data from Ho Chi Minh City and production areas of Duyen Hai District. Charcoal prices in the Ho Chi Minh area are based on charcoal made from mangrove thinnings in Duyen Hai District. The Duyen Hai Forest Enterprise owns three kilns, and in Ho Chi Minh City there are two more kilns, similar in shape and size (loading each about 50 steres of wood). While the mangrove charcoal is of very high quality, it is twice the price of admittedly lower quality charcoal from natural forest wood in Thuan Hai, to the northeast of Ho Chi Minh City.

The charcoal made in Thuan Hai province is partly destined for the Ho Chi Minh area, while the remainder is sold locally. The large price difference can not be explained in any other way but by differences in transport costs, probably differences in quality, raw material and labour costs. The Thuan Hai charcoal is produced by small groups, often a family, using wood from the forest (removed probably without paying any royalties), while the kilns are operated by the family members. However, the question of charcoal pricing in relation to raw material costs, quality and efficiency of charcoal making should be examined before a definite conclusion can be drawn. Such a study may pinpoint areas where improvements can be made, which may improve returns to the charcoal makers.

Table 4.4 Charcoal prices in Dong per kilogram

Location	Rural areas at roadside	Urban Wholesale Buy	Urban Wholesale Sell	Urban retailer Buy	Urban retailer Sell
1. **Quang Nam Da Nang**					750
2. **Thuan Hai Province**					
Tuy Phong District	260				
Phan Thiet town	200-212	200	280	280	350
3. **Ho Chi Minh Province**					
Duyen Hai District	630	650		650	690

Source: Consultant's survey data

(b) Costs of charcoal production

Charcoal is produced at several locations in the southern part of the country, but, due to time constraints, only limited information on the cost price structure of charcoal from one site, i.e. Duyen Hai district in Ho Chi Minh province, could be obtained.

Table 4.5 Cost of mangrove charcoal in Duyen Hai district

Cost item		Cost in Dong
Raw material	- 45 stere @ Dong 33,000 per stere	1,485,000
Fuel	- 10 stere @ Dong 42,000 per stere	420,000
Labor	- 60 man days @ Dong 5,000 per man day	300,000
Maintenance	- Dong 30,000 per year and 12 firings/year	2,500
Depreciation	- Lifetime 20 year and inv. cost 2.4 million	10,000
Tax	- 2.5% over the gross margin	23,000

Total Cost		2,240,500
Yield:		
4,800 kg export grade charcoal	@ Dong 715/kg	3,432,000
1,200 kg broken charcoal	@ Dong 450/kg	540,000
360 kg fines from bark	@ Dong 100/kg	36,000

Total Revenue		4,008,000

Source: HCM City Department of Agriculture, Forestry, Fisheries & Irrigation

Note: The calculation does not take into account interest on working capital. Assuming that working capital will be needed to cover at least three complete kiln cycles, and using an interest rate of 30%, the total production cost would rise to about Dong 2.4 million, which still would leave a substantial margin.

The cost of charcoal making in Duyen Hai district, employing an externally fired hemispherical brick or beehive kiln, amount to about Dong 350 per kilogram as shown in table 4.5, based on financial data. The same table also shows some information on the output and its corresponding salesprices. The prices shown in this table result in an average costprice and selling price of about Dong 350 and 630 per kg, respectively.

4.3 Fuel Substitution And Effects Of Energy Price Changes

4.3.1 Interfuel substitution

As shown previously, biomass energy sources are widely used by the domestic and the rural industrial sectors. The main reason for this, in particular for fuelwood and to a lesser extent for rice straw and other residues, is the ease of its use, availability and in many cases, its low price. However, some negative points may be mentioned also, such as the time involved with its collection. Furthermore, some biomass energy sources are bulky and difficult to store. There are also problems associated with the use, for instance smoke and ash, which may be harmful to health. These problems, however, also pertain with coaldust which, in many cases, is the cheapest energy source as shown in table 4.6. This table shows, for different areas, the actual price of energy sources and the effective price of heat per generated unit, taking into account the end-use efficiencies of domestic stoves.

Prices, as mentioned in table 4.6, were collected in urban and semi-urban areas. These do not necessarily reflect the situation in rural areas. Prices in rural areas tend to be the same or higher for the conventional energy sources, while for biomass energy sources, the price is lower or sometimes negligible. However, the table does show that kerosene and electricity are very expensive in all areas; electricity is expected to become even more expensive in the near future. It is difficult to see biofuel substitution by these two fuels to take place.

With regard to coal, fuel substitution could take place, since it is a cheap fuel, but only in the northern part of the country, where it is available. Even though it is cheap, most of the people, if given a choice, do not use it due to difficulties with the ignition. Moreover, it burns for about 2-3 hours in the form of briquettes, which is too long for normal cooking tasks, and also produces smoke during the ignition, which is usually kindled by waste paper or wood. Coaldust is sold as such, which makes it difficult to handle and use in domestic stoves. The dust has to be mixed in a moist state with mud binder, in order to be formed into coal balls or coal briquettes and sundried. The former is done by the people themselves, while briquettes are produced by factories and home-based industries in and around Hanoi.

Table 4.6 Type, price, calorific value, end-use efficiency and cost per effective MJ heat generated

Energy type	Weight/size per unit	Price in Dong/unit	Cal.val. MJ.	Price per kg or kWh	Price per MJ.	End use effic.	Effective price/MJ.
HANOI							
Wood	1.0 kg.	400	15.0	400	26.7 Dong	17%	157 Dong
Charcoal	1.0 kg.	1,000	28.0	1,000	35.7 Dong	22%	162 Dong
Rice straw	1.0 kg.	80	12.5	80	6.4 Dong	12%	53 Dong
Coal briq. 95% coal/5% mud	1.4 kg.	200	20.0	143	7.1 Dong	23%	31 Dong
Coal dust	1.0 kg.	100	21.0	100	4.8 Dong	20%	24 Dong
Kerosene	1.0 ltr.	2,500	38.0	2,500	65.8 Dong	43%	153 Dong
Electricity	1.0 kwh.	230	3.6	230	63.9 Dong	60%	106 Dong
HO CHI MINH City							
Wood	1.0 kg.	286	15.0	286	19.0 Dong	17%	112 Dong
Charcoal	1.0 kg.	600	26.0	600	23.1 Dong	22%	105 Dong
Charcoal (Mangrove)	1.0 kg.	700	29.0	700	24.1 Dong	22%	110 Dong
Kerosene	1.0 ltr.	2,500	38.0	2,500	65.8 Dong	43%	153 Dong
Electricity	1.0 kwh.	230	3.6	230	63.9 Dong	60%	106 Dong
THAI BINH Province							
Wood	1.0 kg.	200	15.0	200	13.3 Dong	17%	78 Dong
Rice straw	1.0 kg.	80	12.5	80	6.4 Dong	12%	53 Dong
Rice husks	1.0 kg.	100	12.5	100	8.0 Dong	12%	67 Dong
Coal dust	1.0 kg.	110	21.0	110	5.2 Dong	20%	26 Dong
Kerosene	1.0 ltr.	2,500	38.0	2,500	65.8 Dong	43%	153 Dong
Electricity	1.0 kwh.	230	3.6	230	63.9 Dong	60%	106 Dong
THAN HOA Province							
Wood	1.0 kg.	190	15.0	190	12.7 Dong	17%	75 Dong
Saw dust	1.0 kg.	175	15.0	175	11.7 Dong	12%	97 Dong
Rice husks	1.0 kg.	100	12.5	100	8.0 Dong	12%	67 Dong
Coal dust	1.0 kg.	110	21.0	110	5.2 Dong	20%	26 Dong
Kerosene	1.0 ltr.	2,500	38.0	2,500	65.8 Dong	43%	153 Dong
Electricity	1.0 kwh.	600	3.6	600	166.7 Dong	60%	278 Dong
TIEN GIANG Province							
Wood	1.0 kg.	200	15.0	200	13.3 Dong	17%	78 Dong
Coconut leaves	5.0 kg.	500	12.5	100	8.0 Dong	12%	67 Dong
Rice husks	1.0 kg.	25	12.5	25	2.0 Dong	12%	17 Dong
Kerosene	1.0 ltr.	2,500	38.0	2,500	65.8 Dong	43%	153 Dong
Electricity	1.0 kwh.	230	3.6	230	63.9 Dong	60%	106 Dong
TUAN HAI Province							
Wood	1.0 kg.	143	15.0	143	9.5 Dong	17%	56 Dong
Split firewood	1.0 kg.	250	15.0	250	16.7 Dong	17%	98 Dong
Charcoal	1.0 kg.	450	26.0	450	17.3 Dong	22%	79 Dong
Kerosene	1.0 ltr.	2,600	38.0	2,600	68.4 Dong	43%	159 Dong
Electricity	1.0 kwh.	230	3.6	230	63.9 Dong	60%	106 Dong

Note: Prices mentioned are valid in urban and semi-urban areas only.

Coal briquettes, which require a special stove, have the same problem with ignition and smoke, but development work undertaken by the Coal Research Institute of the Ministry of Energy has resulted in briquettes, which are very easy to ignite and burn without smoke. These briquettes are about three times more expensive (Dong 600 a piece) than the standard coal briquettes. By using a specially designed stove, one briquette can last for a whole day, which decreases the cost to the consumer. Production and marketing trials have shown that consumers like this briquette very much. It could, if available on a larger scale, become an attractive option. However, as special care has to be taken to produce these new briquettes (a pyrotechnic substance is used to facilitate ignition, which, if not properly applied could produce dramatic results in kitchens), it will only be possible to make them in factories with a well established quality control system (personal communication Mr. Nguyen Khac Quang). Therefore, it can be assumed that substitution to any meaningful extent will only take place in large cities that can warrant the setting up of a briquette factory.

An improved briquette ignited with only one match

In almost all cases, it should be noted that the commercial energy prices as paid by the consumers may not reflect the actual economic price. Comparing the price of coaldust with world market prices, it appears that the price in Vietnam is low. This could imply some kind of subsidy by the Government. Unfortunately, no information could be obtained on the prospects for exporting coaldust (mined in dust form with unknown calorific value, sulfur and moisture content). With regard to the price of other conventional energy sources, e.g. kerosene and electricity, both seem to reflect real prices. The price of kerosene is comparable with world market prices. Electricity, which is generated using imported oil, local coal and hydropower does not, according to the World Bank report quoted earlier, reflect the opportunity cost. As the price has risen and is expected to rise even more (possibly from about 3.3 to about 5 US cents per kwh.), this probably is no longer true.

4.3.2 Effects of price changes

As is clear from table 4.6, biomass energy and coal dust are in many cases more cost-effective, e.i. they deliver more heat for the money spent than conventional energy sources. This implies that these biomass energy sources would have to rise considerably in price in order to, when judging on price alone, have people switch to conventional sources such as kerosene and electricity. However, together with the direct price differences, other factors must be taken into consideration. The easy use of conventional energy sources may swing the balance earlier from biomass energy to conventional ones, while the availability (stable supply at all times) could swing the balance the other way round.

Much will depend on the way the economy of Vietnam will develop. Many uncertainties exist, e.g. the disappearance of aid from the former East bloc, inflation and unemployment rates etc.. Some Vietnamese economists believe that thousands of non-profit making state industries may have to be closed down[3/], which will influence energy requirements. Capital needed for planned investments to upgrade the electrical energy sector - e.g. to improve the existing grid and decrease transmission losses, connect transmissions systems of the three power companies, new power stations - might not be readily available, which would influence electric power generation and distribution.

Electricity, together with kerosene, is expected to provide an increasing share in the domestic energy consumption, in particular in urban and semi-urban areas. An increased use of coal is expected to take place in rural areas. Coal consumption may rise from less than one million tons at present to about 2-3 million tons by the year 1995. However, the share of coal as well as other conventional energy sources is relatively small. Even if the use of these energy sources will certainly increase, it is doubtful, whether this would notably influence the use of fuelwood and residues, particularly in rural areas. The increased electricity price has forced many urban people to switch from electricity to coal. This trend can be expected to continue, since further increases in the price of electricity are likely. Unless massive efforts in the field of energy substitution and conservation are made, it may be assumed that the share of fuelwood and residues in the overall energy consumption in the domestic sector will not show dramatic changes.

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[3]/ Far Eastern Economic Review, March 7, 1991.

5. ENVIRONMENTAL ASPECTS

5.1 Background Data

Deforestation is a major problem in Vietnam. Forests, especially those close to human settlements, are subject to unplanned cutting and selective removal of trees for several purposes, for instance clearing for agricultural purposes, harvesting of other forest products and fuelwood collection. The forest areas are also subject to shifting cultivation, which may or may not involve prior harvesting of wood. However, precise data to assess the actual situation, and to assist planning and remedial programmes is limited. Many reports of TFAP consultants and of the United Nations agencies have commented on the progressive deforestation in Vietnam, discussed causes and quoted figures. However, most of this is based on recycled data of a limited value.

In its review, the World Bank (1990) found that deforestation appeared to range from 100,000 to 300,000 ha/year and concluded that it may exceed 200,000 ha/year. A UNDP/FAO Programming Mission put the figure at 150,000 to 200,000 ha/year (UNDP, 1986). An official report by Yen (probably 1990) places the loss of forest at over 100,000 ha per year. This figure comprises of the clearing of virgin forests and clearing for hydropower and irrigation systems (30,000 ha per year), shifting cultivation (50,000 ha per year), and uncontrolled logging and fire damages (12,000 ha per year). Sharma (1990) quotes the same figures of 50,000 ha/year for shifting cultivation practiced by 2.5 million people (3 million according to the 1989 census), and affecting some 200,000 to 250,000 ha/year of forest land.

Indiscriminate cutting of mangrove may lead to serious coastal erosion problems

Armitage (1990) has used more analytical approach and concluded that the only meaningful measure is the comparison of the 1983 and 1987 inventories (MoF, 1988c), which were based on satellite imagery. The aggregated national data indicates a loss of 6.4% of the rich-medium forests, and 10.6% of the bamboo/wood type (mixed deciduous) forests or some 45,000 ha per year. The poor forests have marginally increased in aggregate reflecting the degradation process, although large losses are reported in some areas.

However, Armitage considered that the indicated losses are likely to be conservative. He has estimated that the forest loss could be as high as 80,000-100,000 ha per year in the productive and protection classes. He stresses the need to collect data, and commends the MoF proposal for a comprehensive new forest inventory. Because of its importance in the key land allocation and settlement programmes, the inventory should include a survey of land capability of the bare forest lands, covering their present vegetation and land use status.

Rainforest management practices in major tropical countries were reviewed by the International Institute of Environmental Development (IIED, 1988) for the International Union for the Conservation of Nature (IUCN), although Vietnam was not specifically included. A major conclusion was that technically sound sustained yield management procedures are planned in most countries, but, in general, these plans are not properly implemented with the exception of North Queensland in Australia and Peninsular Malaysia. Considerable data inventories, planning skills, knowledge on products and marketing skills are required to manage tropical rainforests so that both timber production and floristic compositions are sustained. Even so, purist conservationists still question the foresters' ability to maintain the integrity of forest ecosystems in meeting these two criterias above.

The review of natural forest management in Vietnam (Armitage 1990) has indicated that procedures, manuals and technical ability do not seem to be major constraints. However, degrading of forests is occurring in some areas near to roads through short cutting cycles caused by inadequate access road network inside the intended extracting area. Excessive commercial timber wastage during logging and underutilization of lesser known species are aspects of the process. Hence, it may be concluded that sustained yield management in the sense indicated in the previous paragraph is not achieved, although it would be possible with increased administrative, technical, financial and institutional inputs.

It should be kept in mind that poor management practices can have an important impact. Such practices may imply to the rural population, especially those living near or in the forests, that the State does not place a high value on the natural forest resources. This, in its turn, may encourage shifting cultivation, unauthorized tree removals and further forest loss. The best way to ensure that the forests are preserved is to place a higher economic value on them than on the alternatives, including shifting cultivation. This means optimizing forest management practices and the resource rent.

5.2 Impact Of Fuelwood Harvesting

Numerous reports describe progressive reduction of forest area by rural wood harvesters, who gather fuelwood for their own use and for cash sale to supplement their household income. This process is clearly visible, especially along the main road through Lang Son Province and along the main north-south highway on the hills of densely settled coastal lands, notably in Thanh Hoa and Nghe Tinh provinces. In many places, there are distinct foot tracks up steep hillsides used by the gatherers, who frequently can be seen carrying wood to roadsides from natural forests.

There remains a tension between those interested in shifting cultivation and fuelwood gatherers. The former means a cyclic removal of all woody biomass and occupying space from wood production. No doubt there is some collusion between these activities. Supposedly, all usable and marketable woody biomass is removed prior to burning the soil in the preparation of hillside cultivation. Hence, the progressive removal of forest through harvesting, initially perhaps for saw logs and finally for fuelwood, will encourage the entry of shifting cultivators. This will signal the end of significant forest production, apart from the woody biomass production between shifting cultivation cycles.

Fuelwood harvesting in natural forests is partly responsible for an incremental loss of forest and may in varying degrees of land degradation, especially in many of the heavily populated coastal and midland hill areas. However, **it is not clear, to what extent fuelwood harvesting contributes on a nationwide basis to the loss of forest cover**. The need for agricultural land and land for growing export crops, such as coffee and rubber undoubtedly have a negative impact, too. As shown in Chapter 1 (table 1.2), national statistics indicate that from 1980 to 1989, the cropping area increased from 8.25 million ha to 8.94 million ha, equal to an average annual increase of about 75,000 ha. This latter increase is mainly made up by perennial and industrial crops, e.g. rubber, coffee, tea, sugarcane, pepper and fruit trees, which account for 64,000 ha out of the total annual increase of 75,000 ha.

Although this increase in cropping area certainly has not been achieved solely by clear-felling forests. Nevertheless, sometimes this happens, notably in areas where rubber, coffee and tea are grown. These three crops together show an average annual increase of about 40,000 ha in cropping area. This trend is expected to continue in the future. Areas devoted for rubber, coffee and tea are projected to grow at an annual rate of 4.5%, 7.7% and 5.3%, respectively (UNDP, 1986). It is clear that these will require large areas but, as not enough is known, no final conclusion can be drawn on its effect on forests. This may need further study.

5.3 Suggested Land Use Approach

Based on above discussions, it is impossible to guess the precise environmental impact of fuelwood harvesting, such as increased run-off or soil loss. At some locations, fuelwood gathering has had a significant impact on the environment, **but generalizations should be avoided**. Trees and forests are not always essential in the maintenance of watershed stability. It is essential to maintain a dense protective ground cover, which may be equally well provided by disclimax vegetation, such as woody shrub and herb vegetation layers.

It may be quite acceptable environmentally to maintain a former forest cover at an earlier tall woody shrub or coppice stage, or perhaps allow some stems to grow into tall trees or "standards" for use as poles, while the smaller coppice material is useful for fuelwood, animal bedding and fodder. Developing this idea further, it is felt that there may be too much emphasis on plantation establishment as **the only answer** to the reforestation of bare forest lands. As pointed out above, the natural vegetation, though degraded, may be quite adequate for maintaining watershed stability, providing it is protected and maintained at **the desired and planned level of productivity**. This may be achieved through the involvement of the people in forest protection through the principle of equity in the very forests they are presently destroying. This is not a simple process, but the principles of household equity concerning forests are now established in the policies and practices in Vietnam. Good working models of community forestry in similar natural forest situations can also be seen, for example, in Nepal and India.

Plantation development will continue to be important at locations appropriate for such an activity. These new forests may produce fuelwood economically as a **secondary product** for use of households and for the urban cash markets. The optimal location of plantations can then be planned according to these main criteria: (1) land capability, (2) availability of future markets for various products, and (3) their socio-economic soundness, which includes adequate profit for the household, which will take equity.

5.4 Coastal Environmental Problems

There are two reported coastal environmental concerns in Vietnam: (1) the wind damages caused by typhoons, especially in the north of the country, and (2) the problem of stabilizing large areas of sand dunes, especially along the central and southern coastline.

Coastal protection through large scale planting of Filao

A solution to both problems has been mainly the planting of Casuarina equisetifolia, or locally known as *filao*. It is an ideal species for absorbing wind energy and has been shown to grow well on coastal sands. Large areas for *filao* have been established, and there is a proposal to establish a further 20,000 ha in 12 coastal provinces from Quang Ninh in the north to Thuan Hai in the south. According to the proposed plan, only 30% of the wood produced would be harvested; of that 60% would be poles and only 40% fuelwood, mainly for the urban cash market. While *filao* plantations may be effective, some questions remain about the programme itself.

1. *For sand dune stabilization, there may be less expensive and equally or more effective methods. For example, there are grasses with strong rhizome systems, which are well tested, e.g. marram grass. Filao may be economically more productive, and if it is to be used, perhaps there is* ***an opportunity of harvesting more than 30% of the trees*** *by designing the felling in a mosaic pattern to maintain stability of the stand in strong winds.*

2. *There may be more productive and socially more attractive agroforestry models, which might even allow settlement in some areas. Filao windbreaks can be maintained, with a combination of food trees and even some limited cropping. The investigation of more innovative models should be explored with the assistance from FSIV, agricultural departments and external sources.*

5.5 Use Of Agricultural Residues

The use of agricultural residues accounts for over 40% of the amount of biomass fuel used (wood equivalent basis). This may contribute to fertility loss and even land degradation. The degree of this contribution is not known, but it is of concern to the Government. However, there is a variety of practical and economic considerations, which may prevent farmers from doing what in strict soil scientific terms would be the best. Firstly, plowing under straw is not a simple task; and secondly, some crop residues, notably rice husks, decompose so slowly as to be of little nutritional or structural benefit to the soil.

In practice, most farmers remove residues from the field and use them for other purposes such as animal feed, litter, fuel, or even, as is the case in biomass deficit areas, sell them. It is thought that, in the cases where there are no alternative uses for the residues, farmers will burn the residues in the field and use the ashes as fertilizer or soil conditioner. Even though most of the residues are removed, ashes and carbon particles are often returned as part of the organic fertilizer, as described in an earlier chapter.

Selling residues for fuel and buying fertilizer instead, makes often financial sense. Rice straw can in some cases fetch about 80 Dong per kg, equal to about 10 US$ per ton. A ton of straw contains about 17 kg potassium (K), which, if completely replaced by fertilizer, would require the application of about 50-100 kg of high potassium fertilizer. This type of fertilizer is available in the market at a price of about Dong 300-400 per kg, or a total cost of 2-5 US$ per ha per ton of straw removed. Although this direct comparison can be questioned, it shows that selling straw as fuel instead of recycling it, may make sense to farmers.

A conclusion, which may be drawn from this is that the use of residues as fuel may contribute to land degradation. However, with prudent practices, such as the application of compost, manure and artificial fertilizers, such a statement may no longer be valid. The use of residues as fuel therefore should not be categorically condemned.

It appears that virtually no systematic work has been done to document tradeoffs between different residue uses on a village or farm level. Very little is known about how farmers themselves see the tradeoffs involved. Since farmers themselves make decisions on how residues are used, and they bear the consequences, their views should also be heard. There may thus be a need for more basic research in order to analyze the overall implications and reach conclusions beyond the theoretical and largely abstract discussions.

However, in response to the Government's concern, an estimate has been provided on the amount of fuelwood, which must be produced in plantations in order to provide a fuelwood alternative to these residues (see Chapter 2). As indicated earlier, this is a formidable task involving the establishment of some 300,000 ha of plantations annually and some the planting of 1,200 million scattered trees per year, i.e. three times the size of existing programmes. This strategy may turn out to be economically and technically unrealistic.

6. INSTITUTIONAL ASPECTS

Although biomass energy plays a very important role the in Vietnamese economy, this is not reflected in the national policy and strategy on energy use in the country. A 96-page report entitled *"Energy Planning Practices and Methodologies in the Socialist Republic of Vietnam"*, compiled by the Institute of Energy of the Ministry of Energy and presented at the APDC Energy Planning workshop in Hanoi in November 1990, only briefly mentions biomass energy, stating that an estimated 55-65% of the gross energy demand is met by the source (MOE-EI, 1990[1]). A table presented, reproduced here as table 6.1 below, gives information on energy demand forecasting and its periodicity. It shows that traditional, new and renewable forms of energy are not considered at all in the industrial sector, while in the domestic sector they are only considered on an *ad-hoc* basis.

Table 6.1. Energy demand analysis and forecast

Sectors consuming energy	Commercial, Conventional Energy	Traditional, New and Renewable Energy	
	Coal and Oil Products	Traditional	Renewable
- Industry, Agriculture, Communication, Transport and Non-Industrial power Commercial, Public and Households	Regular basis. Aggregate national basis. Periodicity 1 year and 5 year	Nil	Nil
- Rural cooking energy	Ad-hoc basis. Disaggregate national basis. Periodicity 5 - 10 years depending on data needs of energy inquiries.		Ad-hoc basis

Source: MOE-EI (1990)

The reason, why biomass energy has received minimal attention is not clear. One reason could be the centralized planning system of Vietnam. Energy demand planning appears to be based on macro-economic forecasts for the country, drawn up by the State Planning Committee. On the basis of this planning framework, provincial authorities and ministries have to draw up economic development plans for their own area or sector. Based on these plans and forecasts, the Ministry of Energy and the Ministry of Trade establish national energy demand forecasts and

[1] This report was not available from the Institute of Energy in Hanoi, but was obtained in Thailand after the mission had been completed. It is therefore not clear, how this figure of 55-65% was calculated. Based on a table in the report, which shows the rural energy demand being about 410 PJ, and estimating the share of the rural population as 80% of the total, this would give the result of 420 kg of WE per capita - far lower than the 580 kg WE as calculated by the consultant, based on information provided in Vietnam and received elsewhere.

development plans. The Ministry of Energy develops electricity and coal demand forecasts, and the Ministry of Trade, oil and oil product forecasts (imported commodities). These plans are then submitted to the State Planning Committee for approval to ensure that the sectoral or regional plans are consistent with the national plan. As biomass energy sources are in many cases not formally traded, it seems that these energy sources have been "lost" in the system, where emphasis was placed on industries and industrialization. This is why so little information - almost all of the data is gathered in the last 10-15 years - is available, since data were not directly needed in this centralized economic planning process.

Although biomass energy has not been considered in the national energy planning, some efforts have been made to change this situation. Surveys on energy demand have been carried out for Hanoi, its suburbs and rural areas by the Institute of Energy. On a national basis, some sample surveys have been carried out by local authorities in co-operation with the Central Department of Statistics and the Ministry of Forestry. These surveys were confirmed during field visits to various provincial offices of the Forestry Department. According to local officials, various sample surveys are regularly carried out with regard to household demand for fuelwood. The data are forwarded to the Ministry of Forestry in Hanoi.

Unfortunately, very little of these data were made available either directly by these provincial authorities during the visits, or from the records of the Ministry of Forestry in Hanoi. It is not known, how the data or what type of data have been collected during these surveys. Given the widely varying quantities of wood fuel consumed per capita per year - as quoted by provincial authorities, ranging from 0.25 cu. m. in Tuan Hai province, which has a forest cover of about 40%, to 2 cu.m. in Tien Giang province with almost no forests - the validity of the methods used and the results may be questioned.

In addition to these activities by the **Institute of Energy** and the **Ministry of Forestry**, other organizations are involved with traditional energy (biomass), and new and renewable energy. These include the **Polytechnic Institute** in Hanoi under the Ministry of Education, the **Forest Inventory and Planning Institute (FIPI)** of the Ministry of Forestry, and possibly others, such as the **State Science Commission (SSC)** and **Provincial Science Departments**.

The **Institute of Energy**, which is a part of the Ministry of Energy, has a specialized department, the so-called Centre of New and Renewable Energy and Technology Transfer, which is one of the 18 departments and centres of the institute. This centre was set up in 1980 and instructed by the Ministry of Energy to become involved in research and development work in the field of non-conventional energy sources (biogas, wind energy, etc.) on a national level. In 1985, activities started in stove development. Prototypes of biogas digesters and windmills (micro-hydropower is covered by another specialized department) have been developed and have been put into test in villages with widely varying conditions. Although technical problems have been overcome, the acceptance of these equipment is not widespread, and their effect on the total biomass energy consumption is negligible.

The Ministry of Higher Education is in charge, on behalf of the State Science Commission (SSC), of a National Programme on New and Renewable Energy; the **Polytechnic Institute of Hanoi** acts as the focal point. Several small projects have been set up in various provinces with funds from the Government or from SSC. The results are said to be promising. Micro-hydropower stations are commercially available from the institute, but it is not known, how far the Institute of

Energy with its micro-hydropower department has been involved. Biogas units are also available, but according to the staff of the Polytechnic Institute, the investments in a biogas unit are high, making the use of the unit economically questionable.

The **Forest Inventory and Planning Institute** of the Ministry of Forestry has some personnel involved with wood energy, but mainly on the supply side, for example in the inventory of existing resources and charcoal making.

The above mentioned centres and institutes are staffed with capable and qualified personnel, but facilities are in most cases inadequate to carry out research and development work in the field of new and renewable energy. All also face problems with funding: in the past, funds have been very limited and fractionated. In the near future, it is expected that this problem will remain the same or even worsen, due to the economic difficulties the country is facing. This type of development could reduce the staffing of the institutes.

Overall, there seems to be little co-ordination and co-operation between the institutes, which is partly caused by the centralized planning of activities. Another reason is believed to be, although this could not be confirmed, the financial situation. An information or knowledge available at an institute can potentially becomes a source of income, and for that reason is not freely shared with other institutes. Although this is understandable in the prevailing economic conditions, it has led to duplication of efforts, not only between institutes of different ministries, but also within a single ministry.

The Institute of Energy of the Ministry of Energy has just completed a survey on energy use within Hanoi City, while the **Forest Science Institute of Vietnam** is going to carry out a similar exercise under the framework of a FAO-supported programme (VIE/86/027). The Institute of Energy has put and is still putting a lot of effort in stove development, while the **Institute for Coal Research** under the Ministry of Energy is doing the same without any exchange of information. In the Ministry of Forestry, there also seems to be duplication of work, although to a lesser extent, such as in stove development of the Wood Processing and Supplying Union and the Forest Science Institute of Vietnam.

This general lack of co-ordination has resulted in many overlaps. The resources could have been efficiently used for other purposes, for instance, to inform ministries on the important role of biomass energy in the overall energy consumption in the country, the need for data collection and consolidation, training needs of various agencies to be involved in data collection and processing, and the need for energy conservation measures.

During discussions with personnel from various institutes and ministries, it was agreed that fuelwood - and biomass energy in general - forms a major part of the national energy sector. Policy decisions regarding one energy sub-sector therefore will have an impact on other energy sub-sectors. In other words, it is essential to develop a national energy policy in close co-operation with all concerned sectors to allow rational planning. It must be recognized, that the MOF remains the primary agency responsible for fuelwood production, and should be responsible for solving the problem of fuelwood scarcity.

It would therefore be helpful to have a central agency responsible for the co-ordination of all energy planning matters on a national level, with designated responsibilities agreed for the various energy sub-sectors.

The **Regional Wood Energy Development Programme (RWEDP)**, executed by FAO and based in Bangkok, in which Vietnam participates, is active in the field of fuelwood and energy. In Vietnam, this programme is represented by a national coordinating committee and a focal point. Under the framework of this regional programme, training and exchange of information have been provided regionwide; also national events have been supported. Under the RWEDP, the national committee of Vietnam - in which most, but not all of the institutions and organizations involved in fuelwood and energy are represented - could become instrumental in promoting co-ordination and co-operation between these institutions and organizations in Vietnam. The lack of funding from the participating organizations, institutes and the Government has, however, hampered the effective work of the national committee: activities are therefore carried out on an *ad-hoc* basis.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 General

Biomass energy and in particular woodfuel, supplies a major part of the total amount of energy consumed in Vietnam, especially by the domestic and rural industrial sectors. Although Vietnam has extensive deposits of conventional energy sources consisting of coal, oil and possibly natural gas, these are important as export commodities. It is expected that only a little of these will be available for use within the country itself, especially in the rural areas.

From the findings, it is also clear that Vietnam is facing serious problems, in particular in rural areas. Due to geo-climatic diversities, a weak economic performance, seriously degraded environment, continued deforestation, coupled with a very large and fast growing population who are often poor and face energy shortages, it appears that it will take some time for the country to substantially address most of these problems related to energy. It is also evident that efforts will have to be made to stimulate the rural economy in order to maintain or improve the standard of living of the population and to sustainably manage the environment and to address deforestation.

The report is based as much as possible on information gathered in Vietnam, either in the form of reports, statistics or during numerous discussions with Government officials and other knowledgeable people in the field. In some cases, information had to be obtained elsewhere as it was found to be impossible to obtain them in Vietnam. Efforts were made also to collect firsthand information. However, this has not always been possible and due to time limitation may have resulted in some loss of background information. It should be noted that this may have some bearing on the general validity of the assumptions made.

7.1.2 Biomass energy demand

The main conclusion, which can be drawn, based on the available information, is that **biomass energy, and wood energy in particular, supply a large part of the total energy consumption in the country, estimated respectively at about 74% (all biomass) and 34% (fuelwood only)** as shown in annex 1. The domestic sector is by far the largest consumer of energy, accounting for about 66% of the total amount of energy consumed in the country, with biomass energy supplying about 97% of its domestic demand. The industrial and other sectors consumed about 34% of the total country energy demand with biomass energy supplying about 28% of the total sectoral demand (all in terms of energy content). The latter figures are higher than previously estimated. This is probably caused by the identification of a larger number of industries using fuelwood and residues as energy sources.

The figures will change, if the preparation of pigfeed, which in this report has classified under the industrial and other sectors, is regarded as domestic activity. It should be noted that the amount of conventional energy sources used by the domestic and other sectors could be under- or overestimated, since no data could be obtained on consumption nor supply of these energy sources.

Judging by the available information, it was found that **out of the total amount of 41-42 million tons of biomass consumed as fuel** (expressed as wood equivalent WE), **an approximate 8 million tons WE or about 14 million tons of** (physical) **residues is derived from agricultural residues, weeds and grass.** Cross-checking this with the amount of agricultural residues available (amount generated minus amount used for other purposes), estimated at less than 50% of the 37 million tons currently generated, it appears that this amount estimated is more or less correct. This figure and other figures however should be treated with caution, because a lot of assumptions have been made due to the use of insufficient data.

The demand for wood as energy source has been estimated at about 32-34 million tons per year, of which a rough 22-23 million tons (two thirds) could be derived from natural forests and concentrated plantations, and the remaining 10-11 million tons from home gardens, scattered trees, etc. However, this statement is based on 1986 conditions and may be less so at present.

The increase in the energy used per capita, expressed in wood equivalent, from about 527 kg to about 580 kg (domestic sector only) can not be explained in any other way but by a shift in population from areas with a low consumption of energy to areas with a high consumption, i.e. new economic zones.

Biomass energy substitution where by other energy sources such as coal and electricity, has taken place, but only in urban areas, where bio-fuel is monetized. In rural areas bio-fuel is mostly regarded as a free fuel, options for substitution are therefore more limited due to the costs involved with conventional energy sources. Biogas could be an option seen the large amount of livestock available in rural areas. However, the price of equipment is high and requiring regular maintenance, which may limit its adoption by users.

In many cases, **biomass and conventional energy sources are used inefficiently.** There is great potential for improvements in the domestic as well as in the other sectors. Although the industrial sector, when compared with the domestic sector, uses only a small amount of biomass energy, improvements can be made. This not only concerns energy efficiency but, more importantly, the whole production process, which could result in improved quality, larger output and increased labour productivity. This could add considerably to the income of the rural producers, particularly women in the field of food and agro-processing.

7.1.3 Fuelwood supply

In Vietnam (as also in many other countries) fuelwood collection especially in rural areas is an informal activity with no clear market structure. Only in the cases, where there is concentrated demand for it, such as in urban areas, fuelwood markets exist. However, very little is known about fuelwood pricing and trade mechanisms.

Based on the limited information on selling prices, it appears that the mean roadside price for fuelwood varies from about Dong 75,000 - 86,000 per ton depending on species and source. Some calculations were made with regard to plantation-grown wood, which show that with existing fuelwood prices, plantations devoted for fuelwood production solely would not be profitable. However, if only a small part (20%) of the wood is destined as fuelwood, plantations could be very profitable provided that a major part is marketable as higher-value products such as pulpwood and poles. However, this lies on an assumption that there are markets for all of the wood grown, which may not be always the case. For fuelwood, markets would possibly exist only in urban areas, since most of the rural people would continue to collect fuelwood freely.

There is a need to produce more fuelwood, in Vietnam in response to a major **concern of the Government that desire to limit the use of agricultural residues for fuel, due to soil depletion.** There are, however, a variety of practical and economic reasons, which may prevent farmers from doing what in strict soil science terms would be the best. It is recognized that the use of residues as fuel, in some cases, may contribute to land degradation. However, with prudent practices (application of compost, manure and some artificial fertilizer), this does not have to happen.

The presently proposed plantation and scattered tree planting programmes, however, would not produce sufficient amounts of fuelwood to meet the national fuelwood shortfall. This is especially so, if, in response to the concern of the Government, agricultural residues as fuel would have to be replaced completely by fuelwood.

In such a scenario the planting targets for the period 1991-1995 would need to rise to 300,000 ha plantations per annum, in addition to 1,200 million scattered trees per annum. Such a programme would generate an estimated 19.8 million tons fuelwood per annum by 1999. As the fuelwood would represents only 50% at most of the product, there will be an equal or greater amount of wood products to be marketed as poles, pulpwood or other higher value products. This may present a major marketing dilemma as it is not known, if the markets will be able to absorb the resulting 19.8 million tons of these non-fuelwood products per year.

Land allocation programmes may provide the key to increased production of fuelwood. It is considered that data on forest lands classified as bare forest land is insufficient for the planning of land allocation and settlement programmes, including the establishment of tree plantations, which in the future will be the major source of fuelwood among other products.

It appears that **there is a strong reliance on a narrow range of species and provenances** for a major part of the plantation programmes in Vietnam. This has meant a focus especially on Eucalyptus (with emphasis on only one or two provenances), and few other species as Acacia and Casuarina. While these species have proven very successful, there are many other species from Australia and elsewhere, in addition to native species to choose from, and the use of a greater proportion of higher value timber species, fodder producers, multipurpose and nitrogen-fixing trees.

More emphasis may be given to the development of agroforestry models as part of the settlement and plantation programmes in land allocation schemes. There appears to be room for a more innovative approach and this could well be implemented through the major donors, such as WFP and FTP. It may need strong support from agencies such as FSIV and other research institutes in the development of appropriate models.

7.1.4 Institutional aspects

Recoginzing that biomass energy plays a very important role in the overall energy scene in the country, **it is concluded that biomass energy has not been accorded with due importance in the energy planning process**, where emphasis is placed mainly on conventional energy sources like coal, oil and electricity. The **wood in energy** and the **fuel in forestry** institutions should be formalized.

Several institutions and persons have in the recent past become involved with biomass energy as well as new and renewable energy technologies. This has resulted in the publication of some information on biomass energy use in the country. However, **the interagency and institutional co-operation and co-ordination appears to be weak,** resulting, in some cases, in the duplication of efforts. The institutions involved with biomass energy are in general well staffed and motivated as far as could be ascertained, but often lack expertise, adequate equipment, facilities and financial support.

With regard to rural energy planning and biomass energy, **the capabilities of the personnel involved in planning technologies and systems** (such as for instance LEAP, ENERPLAN, and MEDEE), **energy consumption survey techniques, require upgrading, not only presently but also in the future.** It should be stressed that rural energy planning is a dynamic process requiring up-to-date planning techniques and systems together with continuous collection and updating of information on energy availability, pricing and end use.

With regard to energy conservation, at present, there appears to be insufficient expertise available in the institutions involved with new and renewable energy. This, in particular seems to be the case with regard to industrial applications (furnaces, gasification, small steam power, charcoal, etc.).

7.2 Recommendations

7.2.1 General

As mentioned above, some of the written information was received outside Vietnam, such as translations of articles and reports written by persons or institutes in Vietnam (Ministry of Forestry, the Ministry of Energy and their institutes). Although the title of the documents, the name of the authors and the respective institutes were known, it was not always possible to obtain them in Vietnam. It is therefore highly recommended that **information in whatever form produced in Vietnam is documented and stored, in a retrievable form, in a central place, freely accessible** to all institutes or persons who have a need for such information. This data storage and retrieval system should be enlarged and kept updated on a continuous basis.

Such a central place, which may be set up under the proposed "Wood Energy Conversion and Utilization" project, could be instrumental in standardizing terms and measurements, and may prevent the duplication of activities now sometimes occurring as it is not known whether other organizations have carried out similar work. Besides, it may provide the basis for an institutional framework to facilitate inter-agency co-operation and co-ordination.

7.2.2 Biomass energy survey (demand - supply data)

Considering the important role biomass plays in the overall energy scene, it is recommended to **continuously update the information on biomass energy availability, consumption and end-use in all sectors of the economy to ensure the availability of reliable information.** Such information should be used to convince policy makers and planners in order to secure sufficient resources and to ensure its sustainability in R&D, planning, tree planting, etc. It is recommended that such a database should also include the supplies in order to develop supply strategies, preferably at provincial level.

7.2.3 Biomass energy conservation

As large amounts of biomass and other energy sources are used often inefficiently, it is worthwhile to initiate some energy conservation measures, such as **the introduction of more efficient stoves for domestic cooking and improved devices for industrial applications.** In the case of domestic stoves, emphasis should be placed on those areas, which face serious shortages of fuelwood and biomass, or areas, where by the adoption of energy-saving measures, other productive activities can be started, simultaneously giving opportunities for increased income for the people.

In the industry, **energy audits** should be carried out to identify wasteful practices, not only with regard to energy, but also with regard to processing, with a view to improve the quality of the processed goods. An example is the sugar industry, which, if processing would be improved, could reach considerably higher yields than the present 7%. In other countries, a yield of 10% of cane to sugar is considered normal. With regard to tea and coffee, the quality could be upgraded with improved processing methods, resulting in higher prices and a better export potential.

The **use of other technologies,** e.g. carbonization, gasification, densification, small steam systems etc. should be selectively investigated. Charcoal gasifiers are used in Vietnam for transport. Their use as a power source for small industries (e.g. saw milling and sugar production) could have advantages, in particular where feed stocks (charcoal, wood or rice husks) are available or can be made available at a low cost.

7.2.4 Fuelwood supply

The estimates made of the present and the expected shortfall of fuelwood supplies may provide an important input to the wood energy planning and policy development process. However, other key factors, such as the availability and the unit cost of alternative energy sources and the net disposable income of the population, need to be incorporated. **The use of specialized tools, e.g. planning models like LEAP are therefore recommended,** since such models can cope with the complexities and uncertainties of the future, in particular with regard to technical, economic and socio-economic change.

Assuming that the forecast biomass energy shortfall is to be met, the solution may either be sought in **demand modification and/or increasing the supplies.** The former may include energy conservation measures as described above and substitution, e.g. extending the electricity supply and the promotion of other energy sources, such as natural gas and LPG. With regard to **supply increases, an assessment should be made of the past and present tree planting programmes,** be it large plantations, scattered tree planting or something else. This could reveal weaknesses and shortcomings, and would be able to assess the important human factor. Both may provide important inputs to the national tree planting programmes and the proposed land allocation programmes.

To provide guidelines for future plantation and settlement programmes proposed by the Government, it is recommended that the following surveys be carried out. They may be carried out in conjunction with the proposed national forest inventory to be carried out by FIPI with international assistance, if required:

- ***A land capability survey of bare forest lands*** *to produce guidance for the establishment of plantations and land settlement programmes. This should include vegetation mapping to assist in planning of natural regeneration of bare lands as appropriate. The survey should examine existing plantation performances and correlate these with land capability.*

- ***A socio-economic baseline survey*** *should be carried out, especially in farmer's households/ communities participated in plantation programmes under land allocation. This study should assess the success of people's involvement, solicit their opinions and identify any issues, which may impede the implementation of successful future programmes.*

- *The proposed* ***national forest inventory*** *should preferably include a detailed assessment of the potential for fuelwood production from scattered trees in home gardens, farm lands and other areas.*

Consideration should be given to **widening the choice of species** in major plantation programmes, and encourage World Food Programme and other agencies to give more thought to this in their projects, including the use of a **higher proportion of higher-value and multi-purpose species.** A greater focus on **agroforestry models** may also be considered in the land allocation programmes in order to maximize household incomes. This approach should be encouraged through major donor support, which may require more innovations and pilots.

The large fuelwood shortfall is at present partly filled by using agricultural residues as fuels. Although the Government has expressed its concern with regard to the continued use of agricultural residues as fuel, it has been argued that there may be economic and practical reasons why farmers continue this practice. In order **to better understand the tradeoffs involved and to analyse the overall implications of the practice, some basic research is recommended** to be carried out. This may lead to conclusions beyond the presently held theoretical and largely abstract discussions on pros and cons.

However, in case the dependence on agricultural residues is eliminated, problems may occur with the marketing of a large amount of non-fuelwood products generated by the increased number of plantations, to be developed to match supplies with fuelwood demand. It is therefore recommended, that **a study should be carried out on the market prospects for these plantation-grown non-fuelwood products.** The study should indicate the maximum market absorption level of the non-fuelwood component to be used as an important input to determine the maximum economic level of plantation establishment in hectares per year.

7.2.5 Institutional aspects

In order to be better prepared for the tasks ahead, it is recommended to **upgrade the capabilities of the local institutions** (staff, equipment, facilities, language capabilities, etc.). This could be carried out by strengthening the institutes and the capabilities of their personnel involved in rural energy planning, biomass and fuelwood energy development activities, in particular with regard to industrial applications, agro-forestry systems, people's participation, through in-service training, fellowships, etc.

The co-operation and co-ordination between concerned agencies and institutes, especially the energy and forestry sectors is strongly recommended in order to tackle tasks in a concerted and united way.

The conclusions and recommendations given here have resulted into a project proposal on a) wood energy conversion and utilization and b) large scale reforestation of bare forest lands. Outlines of these are attached as annex 17.

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Annex 1: ENERGY BALANCE OF VIETNAM (COMPILED FOR 1988 FROM AVAILABLE STATISTICAL DATA AND OTHER SOURCE- SEE ALSO NOTE BELOW)

	COMMERCIAL ENERGY SOURCES				TOTAL commercia energy in PJ	BIOMASS ENERGY			TOTAL biomass energy in PJ	TOTAL amount in PJ	Share in % of total consur
	Coal	Oil products	Natural gas	Electric power		Fuel wood	Resi dues	Char coal			
SUPPLIES											
Primary production	144.9 a	29.9 a	1.7 b	19.5 a	196.0	329.2 b	385.6 b	0.0	714.8	910.9	
Export	(8.4) a	(29.9) a			(38.3)					(38.3)	
Import		113.0			113.0					113.0	
Stock +/-	0.0 x	0.0 x	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ENERGY SUPPLIES	136.5	113.0	1.7	19.5	270.7	329.2	385.6	0.0	714.8	985.6	
% of SUPPLIES	13.8	11.5	0.2	2.0	27.5	33.4	39.1	0.0	72.5	100.0	
TRANSFORMATION											
Charcoal production						(2.8) b		1.4 b	(1.4)	(1.4)	
Elec. power production	(7.7) g	(10.6) h	(0.7) c	5.4 a	(13.5)					(13.5)	
Losses/own use				(6.7) a	(6.7)					(6.7)	
TOTAL FINAL SUPPLIES	128.8	102.4	1.0	18.2	250.6	326.4	385.6	1.4	713.4	963.9	100.0
CONSUMPTION											
Industry	38.9 c	41.4 c	1.0	6.2 a	87.5	39.0 f	50.8 f	x	89.8	177.3	18.4
Agriculture	d	10.7 c		1.6 a	12.3	e	e	x		12.3	1.3
Construction	67.0 a	5.8 a		3.1 a	75.9	3.2 a	e	x	3.2	79.0	8.2
Transport	d	25.6 c		0.1 a	25.8	0.0 c	0.0 c	0.0 c	0.0	25.8	2.7
Others	13.5 c	13.9 c		2.3 a	29.8	e	e	x		29.8	3.1
Domestic use	9.5 b	5.1 b		4.8 a	19.3	284.3 b	334.8 b	1.3 b	620.4	639.7	66.4
Total Consumption	128.8	102.4	1.0	18.2	250.5	326.4	385.6	1.4	713.4	963.9	100.0
Stock +/-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Share in %	13.4	10.6	0.1	1.9	26.0	33.9	40.0	0.1	74.0	100.0	

Note: a = based on semi-official statistics
b = based on calculations (see annexes)
c = based on estimates (to be checked)
d = amount included in "Others"
e = amount included in "Industry"
f = preliminary estimate
g = based on 540 gr./kWh
h = based on 280 gr./kWh
x = not known

Data on construction cover only building materials including cement and were provided by the Ministry of Construction

All energy amounts have been converted to PJ (10^15), using the following conversion factors:

Crude oil	1,000	0.04270	PJ	Coal	1,000 ton =	0.0210	PJ
Oil prod.	1,000	0.04270	PJ	Charcoal	1,000 ton =	0.0290	PJ
Elect.	1,000	0.00360	PJ	Fuelwood	1,000 ton =	0.0150	PJ
Nat.gas	Mil.CF	0.00099	PJ	Residues	1,000 ton =	0.0125	PJ

File: ENBAL-90-2202

Annex 2: Domestic energy use in tons wood energy equivalent (W.E.) and amounts of energy sources in tons or MWh taking into account the end-use efficiency and heating value (NHV) of the different energy sources

Province	Area in sq.km.	Popul. in '000	Population density cap/sq.km.	Domestic energy use (W.E.) kg/cap/yr.	Total amount of W.E.	% Share of the energy sources: Fuel wood	Resi dues	Elec tric	Kero sene	Coal	Char coal	Amount of different energy sources in tons W.E. used for domestic purposes (excl. pig feed preparation): Fuelwood	Residues	Electric.	Kerosene	Coal	Charcoal	Effic %	Amount of different energy sources in tons or MWh (e taking into account end-use efficiency and heat valu: Fuelwood 17	Residues 12	Electric. 60
Lai Chau	17,142	438	26	910	398,580	96	0	1	3	1	0	381,840	0	2,391	10,363	3,986	0		381,840	0	2,823
Son La	14,210	682	48	780	531,960	83	13	1	3	1	0	442,591	67,027	3,192	13,831	5,320	0		442,591	113,946	3,768
Ha Son Binh	5,796	1,840	317	700	1,288,000	74	21	1	3	1	0	958,272	275,632	7,728	33,488	12,880	0		958,272	468,574	9,123
Hoang Lien Son	14,852	1,032	69	780	804,960	83	13	1	3	1	0	669,727	101,425	4,830	20,929	8,050	0		669,727	172,422	5,702
Ha Tuyen	13,632	1,026	75	780	800,280	83	13	1	3	1	0	665,833	100,835	4,802	20,807	8,003	0		665,833	171,420	5,669
Vinh Phu	4,569	1,806	395	610	1,101,660	66	30	1	3	1	0	729,299	326,091	6,610	28,643	11,017	0		729,299	554,355	7,803
Lang Son	8,187	611	75	780	476,580	83	13	1	3	1	0	396,515	60,049	2,859	12,391	4,766	0		396,515	102,083	3,376
Cao Bang	8,445	566	67	910	515,060	96	0	1	3	1	0	493,427	0	3,090	13,392	5,151	0		493,427	0	3,648
Bac Thai	6,503	1,033	159	740	764,420	78	18	1	3	1	0	596,248	136,067	4,587	19,875	7,644	0		596,248	231,313	5,415
Quang Ninh	5,939	814	137	740	602,360	78	18	1	3	1	0	469,841	107,220	3,614	15,661	6,024	0		469,841	182,274	4,267
Ha Bac	4,615	2,061	447	610	1,257,210	66	30	1	3	1	0	832,273	372,134	7,543	32,687	12,572	0		832,273	632,628	8,905
Hai Hung	2,553	2,440	956	490	1,195,600	53	42	1	3	1	0	638,450	506,934	7,174	31,086	11,956	0		638,450	861,788	8,469
Hanoi	2,141	3,057	1,428	490	1,497,930	37	22	10	11	20	0	554,234	329,545	149,793	164,772	299,586	0		554,234	560,226	176,839
Ha Nam Ninh	3,798	3,157	831	490	1,546,930	53	42	1	1	3	0	826,061	655,898	9,282	9,282	46,408	0		826,061	1,115,027	10,957
Haiphong	1,503	1,448	963	490	709,520	37	22	10	11	20	0	262,522	156,094	70,952	78,047	141,904	0		262,522	265,360	83,763
Thai Binh	1,532	1,632	1,065	490	799,680	53	42	1	3	1	0	427,029	339,064	4,798	20,792	7,997	0		427,029	576,409	5,664
Thanh Hoa	11,168	2,991	268	700	2,093,700	74	21	1	3	1	0	1,557,713	448,052	12,562	54,436	20,937	0		1,557,713	761,688	14,830
Nghe Thin	22,500	3,582	159	740	2,650,680	78	18	1	3	1	0	2,067,530	471,821	15,904	68,918	26,507	0		2,067,530	802,096	18,776
Binh Trie Thien	17,561	1,995	114	540	1,077,300	53	42	1	3	1	0	575,278	456,775	6,464	28,010	10,773	0		575,278	776,518	7,631
Quang Nam Da Nang	11,989	1,739	145	540	939,060	30	67	0	2	1	0	285,474	630,109	3,756	15,025	4,695	0		285,474	1,071,186	4,434
Nghia Binh	11,908	2,288	192	540	1,235,520	30	67	0	2	1	0	375,598	829,034	4,942	19,768	6,178	0		375,598	1,409,358	5,834
Phu Khanh	9,804	1,463	149	540	790,020	30	67	0	2	1	0	240,166	530,103	3,160	12,640	3,950	0		240,166	901,176	3,731
Thuan Hai	11,423	1,170	102	540	631,800	30	67	0	2	1	0	192,067	423,938	2,527	10,109	3,159	0		192,067	720,694	2,984
Gia Lai Kon Tum	25,596	873	34	910	794,430	96	0	0	3	1	0	762,653	0	3,178	20,655	7,944	0		762,653	0	3,751
Dac lac	19,800	974	49	910	886,340	96	0	0	3	1	0	850,886	0	3,545	23,045	8,863	0		850,886	0	4,185
Lam Dong	10,173	639	63	910	581,490	96	0	0	3	1	0	558,230	0	2,326	15,119	5,815	0		558,230	0	2,746
Song Be	9,546	939	98	540	507,060	30	67	0	2	1	0	154,146	340,237	2,028	8,113	2,535	0		154,146	578,403	2,394
Dong Nai	7,585	2,007	265	540	1,083,780	30	67	0	2	1	0	329,469	727,216	4,335	17,340	5,419	0		329,469	1,236,268	5,118
Tay Ninh	4,017	791	197	540	427,140	30	67	0	2	1	0	129,851	286,611	1,709	6,834	2,136	0		129,851	487,239	2,017
HCM City	2,089	3,934	1,883	480	1,888,320	40	20	16	16	6	2	755,328	377,664	302,131	302,131	113,299	37,766		755,328	642,029	356,683
Vung Tau-Con Dao	238	136	571	540	73,440	10	87	2	2	0	0	7,344	63,526	1,469	1,102	0	0		7,344	107,994	1,734
An Giang	3,423	1,793	524	540	968,220	10	87	1	2	0	1	96,822	837,510	9,682	14,523	0	9,682		96,822	1,423,768	11,430
Kien Giang	6,243	1,198	192	540	646,920	10	87	1	2	0	1	64,692	559,586	6,469	9,704	0	6,469		64,692	951,296	7,637
Minh Hai	7,671	1,562	204	540	843,480	10	87	1	2	0	1	84,348	729,610	8,435	12,652	0	8,435		84,348	1,240,337	9,958
Long An	4,338	1,121	258	540	605,340	10	87	1	2	0	1	60,534	523,619	6,053	9,080	0	6,053		60,534	890,152	7,146
Dong Thap	3,276	1,337	408	540	721,980	10	87	1	2	0	1	72,198	624,513	7,220	10,830	0	7,220		72,198	1,061,672	8,523
Tien Giang	2,339	1,484	634	540	801,360	10	87	1	2	0	1	80,136	693,176	8,014	12,020	0	8,014		80,136	1,178,400	9,461
Ben Tre	2,247	1,214	540	540	655,560	10	87	1	2	0	1	65,556	567,059	6,556	9,833	0	6,556		65,556	964,001	7,739
Cuu Long	3,857	1,812	470	540	978,480	10	87	1	2	0	1	97,848	846,385	9,785	14,677	0	9,785		97,848	1,438,855	11,552
Hau Giang	6,161	2,682	435	540	1,448,280	10	87	1	2	0	1	144,828	1,252,762	14,483	21,724	0	14,483		144,828	2,129,696	17,098
TOTAL	330,369	64,412	195		37,620,430							18,952,858	15,753,325	739,978	1,244,336	815,472	114,463		18,952,858	26,780,652	873,585

Source: Adapted from "Report on Daily Life Fuel at National Level (1987)", Institute of Energy and Electricity of Min. of Energy, information supplied by NATCOM members and data obtained during fieldtrips.

File : Fuel-dom-1003 Note: Percentages might not ad up to 100 due to rounding

Annex 3: Population growth rates and rural population data

Province	Total Population in '000 1979	Total Population in '000 1989	Growth rate %	Rural Population in '000 1979	Rural Population in '000 1989	Growth rate %	Rural pro-portion %
Lai Chau	322	438	3.12	275	380	3.29	87
Son La	487	682	3.43	427	595	3.37	87
Ha Son Binh	1,537	1,840	1.82	1,432	1,662	1.50	90
Hoang Lien Son	778	1,032	2.87	674	872	2.61	84
Ha Tuyen	782	1,026	2.75	722	939	2.66	92
Vinh Phu	1,488	1,806	1.98	1,371	1,594	1.52	88
Lang Son	484	611	2.38	436	533	2.03	87
Cao Bang	479	566	1.68	432	512	1.71	90
Bac Thai	815	1,033	2.40	634	838	2.83	81
Quang Ninh	750	814	0.82	463	464	0.02	57
Ha Bac	1,662	2,061	2.18	1,533	1,958	2.48	95
Hai Hung	2,145	2,440	1.30	2,008	2,318	1.45	95
Hanoi	2,570	3,057	1.75	1,673	1,968	1.64	64
Ha Nam Ninh	2,781	3,157	1.28	2,490	2,828	1.28	90
Haiphong	1,279	1,448	1.25	893	992	1.06	69
Thai Binh	1,506	1,632	0.81	1,416	1,547	0.89	95
Thanh Hoa	2,532	2,991	1.68	2,341	2,788	1.76	93
Nghe Thin	3,111	3,582	1.42	2,916	3,288	1.20	92
Binh Trie Thien	1,901	1,995	0.48	1,639	1,651	0.07	83
Quang Nam Da Nang	1,529	1,739	1.30	1,155	1,214	0.50	70
Nghia Binh	2,095	2,288	0.89	1,829	1,978	0.79	86
Phu Khanh	1,188	1,463	2.10	863	1,041	1.89	71
Thuan Hai	938	1,170	2.23	750	911	1.96	78
Gia Lai Kon Tum	595	873	3.91	485	698	3.71	80
Dac Lac	490	974	7.11	418	809	6.83	83
Lam Dong	396	639	4.90	287	429	4.10	67
Song Be	659	939	3.60	525	895	5.48	95
Dong Nai	1,304	2,007	4.41	968	1,528	4.87	76
Tay Ninh	684	791	1.46	597	704	1.66	89
HCM City	3,419	3,934	1.41	719	765	0.62	19
Vung Tau-Con Dao	91	136	4.10	10	12	1.84	9
An Giang	1,532	1,793	1.59	1,252	1,332	0.62	74
Kien Giang	994	1,198	1.88	835	945	1.25	79
Minh Hai	1,219	1,562	2.51	988	1,271	2.55	81
Long An	957	1,121	1.59	826	932	1.21	83
Dong Thap	1,182	1,337	1.24	1,064	1,184	1.07	89
Tien Giang	1,264	1,484	1.62	1,070	1,300	1.87	88
Ben Tre	1,041	1,214	1.55	969	1,123	1.48	93
Cuu Long	1,504	1,812	1.88	1,368	1,636	1.81	90
Hau Giang	2,232	2,682	1.85	1,852	2,208	1.74	82
Special Enumerat.		1,045					
	52,722	64,412	2.02	42,605	50,642	1.74	80

Source : Agricultural and Food Production Review
State Planning Committee and UNDP/FAO, 1989
File : RURA-POP-1203

Annex 4: Overview of industrial and agricultural processing activities which require biomass energy sources.

Type of activity	Type of operation	Specific Energy Use (SEC) per unit as specified (local info + estimates)		Amount produced/reared/constructe * '000	Units	Info. source	Amount of fuel used in tons WE	Remarks
FOOD PROCESSING								
Restaurants/food processing	Several	5.00	kg/day	64	rest.	Estimate	116,800	Assumed 1 rest. per 1,000 persons
Bakeries	Baking	0.80	kg/kg. bread	56,000	kg.	MAFI/FAO	44,800	30,000 ton bread and 26,000 ton biscuits
Beancurd (tofu)	Boiling	0.75	kg/kg. tofu	25,000	kg.	MAFI/FAO	18,750	
Noodles (fresh, dry, etc.)	Steaming	0.15	kg/kg. noodle	64,000	kg.	Estimated	9,600	1 kg/cap/year excl. instant noodle
Animal fat (pork)	Extraction	1.00	kg/kg.				x	Included in domestic use
Fish smoking/drying	Smoking	3.00	kg/kg. fish	x			x	Advanced driers used, product for export
Fish (fresh water and sea)				896,000	kg.	Statistics	x	Apparently no processing
MINERAL BASED INDUSTRIES								
Bricks	Firing	0.50	kg/brick, wood only	3,534,000	pcs.	MOC Statistic	1,767,000	Amounts of energy as given by MOC are
		0.30	kg/brick (coal +					210,000 tons wood, 1,387,000 tons of coal
		0.10	kg/brick wood)					and 412,500 MWh electricity for brick-
	Firing	0.70	kg/tile, wood only	466,000	pcs.	MOC Statistic	326,200	and rooftile firing
Tiles		0.33	kg/tile (coal +					
		0.10	kg/tile wood)					
Lime	Firing	0.45	kg/kg. Q.L. (coal)					Amounts of energy as given by MOC does
		0.60	kg/kg. Q.L. (wood)	629,000	kg.	MOC Statistic	377,400	include also cementitious material but
		0.60	kg/kg. l.s. (coal)					not large scale cement production
Porcelain building materials	Firing	x						Electricity used 22,380 MWh (MOC)
Porcelain/ceramics	Firing	0.20	kg/piece	1,280	pcs.	Estimated	256	
AGRO-PROCESSING								
Sugar (gur and molasses)	Evaporation	1.30	kg/kg. gur	366,000	kg.	Statistics	475,800	SEC is given kg. bagasse per kg. gur
Sugar (refined)				43,000	kg.			Amount is included in gur production
Tea (as green tea)	Drying	2.00	kg/kg. green tea	17,300	kg.	MAFI/FAO	34,600	Production of green tea mir minus black tea
Tea (as black tea)		5.00	kg/kg. black tea	14,700	kg.	Statistics	73,500	Export assumed to be black tea
Coffee	Drying	1.00	kg/kg.	220,372	kg.	Statistics	220,372	Part is dried with solar energy
Coconut and other vegetable oil	Extraction	0.08	kg/kg. oil	65,000	kg.	MAFI/FAO	4,875	
Rubber	Smoking	1.20	kg/kg. smoked sheet	51,000	kg.	Statistics	61,200	Production assumed as smoked sheet
	Drying	0.20	kg/kg. crepe rubber					Crepe rubber included in smoked sheet
Tobacco	Curing	8.00	kg/kg. tobacco	25,000	kg.	Statistics	200,000	
TEXTILE BASED PROCESSING								
Cocoons (degumming)	Boiling	15.00	kg/kg. cocoon	1,165	kg.	Statistics	17,475	
OTHER ACTIVITIES/INDUSTRIES								
Pig feed (cassava,potato, etc.)	Cooking	350	kg/pig/yr.	11,600	pigs	Statistics	4,060,000	Estimate
Salt	Evaporation	2.50	kg/kg. salt	811,000	kg.	Statistics		Salt assumed to be dried with solar ener.
Paper	Boiling			78,000	kg.	Statistics	x	SEC not known, mainly large scale prod.
Soap	Boiling	0.75	kg/kg. soap	53,000	kg.	Statistics	39,750	
Road tarring	Melting	50.00	kg/10 sq.m.	600	km.	Estimate	12,000	600 km/year average width 4 m. + repairs
							7,860,378	

File: Fuel-ind-1103 Note: X denotes "Not known"

Annex 5: Amount of biomass energy used to process agricultural crops

Province	Rubber	Coconut	Coffee	Tea	Tobacco	Sugarcane	BIOMASS ENERGY USE IN TONS		
	Prod. in tons	Prod. in tons	Prod. in tons	Prod. in tons	Prod. in tons	Prod. in tons	TOTAL AMOUNT BIOMASS	TOTAL AMOUNT WOOD	TOTAL AMOUNT RESIDUES
Lai Chau		100	109	1,560		16,900	2,863	1,129	1,689
Son La			3	6,692		17,800	6,942	4,659	2,282
Ha Son Binh				4,334		77,500	10,369	3,016	7,352
Hoang Lien Son				24,661	6	16,500	21,246	17,207	4,039
Ha Tuyen				15,820		41,300	16,334	11,011	5,323
Vinh Phu				15,184	200	63,100	19,366	12,008	7,358
Lang Son				1,500	1,352	20,600	13,850	10,778	3,072
Cao Bang				485	742	26,000	8,639	5,680	2,959
Bac Thai				14,221	341	42,900	17,925	12,353	5,572
Quang Ninh				345	6	6,400	894	283	611
Ha Bac		6		2,974	992	33,700	13,316	9,212	4,104
Hai Hung		2,883		240	18	20,800	2,204	300	1,905
Hanoi		746		241	935	26,400	10,028	6,901	3,127
Ha Nam Ninh		273		2,085	41	53,400	6,753	1,747	5,006
Haiphong		928				4,000	361	1	360
Thai Binh		264			6	7,500	717	43	674
Thanh Hoa	790	13,260	50	2,653	281	96,400	14,028	4,853	9,155
Nghe Thin	1,848	2,730	3,692	6,573	97	129,100	23,456	8,971	13,008
Binh Trie Thien	953	3,385	40	915	1,060	26,100	12,739	9,432	3,291
Quang Nam Da Nang		12,670	0	1,644	796	106,800	17,265	6,890	10,375
Nghia Binh		67,102	0	271	841	454,400	47,788	6,319	41,468
Phu Khanh		13,371	1,155	18	1,949	193,600	34,077	14,522	19,092
Thuan Hai	50	8,006	265	60	3,587	51,300	33,682	26,043	7,533
Gia Lai Kon Tum	1,288	220	7,460	3,874	517	68,400	22,333	10,949	8,401
Dac lac	2,060	346	80,340	196	36	78,700	90,267	35,004	23,127
Lam Dong		0	24,195	29,409		90,000	55,737	30,147	15,912
Song Be	17,288	2,910	1,781		527	85,100	34,337	25,256	8,369
Dong Nai	22,515	10,075	100,560	26	2,436	391,400	181,998	84,811	56,963
Tay Ninh	3,700	27,200	7		157	383,700	40,025	5,604	34,418
HCM City	120	56,400			1,293	222,600	30,629	9,517	21,111
Vung Tau-Con Dao		750				3,100	280	1	279
An Giang		92,726			2,490	101,700	29,499	18,033	11,467
Kien Giang		62,325				166,900	15,214	70	15,144
Minh Hai		73,201	18			199,100	18,161	90	18,064
Long An		34,718			120	328,700	30,427	903	29,523
Dong Thap		11,839			1,348	223,300	30,736	9,719	21,017
Tien Giang		25,920			2	130,000	11,739	44	11,695
Ben Tre		143,887	26		63	450,500	41,458	626	40,822
Cuu Long		186,016	7		1,516	228,800	33,559	11,128	22,428
Hau Giang		67,895	664		141	660,100	60,957	1,357	59,334
	50,612	922,152	220,372	135,981	23,896	5,344,600	1,062,196	416,617	557,430

Source : Statistical data of the Socialist Republic of Vietnam 1976-1988, Field Document 9 of GCP/RAS/107/JPN (FAO-BKK, 1986) and Central Department for Statistics.

File : BIO-AGRI-0203

Annex 6: Use of biomass as fuel for food processing and other activities

Province	Populat in '000	Food processing Wood	Food processing Residues	No. of pigs * 1,000	Pigfeed cd cooking Wood	Pigfeed cd cooking Residues	Other activ. Wood	Total amount of Wood	Total amount of Residues
Lai Chau	438	669	512	138.9	24,308	41,323	358	25,334	41,834
Son La	682	1,041	797	246.4	43,120	73,304	557	44,718	74,101
Ha Son Binh	1,840	2,809	2,150	397.5	69,563	118,256	1,503	73,874	120,406
Hoang Lien Son	1,032	1,575	1,206	332.5	58,188	98,919	843	60,606	100,124
Ha Tuyen	1,026	1,566	1,199	320.2	56,035	95,260	838	58,439	96,458
Vinh Phu	1,806	2,757	2,110	382.9	67,008	113,913	1,475	71,239	116,023
Lang Son	611	933	714	184.3	32,253	54,829	499	33,684	55,543
Cao Bang	566	864	661	232.1	40,618	69,050	462	41,944	69,711
Bac Thai	1,033	1,577	1,207	281.8	49,315	83,836	844	51,736	85,042
Quang Ninh	814	1,243	951	177.4	31,045	52,777	665	32,952	53,727
Ha Bac	2,061	3,146	2,408	540.5	94,588	160,799	1,683	99,417	163,206
Hai Hung	2,440	3,725	2,850	520.4	91,070	154,819	1,993	96,788	157,669
Hanoi	3,057	4,667	3,571	471.1	82,443	140,152	2,497	89,606	143,724
Ha Nam Ninh	3,157	4,819	3,688	658.7	115,273	195,963	2,578	122,670	199,651
Haiphong	1,448	2,210	1,692	227.6	39,830	67,711	1,183	43,223	69,403
Thai Binh	1,632	2,491	1,907	376.4	65,870	111,979	1,333	69,694	113,886
Thanh Hoa	2,991	4,566	3,494	632.6	110,705	188,199	2,443	117,714	191,693
Nghe Thin	3,582	5,468	4,185	851.6	149,030	253,351	2,925	157,424	257,536
Binh Trie Thien	1,995	3,046	2,331	514.3	90,003	153,004	1,629	94,677	155,335
Quang Nam Da Nang	1,739	2,655	2,032	475.2	83,160	141,372	1,420	87,235	143,404
Nghia Binh	2,288	3,493	2,673	537.9	94,133	160,025	1,869	99,494	162,698
Phu Khanh	1,463	2,233	1,709	228.2	39,935	67,890	1,195	43,363	69,599
Thuan Hai	1,170	1,786	1,367	97.0	16,975	28,858	956	19,717	30,224
Gia Lai Kon Tum	873	1,333	1,020	233.9	40,933	69,585	713	42,978	70,605
Dac lac	974	1,487	1,138	219.3	38,378	65,242	795	40,660	66,380
Lam Dong	639	975	746	93.5	16,363	27,816	522	17,860	28,563
Song Be	939	1,433	1,097	89.4	15,645	26,597	767	17,845	27,693
Dong Nai	2,007	3,064	2,345	187.4	32,795	55,752	1,639	37,498	58,096
Tay Ninh	791	1,208	924	69.6	12,180	20,706	646	14,034	21,630
HCM City	3,934	6,006	4,596	179.4	31,395	53,372	3,213	40,613	57,967
Vung Tau-Con Dao	136	208	159	6.0	1,050	1,785	111	1,369	1,944
An Giang	1,793	2,737	2,095	97.4	17,045	28,977	1,464	21,246	31,071
Kien Giang	1,198	1,829	1,400	163.9	28,683	48,760	978	31,490	50,160
Minh Hai	1,562	2,385	1,825	259.2	45,360	77,112	1,276	49,020	78,937
Long An	1,121	1,711	1,310	137.5	24,063	40,906	915	26,689	42,216
Dong Thap	1,337	2,041	1,562	124.9	21,858	37,158	1,092	24,990	38,720
Tien Giang	1,484	2,265	1,734	199.5	34,913	59,351	1,212	38,390	61,085
Ben Tre	1,214	1,853	1,418	149.9	26,233	44,595	991	29,077	46,013
Cuu Long	1,812	2,766	2,117	261.0	45,675	77,648	1,480	49,921	79,764
Hau Giang	2,682	4,094	3,133	345.3	60,428	102,727	2,190	66,712	105,860
	64,412	96,735	74,027	11,642.6	2,037,455	3,463,674	51,750	2,185,940	3,537,701

Biomass consumption in tons for food processing and other activities

Source : Statistics and estimates, etc.

File : BIO-OTHE-1403

Annex 7: Biomass use as fuel by the mineral based industries

Province	Production of building materials: Bricks '000 pcs.	Rooftiles '000 pcs.	Lime Q.L. '000 tons	Biomass use as fuel by the mineral based industries
Lai Chau	14,052	1,530	4.6	1,558
Son La	8,372	2,984	0.0	1,136
Ha Son Binh	156,554	7,876	41.3	16,443
Hoang Lien Son	53,710	2,279	9.8	5,599
Ha Tuyen	21,834	1,223	0.8	2,306
Vinh Phu	171,571	37,854	38.5	20,943
Lang Son	15,149	1,274	5.5	1,642
Cao Bang	11,385	8,602	0.0	1,999
Bac Thai	25,882	1,367	24.0	2,725
Quang Ninh	23,493	6,103	25.0	2,960
Ha Bac	90,583	10,490	41.1	10,107
Hai Hung	425,609	57,443	101.6	48,305
Hanoi	268,775	11,183	14.8	27,996
Ha Nam Ninh	347,858	34,895	94.6	38,275
Haiphong	106,642	6,700	40.0	11,334
Thai Binh	98,821	10,025	0.0	10,885
Thanh Hoa	196,670	14,872	37.0	21,154
Nghe Thin	122,814	36,210	105.6	15,902
Binh Trie Thien	56,781	18,754	36.2	7,554
Quang Nam Da Nang	105,006	17,645	32.2	82,346
Nghia Binh	108,816	45,151	34.7	98,768
Phu Khanh	99,400	23,700	19.8	81,442
Thuan Hai	72,648	10,780	0.0	56,244
Gia Lai Kon Tum	29,509	3,640	0.0	22,476
Dac lac	42,794	7,368	2.0	33,641
Lam Dong	31,846	3,981	0.0	24,283
Song Be	58,096	3,275	0.0	42,305
Dong Nai	190,639	11,245	0.0	139,070
Tay Ninh	45,322	3,361	0.0	33,406
HCM City	76,560	2,514	1.5	54,850
Vung Tau-Con Dao	1,000	0	0.1	700
An Giang	46,000	3,650	0.0	34,025
Kien Giang	14,775	0	0.0	10,343
Minh Hai	16,500	50	0.0	11,575
Long An	19,458	1,540	0.4	14,391
Dong Thap	34,196	12,438	0.0	30,156
Tien Giang	7,013	1,470	0.0	5,644
Ben Tre	27,847	6,048	0.0	22,517
Cuu Long	84,047	25,091	0.5	71,379
Hau Giang	43,677	1,345	0.1	31,246
	3,371,704	455,956	711.6	1,149,627

Source : Statistics, Ministry of Construction and field visits
File : Bio-mine-0103

Annex 8: Crop residues generated annually per province as derived from production statistics of 1989 (1988 in the case of rice).

Residue production in thousand tons

Province	Forest Distr. no.	Rice straw	Rice husks	Sugarcane bagas	Sugarcane tops	Maize stalks	Maize cobs	Cassava stalks	Groundnut straw/ shells	Potato stalks	Soya bean stalks	Sesame straw	Cotton stalks	Jute sticks	TOTAL AMOUNT OF RESIDUES '000 tons
Lai Chau	1	128	29	2	5	62	8	10	0	2	3	2	6	0	257
Son La	1	118	27	2	5	45	5	22	0	2	4	2	9	0	241
Ha Son Binh	2	598	137	10	22	58	7	17	3	13	3	1	3	0	872
Hoang Lien Son	2	228	52	2	5	60	7	31	1	2	4	2	3	0	397
Ha Tuyen	2	(7)	(2)	5	12	105	13	21	2	4	4	2	2	0	162
Vinh Phu	2	441	101	8	18	80	10	22	5	14	2	1	1	1	704
Lang Son	3	109	25	3	6	23	3	7	1	4	4	0	0	0	184
Cao Bang	3	128	29	3	8	93	11	3	0	5	8	2	3	0	294
Bac Thai	3	246	56	5	12	25	3	9	3	17	3	0	1	0	381
Quang Ninh	3	137	31	1	2	16	2	4	2	16	2	1	0	0	214
Ha Bac	3	710	162	4	10	50	6	14	7	72	12	3	0	1	1,052
Hai Hung	4	1,115	255	3	6	107	13	1	2	38	4	0	0	31	1,575
Hanoi	4	558	128	3	8	130	16	4	4	27	6	3	0	2	887
Ha Nam Ninh	4	1,260	288	7	15	52	6	4	6	43	4	1	0	5	1,691
Haiphong	4	395	90	1	1	13	2	0	0	12	0	2	0	0	516
Thai Binh	4	898	205	1	2	68	8	0	2	34	3	0	0	11	1,232
Thanh Hoa	5	811	185	12	28	51	6	21	8	78	1	3	2	3	1,211
Nghe Thin	5	855	196	16	37	58	7	13	20	118	0	8	3	0	1,333
Binh Trie Thien	5	417	95	3	8	9	1	17	3	48	0	2	0	0	603
Quang Nam Da Nan	6	481	110	13	31	14	2	27	6	35	0	3	1	0	722
Nghia Binh	6	838	192	57	132	10	1	26	5	27	1	0	0	0	1,289
Phu Khanh	6	512	117	24	56	15	2	22	1	4	1	11	2	0	766
Thuan Hai	6	324	74	6	15	19	2	9	2	15	0	1	7	0	474
Gia Lai Kon Tum	7	164	37	9	20	39	5	23	4	13	1	5	0	0	319
Dac lac	7	216	49	10	23	77	9	7	7	15	10	0	0	0	424
Lam Dong	7	111	25	11	26	62	8	4	1	6	3	0	0	0	258
Song Be	8	157	36	11	25	7	1	8	10	4	0	3	0	0	261
Dong Nai	8	337	77	49	114	139	17	35	7	10	41	1	0	0	826
Tay Ninh	8	289	66	48	111	1	0	12	20	0	0	1	0	0	549
HCM City	8	332	76	28	65	3	0	1	8	2	0	0	0	0	514
Vung Tau-Con Dao	8	2	1	0	1	0	0	0	0	0	0	0	0	0	4
An Giang	9	1,373	314	13	29	35	4	3	1	3	11	7	0	2	1,795
Kien Giang	9	1,003	229	21	48	0	0	1	0	5	0	0	0	2	1,309
Minh Hai	9	978	224	25	58	2	0	2	0	5	2	0	0	2	1,297
Long An	9	1,088	249	41	95	0	0	4	11	0	0	0	0	3	1,490
Dong Thap	9	1,194	273	28	65	9	1	0	0	10	24	0	0	0	1,605
Tien Giang	9	1,176	269	16	38	4	0	1	0	2	0	0	0	0	1,505
Ben Tre	9	518	118	56	131	3	0	1	1	3	0	1	0	0	832
Cuu Long	9	1,376	314	29	66	4	0	7	1	32	3	1	0	0	1,834
Hau Giang	9	1,916	438	83	191	2	0	1	0	20	8	2	0	5	2,666
		23,525	5,377	668	1,550	1,552	189	414	154	762	172	70	44	69	34,547

Source : Statistical data of the Socialist Republic of Vietnam 1976-1988 and Field Document 9 of GCP/RAS/107/JPN (FAO-BKK, 1986).

File : Biom-cro-1901

Annex 9: Amount of residues generated annually from perennial crops

Province	Forest Distr. no.	Residues generated annually in tons: Coconut shells	Coconut husks	Coconut fronds	Coffee husks	Tea prunings	Rubber wood	TOTAL AMOUNT OF RESIDUE tons	TOTAL AMOUNT OF WOOD tons
Lai Chau	1	2	5	17	51	293	0	57	309
Son La	1	0	0	0	1	1,196	0	1	1,196
Ha Son Binh	2	0	0	0	0	607	0	0	607
Hoang Lien Son	2	0	0	0	0	2,384	0	0	2,384
Ha Tuyen	2	0	0	0	0	1,965	0	0	1,965
Vinh Phu	2	0	0	0	0	2,250	0	0	2,250
Lang Son	3	0	0	0	0	225	0	0	225
Cao Bang	3	0	0	0	0	61	0	0	61
Bac Thai	3	0	0	0	0	1,749	0	0	1,749
Quang Ninh	3	0	0	0	0	93	0	0	93
Ha Bac	3	0	0	0	0	415	0	1	415
Hai Hung	4	47	140	347	0	32	0	186	378
Hanoi	4	18	53	155	0	62	0	71	217
Ha Nam Ninh	4	23	70	168	0	171	0	94	339
Haiphong	4	35	104	273	0	0	0	139	273
Thai Binh	4	7	20	80	0	0	0	26	80
Thanh Hoa	5	423	1,270	3,581	7	376	5,123	1,701	9,080
Nghe Thin	5	117	351	977	715	721	7,809	1,183	9,506
Binh Trie Thien	5	45	134	502	133	241	4,566	311	5,309
Quang Nam Da Nang	6	109	326	1,997	0	408	0	434	2,405
Nghia Binh	6	1,819	5,458	32,353	0	64	0	7,277	32,417
Phu Khanh	6	960	2,880	17,315	749	4	0	4,589	17,319
Thuan Hai	6	245	735	4,355	159	11	238	1,140	4,604
Gia Lai Kon Tum	7	17	50	746	2,094	823	8,799	2,160	10,368
Dac lac	7	6	19	147	9,570	65	15,875	9,596	16,086
Lam Dong	7	0	0	63	4,579	3,265	0	4,579	3,328
Song Be	8	89	267	624	332	0	126,797	688	127,421
Dong Nai	8	477	1,430	11,283	7,942	10	136,158	9,849	147,451
Tay Ninh	8	240	720	2,919	2	0	24,759	962	27,678
HCM City	8	1,410	4,230	14,629	0	0	548	5,640	15,176
Vung Tau-Con Dao	8	450	1,350	315	0	0	0	1,800	315
An Giang	9	784	2,351	6,365	0	0	0	3,134	6,365
Kien Giang	9	1,958	5,874	24,242	0	0	0	7,832	24,242
Minh Hai	9	4,877	14,630	81,709	12	0	0	19,518	81,709
Long An	9	822	2,465	5,752	0	0	0	3,287	5,752
Dong Thap	9	644	1,932	5,912	0	0	0	2,576	5,912
Tien Giang	9	1,655	4,964	16,947	0	0	0	6,618	16,947
Ben Tre	9	7,708	23,125	97,604	25	0	0	30,858	97,604
Cuu Long	9	4,737	14,211	45,809	9	0	0	18,957	45,809
Hau Giang	9	4,074	12,221	56,001	412	0	0	16,706	56,001
		33,795	101,384	433,184	26,794	17,491	330,672	161,972	781,346

Source : Statistics of the Ministry of Agriculture (cropped area and yield) 10!

File : Biom-per-1003

Annex 10: Total area and area per capita specified as to use

Province	Forest Distr. no.	Total area in sq. km.	Population in '000	Population density per sq.km.	Land area in 1,000 ha. used for: Agricul. product.	Forestry product.	Special needs	Other purposes	Land area in ha. per capita: Agricul. product.	Forestry product.	Special needs	Other purpose
Lai Chau	1	17,142	438	26	105.9	64.4	10.4	1,533.5	0.242	0.147	0.024	3.501
Son La	1	14,210	682	48	147.9	179.1	12.1	1,081.9	0.217	0.263	0.018	1.586
Ha Son Binh	2	5,796	1,840	317	146.1	189.9	60.6	183.0	0.079	0.103	0.033	0.099
Hoang Lien Son	2	14,852	1,032	69	199.9	258.8	42.4	984.1	0.194	0.251	0.041	0.954
Ha Tuyen	2	13,632	1,026	75	144.5	476.7	34.8	707.2	0.141	0.465	0.034	0.689
Vinh Phu	2	4,569	1,806	395	153.1	107.9	59.1	136.8	0.085	0.060	0.033	0.076
Lang Son	3	8,187	611	75	95.8	147.7	19.1	556.1	0.157	0.242	0.031	0.910
Cao Bang	3	8,445	566	67	72.7	208.6	21.3	541.9	0.128	0.369	0.038	0.957
Bac Thai	3	6,503	1,033	159	87.6	219.8	53.5	289.4	0.085	0.213	0.052	0.280
Quang Ninh	3	5,939	814	137	59.3	229.1	32.7	272.8	0.073	0.281	0.040	0.335
Ha Bac	3	4,615	2,061	446	147.5	86.7	91.7	135.6	0.072	0.042	0.044	0.066
Hai Hung	4	2,553	2,440	956	159.7	11.7	55.4	28.5	0.065	0.005	0.023	0.012
Hanoi	4	2,141	3,057	1,427	103.8	10.9	58.3	41.1	0.034	0.004	0.019	0.013
Ha Nam Ninh	4	3,798	3,157	832	225.3	12.0	65.0	77.5	0.071	0.004	0.021	0.025
Haiphong	4	1,503	1,448	963	62.5	1.6	28.2	58.0	0.043	0.001	0.019	0.040
Thai Binh	4	1,532	1,632	1,065	104.9	1.4	34.8	12.1	0.064	0.001	0.021	0.007
Thanh Hoa	5	11,168	2,991	268	264.0	292.4	70.9	489.5	0.088	0.098	0.024	0.164
Nghe Thin	5	22,500	3,582	159	320.2	825.7	93.2	1,010.9	0.089	0.231	0.026	0.282
Binh Trie Thien	5	17,561	1,995	114	171.3	551.8	66.4	966.6	0.086	0.277	0.033	0.485
Quang Nam Da Nang	6	11,989	1,739	145	112.4	468.9	88.8	528.8	0.065	0.270	0.051	0.304
Nghia Binh	6	11,908	2,288	192	171.2	206.1	68.5	745.0	0.075	0.090	0.030	0.326
Phu Khanh	6	9,804	1,463	149	117.6	568.6	42.8	251.4	0.080	0.389	0.029	0.172
Thuan Hai	6	11,423	1,170	102	129.8	347.6	27.1	637.8	0.111	0.297	0.023	0.545
Gia Lai-Kon Tum	7	25,596	873	34	180.5	1,472.3	48.8	858.0	0.207	1.686	0.056	0.983
Dac Lac	7	19,800	974	49	134.8	1,293.9	33.1	518.2	0.138	1.328	0.034	0.532
Lam Dong	7	10,173	639	63	68.9	630.0	10.9	307.5	0.108	0.986	0.017	0.481
Song Be	8	9,546	939	98	202.0	255.1	39.6	457.9	0.215	0.272	0.042	0.488
Dong Nai	8	7,585	2,007	265	292.4	266.8	45.9	153.4	0.146	0.133	0.023	0.076
Tay Ninh	8	4,017	791	197	178.4	64.9	23.9	134.5	0.226	0.082	0.030	0.170
HCM City	8	2,089	3,934	1,883	93.8	31.8	35.4	47.9	0.024	0.008	0.009	0.012
Vung Tau-Con Dao	8	238	136	574	4.4	2.0	2.1	15.3	0.032	0.015	0.015	0.113
An Giang	9	3,423	1,793	524	244.6	16.2	28.8	52.7	0.136	0.009	0.016	0.029
Kien Giang	9	6,243	1,198	192	268.7	108.8	44.3	202.5	0.224	0.091	0.037	0.169
Minh Hai	9	7,671	1,562	204	441.5	108.1	37.5	180.0	0.283	0.069	0.024	0.115
Long An	9	4,338	1,121	258	194.7	15.7	32.7	190.7	0.174	0.014	0.029	0.170
Dong Thap	9	3,276	1,337	408	222.1	8.0	32.3	65.2	0.166	0.006	0.024	0.049
Tien Giang	9	2,339	1,484	634	168.5	15.0	12.8	37.6	0.114	0.010	0.009	0.025
Ben Tre	9	2,247	1,214	540	152.6	2.9	15.2	54.0	0.126	0.002	0.013	0.044
Cuu Long	9	3,857	1,812	470	274.4	1.6	29.9	79.8	0.151	0.001	0.017	0.044
Hau Giang	9	6,161	2,682	435	488.8	8.3	48.8	70.2	0.182	0.003	0.018	0.026
Spec. Enumeration			1,045						0.000	0.000	0.000	0.000
TOTAL VIETNAM		330,369	64,412	192	6,914.1	9,768.8	1,659.1	14,694.9	0.107	0.152	0.026	0.228

Source: Statistical data of the Socialist Republic of Vietnam, 1976-1989

File : Land-use-1003

Annex 11: Forest areas of Vietnam specified as to its use; Production forest; Protection forest; Special use and National Parks

Province	Forest Distr. no.	Total land area * '000 ha.	Forest land * 000 ha. Total forest area	With forest	Non forest	Production forest * '000 ha Total area * '000 ha	With forest	Non forest	Land area allocated as protected forests * '000 ha. Total area * '000 ha	Watershed area Total	Forest	Non-for.	Dune/Sea Forest	Non-for.	Special use area * '000 ha. Total area * '000 ha	With forest	Non forest	National parks and historical sites * '000 ha.
Lai Chau	1	1,714	1,442	132	1,310	411	50	361	792	791	69	723	0	0	183	12	171	182
Son La	1	1,421	1,000	138	862	582	53	528	366	366	76	290	0	0	53	9	44	83
Ha Son Binh	2	580	309	N.A.	N.A.	N.A.	N.A.	N.A.	148	168	96	72	0	0	N.A.	N.A.	N.A.	3
Hoang Lien Son	2	1,485	1,061	252	809	501	137	365	523	523	111	413	0	0	37	5	32	5
Ha Tuyen	2	1,363	1,004	477	527	655	230	426	343	343	248	95	0	0	7	0	6	2
Vinh Phu	2	457	179	108	71	120	51	69	45	45	43	2	0	0	14	14	0	5
Lang Son	3	819	634	148	486	372	92	281	198	198	49	149	0	0	64	7	57	3
Cao Bang	3	845	566	186	380	273	106	167	222	242	85	157	0	0	71	15	56	22
Bac Thai	3	650	404	195	209	316	120	196	75	75	68	6	0	0	13	7	6	19
Quang Ninh	3	594	398	198	199	377	188	189	18	16	8	8	1	1	3	2	1	7
Ha Bac	3	462	152	80	72	128	66	62	20	20	10	10	0	0	5	4	0	0
Hai Hung	4	255	12	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0	0	0	N.A.	N.A.	N.A.	0
Hanoi	4	214	22	N.A.	N.A.	N.A.	N.A.	N.A.	2	2	1	1	0	0	N.A.	N.A.	N.A.	9
Ha Nam Ninh	4	380	45	N.A.	N.A.	N.A.	N.A.	N.A.	20	10	5	5	5	5	N.A.	N.A.	N.A.	23
Haiphong	4	150	17	N.A.	N.A.	N.A.	N.A.	N.A.	1	0	0	0	0	1	N.A.	N.A.	N.A.	15
Thai Binh	4	153	5	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	0	0	0	5	N.A.	N.A.	N.A.	0
Thanh Hoa	5	1,117	649	332	317	393	227	166	221	209	69	140	7	5	46	23	23	13
Nghe Thin	5	2,250	1,472	825	647	804	542	263	657	616	244	372	9	12	31	31	0	30
Binh Trie Thien	5	1,756	1,100	558	542	740	321	419	311	309	200	109	8	21	48	29	20	40
Quang Nam Da Nang	6	1,199	887	469	418	592	273	319	256	244	177	68	4	8	43	15	28	7
Nghia Binh	6	1,191	74	N.A.	N.A.	N.A.	N.A.	N.A.	128	111	28	84	6	7	N.A.	N.A.	N.A.	0
Phu Khanh	6	980	680	293	386	542	245	297	92	85	32	54	3	4	45	14	31	19
Thuan Hai	6	1,142	774	452	323	558	343	215	216	201	87	114	5	5	20	17	3	23
Gia Lai-Kon Tum	7	2,560	1,953	1,490	451	1,411	1,089	323	455	455	346	109	0	0	86	67	19	61
Dac Lac	7	1,980	1,285	1,175	110	1,008	910	98	171	170	162	8	0	0	107	103	4	118
Lam Dong	7	1,017	701	630	71	451	411	40	170	170	141	29	0	0	87	78	9	20
Song Be	8	955	438	239	199	308	185	122	98	98	50	48	0	0	21	19	2	26
Dong Nai	8	759	287	N.A.	N.A.	N.A.	N.A.	N.A.	100	100	58	42	0	0	N.A.	N.A.	N.A.	40
Tay Ninh	8	402	145	N.A.	N.A.	N.A.	N.A.	N.A.	30	0	0	0	0	0	N.A.	N.A.	N.A.	10
HCM City	8	209	40	N.A.	N.A.	N.A.	N.A.	N.A.	3	0	0	0	1	2	N.A.	N.A.	N.A.	0
Vung Tau-Con Dao	8	24	11	N.A.	N.A.	N.A.	N.A.	N.A.	2	0	0	0	0	2	N.A.	N.A.	N.A.	6
An Giang	9	342	7	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0	0	0	N.A.	N.A.	N.A.	2
Kien Giang	9	624	9	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	0	0	2	3	N.A.	N.A.	N.A.	5
Minh Hai	9	767	192	119	74	177	108	69	7	0	0	0	3	4	8	6	2	7
Long An	9	434	16	N.A.	N.A.	N.A.	N.A.	N.A.	3	0	0	0	2	1	N.A.	N.A.	N.A.	0
Dong Thap	9	328	5	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0	0	0	N.A.	N.A.	N.A.	0
Tien Giang	9	234	3	N.A.	N.A.	N.A.	N.A.	N.A.	2	0	0	0	1	1	N.A.	N.A.	N.A.	0
Ben Tre	9	225	19	N.A.	N.A.	N.A.	N.A.	N.A.	4	0	0	0	2	2	N.A.	N.A.	N.A.	0
Cuu Long	9	386	18	N.A.	N.A.	N.A.	N.A.	N.A.	3	0	0	0	1	2	N.A.	N.A.	N.A.	0
Hau Giang	9	616	3	N.A.	N.A.	N.A.	N.A.	N.A.	2	0	0	0	1	1	N.A.	N.A.	N.A.	0
National parks etc.			936															135
TOTAL VIETNAM		33,037	18,954	8,496	8,464	10,721	5,746	4,975	5,713	5,567	2,461	3,106	61	92	992	476	516	936

Source:Ministry of Forestry, Statistical data, 1986-1988. Statistical Publishing House, Hanoi, 1989 File :For-area-2312

Annex 12 : Use of biomass (fuelwood and residues) as fuel for domestic purposes and processing of agricultural crops and in industry

Province	Forest Distr. no.	Popul. in '000	Biomass fu onsumption for domestic use: Fuelwood tons	Biomass fu onsumption for domestic use: Residues tons	Biomass consumption for industrial/agricultural processing in tons: Food processing Wood	Food processing Residues	Agro-processing Wood	Agro-processing Residues	Mineral based Wood	Other activ. Wood	Animal fe ed cooking Wood	Animal fe ed cooking Residues	TOTAL POTENTIAL DEMANI: WOOD IN TONS	TOTAL POTENTIAL DEMANI: RESIDUES IN TONS	TOTAL POTENTIAL DEMAND PER C: TONS PER YEAF WOOD	TONS PER YEAF RESIDUES	TONS PER YEAR RESIDUES	TONS PER YEAR TOTAL
Lai Chau	1	438	381,840	0	669	512	2,935	3,740	1,558	358	24,308	41,323	411,666	45,574	0.94	0.10	0.06	1.00
Son La	1	682	442,591	113,946	1,041	797	4,570	5,824	1,136	557	43,120	73,304	493,014	193,870	0.72	0.28	0.17	0.89
Ha Son Binh	2	1,840	958,272	468,574	2,809	2,150	12,329	15,712	16,443	1,503	69,563	118,256	1,060,918	604,692	0.58	0.33	0.20	0.77
Hoang Lien Son	2	1,032	669,727	172,422	1,575	1,206	6,915	8,812	5,599	843	58,188	98,919	742,846	281,359	0.72	0.27	0.16	0.88
Ha Tuyen	2	1,026	665,833	171,420	1,566	1,199	6,875	8,761	2,306	838	56,035	95,260	733,452	276,639	0.71	0.27	0.16	0.88
Vinh Phu	2	1,806	729,299	554,355	2,757	2,110	12,101	15,421	20,943	1,475	67,008	113,913	833,582	685,799	0.46	0.38	0.23	0.69
Lang Son	3	611	396,515	102,083	933	714	4,094	5,217	1,642	499	32,253	54,829	435,935	162,844	0.71	0.27	0.16	0.87
Cao Bang	3	566	493,427	0	864	661	3,792	4,833	1,999	462	40,618	69,050	541,162	74,544	0.96	0.13	0.08	1.04
Bac Thai	3	1,033	596,248	231,313	1,577	1,207	6,922	8,821	2,725	844	49,315	83,836	657,630	325,176	0.64	0.31	0.19	0.82
Quang Ninh	3	814	469,841	182,274	1,243	951	5,454	6,951	2,960	665	31,045	52,777	511,207	242,952	0.63	0.30	0.18	0.81
Ha Bac	3	2,061	832,273	632,628	3,146	2,408	13,810	17,599	10,107	1,683	94,588	160,799	955,607	813,433	0.46	0.39	0.23	0.70
Hai Hung	4	2,440	638,450	861,788	3,725	2,850	16,349	20,835	48,305	1,993	91,070	154,819	799,892	1,040,293	0.33	0.43	0.25	0.58
Hanoi	4	3,057	554,234	560,226	4,667	3,571	20,483	26,103	27,996	2,497	82,443	140,152	692,319	730,053	0.23	0.24	0.14	0.37
Ha Nam Ninh	4	3,157	826,061	1,115,027	4,819	3,688	21,153	26,957	38,275	2,578	115,273	195,963	1,008,159	1,341,636	0.32	0.42	0.25	0.57
Haiphong	4	1,448	262,522	265,360	2,210	1,692	9,702	12,364	11,334	1,183	39,830	67,711	326,782	347,127	0.23	0.24	0.14	0.37
Thai Binh	4	1,632	427,029	576,409	2,491	1,907	10,935	13,935	10,885	1,333	65,870	111,979	518,543	704,230	0.32	0.43	0.26	0.57
Thanh Hoa	5	2,991	1,557,713	761,688	4,566	3,494	20,041	25,540	21,154	2,443	110,705	188,199	1,716,622	978,921	0.57	0.33	0.19	0.77
Nghe Thin	5	3,582	2,067,530	802,096	5,468	4,185	24,001	30,586	15,902	2,925	149,030	253,351	2,264,857	1,090,218	0.63	0.30	0.18	0.81
Binh Trie Thien	5	1,995	575,278	776,518	3,046	2,331	13,367	17,035	7,554	1,629	90,003	153,004	690,876	948,888	0.35	0.48	0.28	0.63
Quang Nam Da Nang	6	1,739	285,474	1,071,186	2,655	2,032	11,652	14,849	82,346	1,420	83,160	141,372	466,707	1,229,438	0.27	0.71	0.42	0.69
Nghia Binh	6	2,288	375,598	1,409,358	3,493	2,673	15,331	19,537	98,768	1,869	94,133	160,025	589,190	1,591,593	0.26	0.70	0.41	0.67
Phu Khanh	6	1,463	240,166	901,176	2,233	1,709	9,803	12,492	81,442	1,195	39,935	67,890	374,774	983,267	0.26	0.67	0.40	0.65
Thuan Hai	6	1,170	192,067	720,694	1,786	1,367	7,839	9,991	56,244	956	16,975	28,858	275,867	760,909	0.24	0.65	0.38	0.62
Gia Lai Kon Tum	7	873	762,653	0	1,333	1,020	5,849	7,454	22,476	713	40,933	69,585	833,957	78,060	0.96	0.09	0.05	1.01
Dac lac	7	974	850,886	0	1,487	1,138	6,526	8,317	33,641	795	38,378	65,242	931,713	74,696	0.96	0.08	0.05	1.00
Lam Dong	7	639	558,230	0	975	746	4,282	5,456	24,283	522	16,363	27,816	604,654	34,019	0.95	0.05	0.03	0.98
Song Be	8	939	154,146	578,403	1,433	1,097	6,292	8,018	42,305	767	15,645	26,597	220,588	614,115	0.23	0.65	0.39	0.62
Dong Nai	8	2,007	329,469	1,236,268	3,064	2,345	13,448	17,138	139,070	1,639	32,795	55,752	519,485	1,311,502	0.26	0.65	0.39	0.65
Tay Ninh	8	791	129,851	487,239	1,208	924	5,300	6,754	33,406	646	12,180	20,706	182,590	515,623	0.23	0.65	0.39	0.62
HCM City	8	3,934	755,328	642,029	6,006	4,596	26,359	33,592	54,850	3,213	31,395	53,372	877,151	733,588	0.22	0.19	0.11	0.34
Vung Tau-Con Dao	8	136	7,344	107,994	208	159	911	1,161	700	111	1,050	1,785	10,324	111,099	0.08	0.82	0.48	0.56
An Giang	9	1,793	96,822	1,423,768	2,737	2,095	12,014	15,310	34,025	1,464	17,045	28,977	164,107	1,470,149	0.09	0.82	0.48	0.58
Kien Giang	9	1,198	64,692	951,296	1,829	1,400	8,027	10,230	10,343	978	28,683	48,760	114,551	1,011,685	0.10	0.84	0.50	0.59
Minh Hai	9	1,562	84,348	1,240,337	2,385	1,825	10,466	13,338	11,575	1,276	45,360	77,112	155,409	1,332,612	0.10	0.85	0.50	0.60
Long An	9	1,121	60,534	890,152	1,711	1,310	7,511	9,572	14,391	915	24,063	40,906	109,125	941,940	0.10	0.84	0.50	0.59
Dong Thap	9	1,337	72,198	1,061,672	2,041	1,562	8,958	11,416	30,156	1,092	21,858	37,158	136,303	1,111,808	0.10	0.83	0.49	0.59
Tien Giang	9	1,484	80,136	1,178,400	2,265	1,734	9,943	12,672	5,644	1,212	34,913	59,351	134,113	1,252,156	0.09	0.84	0.50	0.59
Ben Tre	9	1,214	65,556	964,001	1,853	1,418	8,134	10,366	22,517	991	26,233	44,595	125,284	1,020,381	0.10	0.84	0.50	0.60
Cuu Long	9	1,812	97,848	1,438,855	2,766	2,117	12,141	15,472	71,379	1,480	45,675	77,648	231,289	1,534,092	0.13	0.85	0.50	0.63
Hau Giang	9	2,682	144,828	2,129,696	4,094	3,133	17,970	22,901	31,246	2,190	60,428	102,727	260,757	2,258,457	0.10	0.84	0.50	0.59
		64,412	18,952,858	26,780,652	96,735	74,027	424,584	541,084	1,149,627	51,750	2,037,455	3,463,674	22,713,009	30,859,436	0.35	0.48	0.28	0.64

Note : The two last columns show the demand in tons per capita per year expressed in "Wood Equivalent. Use was made of conversion factors as shown in Annex 15.

Source : Statistics, annex 2, File : Biom-con-911031

Annex 13: Amount of biomass energy sources annually available on a sustainable basis

Province	Forest Distr. no.	Pop. size '000	Sustainable fuelwood supplies: Prod. forest '000 ha.	Prod. forest '000 t/y	Plantations '000 ha.	Plantations '000 t/y	Bare lands '000 ha.	Bare lands '000 t/y	TOTAL '000 t/y	Sustainable wood supplies from "Residues": Scat. trees '000 ha.	Scat. trees '000 t/y	For.ind '000 t/y	Other '000 t/y	Perrer '000 t/y	TOTAL '000 t/y	Residues: Agro. '000 t/y	Perren. '000 t/y	TOTAL '000 t/y	FUELWOOD TOTAL SUSTAINABLE SUPPLIES '000 t/y	RESIDUES TOTAL POTENTIAL SUPPLIES '000 t/y
Lai Chau	1	438	49	23	5	18	1,310	655	696	2	4	11	4	0	19	257	0	257	715	257
Son La	1	682	45	21	8	28	862	431	480	8	16	17	6	1	41	241	0	241	521	241
Ha Son Binh	2	1,840	31	15	9	32	N.A.	0	46	34	68	46	17	1	132	872	0	872	178	872
Hoang Lien Son	2	1,032	101	47	29	102	809	405	553	94	188	26	10	2	226	397	0	397	779	397
Ha Tuyen	2	1,026	179	84	37	130	527	264	477	36	72	26	10	2	109	451	0	451	587	451
Vinh Phu	2	1,806	33	15	14	49	71	36	100	54	108	45	17	2	172	704	0	704	272	704
Lang Son	3	611	63	30	31	109	486	243	381	42	84	15	6	0	105	184	0	184	486	184
Cao Bang	3	566	100	47	7	25	380	190	261	16	32	14	5	0	51	294	0	294	313	294
Bac Thai	3	1,033	109	51	9	32	209	105	187	58	116	26	10	2	153	381	0	381	340	381
Quang Ninh	3	814	154	72	42	147	199	100	319	36	72	20	8	0	100	214	0	214	419	214
Ha Bac	3	2,061	2	1	16	56	72	36	93	102	204	51	20	0	275	1,052	0	1,052	368	1,052
Hai Hung	4	2,440	3	1	3	11	N.A.	0	12	60	120	61	23	0	204	1,575	0	1,575	216	1,575
Hanoi	4	3,057	0	0	8	28	N.A.	0	28	54	108	76	29	0	213	887	0	887	241	887
Ha Nam Ninh	4	3,157	0	0	2	7	N.A.	0	7	90	180	78	30	0	289	1,691	0	1,691	296	1,691
Haiphong	4	1,448	0	0	1	4	N.A.	0	4	46	92	36	14	0	142	516	0	516	145	516
Thai Binh	4	1,632	0	0	1	4	N.A.	0	4	54	108	41	15	0	164	1,232	0	1,232	168	1,232
Thanh Hoa	5	2,991	178	84	55	193	317	159	435	184	368	74	28	9	480	1,211	2	1,212	915	1,212
Nghe Thin	5	3,582	481	227	42	147	647	324	697	292	584	89	34	10	716	1,333	1	1,334	1,414	1,334
Binh Trie Thien	5	1,995	293	138	64	224	542	271	633	226	452	50	19	5	526	603	0	604	1,159	604
Quang Nam Da Nang	6	1,739	264	124	25	88	418	209	421	296	592	43	16	2	654	722	0	723	1,075	723
Nghia Binh	6	2,288	161	76	46	161	N.A.	0	237	386	772	57	22	32	883	1,289	7	1,296	1,120	1,296
Phu Khanh	6	1,463	237	112	7	25	386	193	329	66	132	36	14	17	200	766	5	771	529	771
Thuan Hai	6	1,170	332	157	2	7	323	162	325	10	20	29	11	5	65	474	1	475	390	475
Gia Lai Kon Tum	7	873	980	462	11	39	451	226	726	24	48	22	8	10	88	319	2	321	815	321
Dac Lac	7	974	877	414	20	70	110	55	539	36	72	24	9	16	122	424	10	434	660	434
Lam Dong	7	639	362	171	9	32	71	36	238	78	156	16	6	3	181	258	5	263	419	263
Song Be	8	939	184	87	2	7	199	100	193	28	56	23	9	127	216	261	1	262	409	262
Dong Nai	8	2,007	114	54	52	182	N.A.	0	236	24	48	50	19	147	264	826	10	836	500	836
Tay Ninh	8	791	22	10	2	7	N.A.	0	17	64	128	20	7	28	183	549	1	550	200	550
HCM City	8	3,934	0	0	19	67	N.A.	0	67	72	144	98	37	15	294	514	6	519	361	519
Vung Tau-Con Dao	8	136	0	0	1	4	N.A.	0	4	4	8	3	1	0	13	4	2	6	16	6
An Giang	9	1,793	1	1	9	32	N.A.	0	32	106	212	45	17	6	280	1,795	3	1,798	312	1,798
Kien Giang	9	1,198	25	12	3	11	N.A.	0	22	288	576	30	11	24	641	1,309	8	1,317	663	1,317
Minh Hai	9	1,562	108	51	0	0	74	37	88	230	460	39	15	82	595	1,297	20	1,316	683	1,316
Long An	9	1,121	0	0	5	18	N.A.	0	18	242	484	28	11	6	528	1,490	3	1,494	546	1,494
Dong Thap	9	1,337	0	0	12	42	N.A.	0	42	64	128	33	13	6	180	1,605	3	1,607	222	1,607
Tien Giang	9	1,484	0	0	9	32	N.A.	0	32	120	240	37	14	17	308	1,505	7	1,512	339	1,512
Ben Tre	9	1,214	0	0	6	21	N.A.	0	21	112	224	30	11	98	363	832	31	863	384	863
Cuu Long	9	1,812	0	0	4	14	N.A.	0	14	116	232	45	17	46	340	1,834	19	1,853	354	1,853
Hau Giang	9	2,682	0	0	4	14	N.A.	0	14	194	388	67	25	56	536	2,666	17	2,683	550	2,683
		63,367	5,487	2,588	631	2,209	8,463	4,232	9,028	4,048	8,096	1,575	600	781	11,052	34,835	162	34,997	20,080	34,997

Source : Armitage, 1990; MoF-SPH, 1990; MoF-SPH, 1989 and annexes 8, 9, 10, 11

File : Biom-all-911103

Annex 14 : Demand and supply balance for fuelwood and residues as fuel as well as for other purposes (in tons)

Province	Forest Distr. no.	Popul. in '000	POTENTIAL ENERGY DEMAND IN TONS PER YEAR (See annex 12) WOOD	POTENTIAL ENERGY DEMAND RESIDUES	CONVERSION OF RESIDUES: RESIDUES AS WOOD	CONVERSION OF RESIDUES: RESIDUES AS RESIDUES	TOTAL POTENTIAL DEMAND FOR BIOMASS ENERGY TONS PER YEAR WOOD	TOTAL POTENTIAL DEMAND RESIDUES	POTENTIAL ENERGY SUPPLIES IN TONS PER YEAR (See annex 13) WOOD	POTENTIAL ENERGY SUPPLIES RESIDUES	DEMAND FOR RESIDUES FOR OTHER PURPOSES TONS PER YEAR FEED/LITTER	DEMAND FOR RESIDUES MANURE	DEMAND/SUPPLY BALANCE +/- WOOD IN TONS	DEMAND/SUPPLY BALANCE +/- RESIDUES IN TONS	DEMAND/SUPPLY BALANCE + TONS PER CAPITA PER YEAR WOOD TONS	RESIDUES TONS	TOTAL TONS W.E.
Lai Chau	1	438	411,666	45,574	15,094	19,914	426,761	19,914	714,874	256,734	177,000	46,200	288,114	13,620	0.66	0.03	0.68
Son La	1	682	493,014	193,870	64,210	84,713	557,224	84,713	520,873	241,047	265,000	48,700	(36,351)	(157,366)	(0.05)	(0.23)	(0.19)
Ha Son Binh	2	1,840	1,060,918	604,692	200,275	264,224	1,261,193	264,224	177,976	872,466	265,000	156,900	(1,083,217)	186,342	(0.59)	0.10	(0.53)
Hoang Lien Son	2	1,032	742,846	281,359	93,187	122,942	836,033	122,942	779,246	397,402	308,000	71,000	(56,787)	(104,540)	(0.06)	(0.10)	(0.11)
Ha Tuyen	2	1,026	733,452	276,639	91,623	120,879	825,076	120,879	586,638	450,835	390,000	69,700	(238,438)	(129,744)	(0.23)	(0.13)	(0.31)
Vinh Phu	2	1,806	833,582	685,799	227,138	299,664	1,060,720	299,664	272,065	704,119	335,000	128,600	(788,655)	(59,146)	(0.44)	(0.03)	(0.46)
Lang Son	3	611	435,935	162,844	53,934	71,156	489,869	71,156	486,311	184,152	346,000	43,100	(3,558)	(276,103)	(0.01)	(0.45)	(0.27)
Cao Bang	3	566	541,162	74,544	24,689	32,572	565,852	32,572	312,956	293,658	316,000	35,500	(252,895)	(90,415)	(0.45)	(0.16)	(0.54)
Bac Thai	3	1,033	657,630	325,176	107,699	142,088	765,329	142,088	340,465	381,460	298,000	77,100	(424,864)	(135,728)	(0.41)	(0.13)	(0.49)
Quang Ninh	3	814	511,207	242,952	80,466	106,160	591,673	106,160	418,918	213,590	99,000	42,700	(172,756)	(34,270)	(0.21)	(0.04)	(0.24)
Ha Bac	3	2,061	955,607	813,433	269,411	355,435	1,225,018	355,435	367,911	1,051,745	335,000	182,800	(857,106)	178,510	(0.42)	0.09	(0.36)
Hai Hung	4	2,440	799,892	1,040,293	344,547	454,563	1,144,439	454,563	216,043	1,575,356	158,000	234,700	(928,396)	728,093	(0.38)	0.30	(0.21)
Hanoi	4	3,057	692,319	730,053	241,795	319,001	934,114	319,001	241,145	886,887	202,000	121,500	(692,969)	244,386	(0.23)	0.08	(0.18)
Ha Nam Ninh	4	3,157	1,008,159	1,341,636	444,353	586,236	1,452,512	586,236	295,841	1,690,990	192,000	287,100	(1,156,671)	625,654	(0.37)	0.20	(0.25)
Haiphong	4	1,448	326,782	347,127	114,969	151,680	441,751	151,680	145,474	516,221	59,000	90,200	(296,277)	215,342	(0.20)	0.15	(0.12)
Thai Binh	4	1,632	518,543	704,230	233,243	307,718	751,785	307,718	167,596	1,232,487	95,000	159,800	(584,189)	669,969	(0.36)	0.41	(0.12)
Thanh Hoa	5	2,991	1,716,622	978,921	324,220	427,746	2,040,842	427,746	914,869	1,212,495	536,000	239,900	(1,125,973)	8,849	(0.38)	0.00	(0.37)
Nghe Thin	5	3,582	2,264,857	1,090,218	361,082	476,378	2,625,939	476,378	1,413,777	1,334,300	938,000	290,700	(1,212,163)	(370,777)	(0.34)	(0.10)	(0.40)
Binh Trie Thien	5	1,995	690,876	948,888	314,274	414,623	1,005,150	414,623	1,159,095	603,524	353,000	138,600	153,945	(302,698)	0.08	(0.15)	(0.01)
Quang Nam Da Nang	6	1,739	466,707	1,229,438	407,193	537,211	873,900	537,211	1,075,078	722,862	314,000	117,200	201,178	(245,549)	0.12	(0.14)	0.03
Nghia Binh	6	2,288	589,190	1,591,593	527,139	695,457	1,116,329	695,457	1,119,919	1,296,034	641,000	201,300	3,590	(241,723)	0.00	(0.11)	(0.06)
Phu Khanh	6	1,463	374,774	983,267	325,660	429,645	700,434	429,645	528,979	770,593	309,000	91,600	(171,455)	(59,652)	(0.12)	(0.04)	(0.14)
Thuan Hai	6	1,170	275,867	760,909	252,015	332,484	527,882	332,484	390,011	475,449	230,000	76,500	(137,871)	(163,535)	(0.12)	(0.14)	(0.20)
Gia Lai Kon Tum	7	873	833,957	78,060	25,853	34,109	859,810	34,109	814,503	321,143	295,000	68,800	(45,307)	(76,765)	(0.05)	(0.09)	(0.10)
Dac lac	7	974	931,713	74,696	24,740	32,639	956,453	32,639	660,173	433,931	176,000	58,000	(296,280)	167,292	(0.30)	0.17	(0.20)
Lam Dong	7	639	604,654	34,019	11,267	14,865	615,922	14,865	419,062	262,506	92,000	32,500	(196,860)	123,141	(0.31)	0.19	(0.19)
Song Be	8	939	220,588	614,115	203,396	268,341	423,984	268,341	408,871	261,734	147,000	54,000	(15,113)	(207,607)	(0.02)	(0.22)	(0.15)
Dong Nai	8	2,007	519,485	1,311,502	434,372	573,069	953,857	573,069	500,050	835,545	126,000	77,300	(453,807)	59,176	(0.23)	0.03	(0.21)
Tay Ninh	8	791	182,590	515,623	170,775	225,305	353,365	225,305	200,203	549,591	187,000	95,600	(153,162)	41,686	(0.19)	0.05	(0.16)
HCM City	8	3,934	877,151	733,588	242,966	320,546	1,120,117	320,546	360,706	519,185	119,000	74,100	(759,410)	5,539	(0.19)	0.00	(0.19)
Vung Tau-Con Dao	8	136	10,324	111,099	36,796	48,545	47,120	48,545	16,483	6,222	3,000	900	(30,637)	(46,224)	(0.23)	(0.34)	(0.43)
An Giang	9	1,793	164,107	1,470,149	486,916	642,391	651,024	642,391	311,974	1,797,968	118,000	262,900	(339,050)	774,677	(0.19)	0.43	0.06
Kien Giang	9	1,198	114,551	1,011,685	335,072	442,062	449,624	442,062	663,416	1,317,175	82,000	245,100	213,792	548,012	0.18	0.46	0.45
Minh Hai	9	1,562	155,409	1,332,612	441,364	582,293	596,773	582,293	683,299	1,316,429	101,000	246,300	86,526	386,836	0.06	0.25	0.20
Long An	9	1,121	109,125	941,940	311,973	411,587	421,098	411,587	545,729	1,493,552	179,000	256,600	124,631	646,365	0.11	0.58	0.45
Dong Thap	9	1,337	136,303	1,111,808	368,233	485,812	504,536	485,812	221,803	1,607,103	68,000	218,900	(282,734)	834,391	(0.21)	0.62	0.16
Tien Giang	9	1,484	134,113	1,252,156	414,717	547,138	548,830	547,138	339,384	1,511,985	79,000	224,000	(209,447)	661,847	(0.14)	0.45	0.12
Ben Tre	9	1,214	125,284	1,020,381	337,952	445,862	463,237	445,862	384,273	862,767	98,000	113,900	(78,964)	205,005	(0.07)	0.17	0.03
Cuu Long	9	1,812	231,289	1,534,092	508,094	670,331	739,383	670,331	354,004	1,853,231	198,000	283,600	(385,379)	701,299	(0.21)	0.39	0.01
Hau Giang	9	2,682	260,757	2,258,457	748,006	986,848	1,008,763	986,848	550,057	2,682,995	112,000	462,500	(458,705)	1,121,648	(0.17)	0.42	0.07
		64,412	22,713,009	30,859,436	10,220,708	13,484,232	32,933,717	13,484,232	20,080,049	34,997,469	9,341,000	5,726,400	(12,853,668)	6,445,837	(0.20)	0.10	(0.14)

Source : Annexes 12, 13

File : BIOM-BAL-911105

Annex 15

CONVERSION TABLES

Wood conversion factors:

1 cubic meter wood (solid) equals 1.33 - 1.55 stere or stacked cubic meter
1 stere equals 0.65 - 0.75 cubic meter (solid)
1 stere weighs approximately 500 kg. (depending upon specie)
1 ton wood equals about 2 stere or 1.4 cubic meter wood (solid)

Calorific values of different fuels:

1 kg. wood = 15.0 MJ	1 kg. charcoal = 29.0 MJ
1 kg. residues = 12.5 MJ	1 kg. kerosene = 42.7 MJ
1 kg. coal = 21.0 MJ	1 kWh electricity = 3.6 MJ

Average end-use efficiencies taken into account for domestic stoves:

Fuelwood burning stoves	17%	Coal stoves (briquettes)	22%
Residue burning stoves	12%	Electric stoves	60%
Charcoal stoves	22%	Kerosene stoves	43%

Conversion factors of different fuels to tons wood equivalent (TWE) *

1 ton residues = 0.59 TWE	1 TWE = 1.70 ton residues
1 ton coal = 1.81 TWE	1 TWE = 0.55 ton coal
1 ton charcoal = 2.50 TWE	1 TWE = 0.40 ton charcoal
1 MWh electricity = 0.85 TWE	1 TWE = 1.18 MHh electricity

* Taking into account end-use efficiency for domestic stoves.

Conversion factors of fuels for industrial purposes

1 ton wood	= 0.71 ton coal	= 0.35 ton oil
1 ton coal	= 1.40 ton wood	= 0.49 ton oil
1 ton oil	= 2.03 ton coal	= 2.85 ton wood

Annex 16

VIETNAM FORESTRY SECTOR REVIEW MISSION
TROPICAL FORESTRY ACTION PLAN

VIE/88/037
and
GCP/RAS/131/NET - Regional Wood Energy Development Program

Terms of Reference
Consultants on Fuelwood and Energy Sectoral Review

Under the overall supervision of the Director, Forestry Operations, FODO, and the TFAP Coordinator, Forestry Department, FAO, and the direct guidance of the Team Leader of VIE/088/037 and Chief Technical Adviser of GCP/RAS/131/NET, and in close cooperation with national counterparts in Vietnam, the consultants will review, evaluate and suggest measures for the improvement of the wood energy situation in Vietnam. More specifically the consultants will:

1. Review the country energy situation to show the importance of forest resources as a supplier of fuel for different sectors of the national economy and so to establish a priority to be given to the wood-based energy aspects in the context of the national TFAP exercise.

2. Identify, formulate and evaluate a number of project proposals, estimate the resources required and suggest the institutional arrangements for its implementation, taking into consideration the overall objectives of the national TFAP exercise.

3. Prepare a mission report which should:

   a) describe the importance and priority which should be assigned to the fuelwood and energy aspects to tackle the main problems and constraints, providing all the information and data required for the justification of such priority;

   b) provide a concise diagnosis of the energy sector of the country with particular reference to the contribution of forest biomass in meeting the energy needs of different economic sectors;

   c) assess the wood energy conversion technologies in use in residential (households), industrial, public and commercial sectors in order to identify solutions for a more efficient generation and utilisation of energy;

   d) examine the present practices of fuelwood and charcoal distribution, marketing and prices and identify improved options to be introduced, bearing in mind the prices and availability of alternative sources of energy which could be used as substitutes;

e) assess the different sources of woodfuel supply in such a way to give a clear idea of the flow of wood fuel used by different customers or sectors. Review the availability of forest resources to ensure a sustainable supply of wood fuels and where there is a definite deficit, suggest lines of intervention to solve the problem;

f) analyse financial, economic and social aspects involved in the implementation of past and present woodfuel programs to identify possible solutions;

g) evaluate the environmental damage provoked by the use of woodfuels and analyse the impact of adopting improved practices of management of the wood energy systems; better management of existing forest resources for wood fuels, creation of tree plantations for energy purposes, introduction of improved wood energy conversion devices, fair wood fuel prices etc;

h) review the institutional aspects which have restricted the proper development of wood-based energy programs and suggest the necessary new institutional arrangements to develop the fuelwood and energy proposed for the TFAP exercise;

i) conclusions and recommendations and

j) on the basis of the conclusions and recommendations, the consultant should identify, formulate and evaluate specific wood-based energy projects which should be implemented by the forestry development program proposed by the TFAP exercise.

Note: The above tasks are to be carried out by two consultants - to be provided for the Forestry Sector Review in Vietnam by A) GCP/RAS/131/NET and, B) Australian International Development Assistance Bureau (AIDAB).

As regards item 3 of the Terms of Reference (mission report), the distribution of their responsibilities is as follows:

Consultant A: to cover paras. a, b, c, f, h, i and j
Consultant B: to cover paras. d, e, g, h, i and j

Duty station : Hanoi with in-country travel
Duration : Two months each consultant
EOD : Soonest in 1990
Language : English

Annex 17 (a)

PROJECT PROFILES

Project profile No. 1

Project title : Wood Energy Conversion and Utilization

Donor input : US 1,750,000

Duration : 4 years

Background and Justification

Vietnam with a population of about 64 million is still an agrarian society with an estimated 70% of the people engaged in farming. The amount of agricultural land per capita at 0.107 ha. is very low, resulting in a serious pressure on productive forest areas which stand at 0.152 ha./capita. The demand for fuelwood in the country is estimated to be about 33-34 million tons which is expected to increase to about 40 million tons by the year 2000, basically due to population growth and other factors. During 1981-1985 it was reported that the rate of deforestation was 260,000 ha/year, forecasted to go up to 320,000 ha/year during 1986-1990 (GCP/RAS/106/JPN, March 1987). With this background, the implementation of energy and fuelwood conservation measures is considered essential so as to curb domestic as well as industrial demand, in particular in rural areas.

Objectives

- To promote the efficient use of wood energy and forestry development activities for rural and industrial development;
- To strengthen the role of wood energy in a sustained national energy and economic development plan;
- To promote the development of manpower and expertise for programme planning, management and field implementation of wood energy conversion devices and energy conservation programmes;
- To promote the setting up and improvement of wood energy information systems (resources, use, etc.), required for development planning and intervention;
- To initiate R&D activities on wood energy conversion, utilization and conservation technologies;

- To demonstrate and assess selected and potentially high impact technologies for rural applications for domestic, agricultural and industrial purposes;

- To disseminate improved wood energy conversion systems and technologies through training, extension and technical assistance.

Proposed activities

- Wood energy planning activities which will require reliable information (both available and to be collected), methodologies and techniques for data collection, processing and interpretation and setting up of an institutional framework to cope with the intersectoral nature of wood energy planning and its dynamism;

- Establishment of a computer based wood energy information and processing system (equipped with well trained staff and necessary facilities). The integrated wood energy data-base should cover national, regional and district levels of wood fuel resources and production, trade, consumption and information on end-users;

- Institutional strengthening of key institutes involved in wood energy development (manpower strengthening, facilities, etc.);

- Manpower development and training at lead regional and international training institutes on direct or indirect related wood energy development and technologies. This could include Khon Kaen University in Thailand for RRA tools and techniques, AIT in Thailand for wood/biomass energy technologies, IIT Delhi and Punjab University in India for improved wood and biomass cooking stoves, Institut Teknologi Bandung in Indonesia for biomass gasification systems, Twente University in the Netherlands for Rural Energy Matters, etc.

- Support to research and pilot projects on wood energy and related systems in the following areas: Fuelwood/wood energy flow studies, wood/biomass energy conservation in the domestic sector for cooking, heating (in cold districts) and pigfeed preparation, wood energy conservation in rural industries with emphasis on mineral based industries, food processing, agro processing, etc., charcoal production development and systems for specific types of fuelwood resources like from land clearings, etc., R&D on biomass densification, briquetting (sawdust, charcoal fines, coaldust), gasification for power and heat production, studies on economic, socio-economic and cultural issues and their impacts on the adoption of alternative energy sources and equipment;

- Special studies related to national level policy issues and strategies in wood energy development (parallel with other energy sources).

Estimated inputs

Fellowships (60 m/m), In service training, workshops, etc.		225,000
Equipment, vehicles, miscellaneous, etc.		400,000
International personnel (CTA and 6 project specialists in data collection and processing, rural energy planning, cookstove development, energy conservation in rural industries and commercial applications, charcoal production and small scale power generation from wood - 120 m/m)		630,000
Field pilots and demonstration activities		150,000
Extension and dissemination		150,000
Other (local travel, administrative support, contingencies, etc.)		195,000

TOTAL	US$	1,750,000
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Counterpart organizations: Ministry of Forestry
Ministry of Energy
State Science Commission

Proposed starting date : As soon as possible

Annex 17 (b)

Project profile No. 2

Project title : Large Scale Bare Forest Land Reforestation Through Land Allocation Programs.

Donor input : US 1,000,000

Objective:

To develop a rational technical and socio-economically viable basis for planning participatory forestry through the land allocation and settlement program on bare forest lands involving (1) large scale tree planting for industrial wood as well as fuelwood (2) reforestation of bare forest lands through natural regeneration and forest management.

Tasks:

1. A vegetation mapping and a forest inventory of bare forest lands on scales of 1:100,000 and 1:250,000 as part of the proposed national forest inventory.

2. A land capability survey of the above bare forest lands on the above scales to provide guidelines for establishment of plantations and to assist in natural regeneration. The survey will study the performance of existing plantations and correlate this with land capability. An assessment should also be made during the national forest inventory of the performance of plantings under the "scattered trees' program 1961-1990.

3. A baseline socio-economic study of existing farmer participants in the land allocation program including forest plantations in order to determine the success of past forestry - people participation programs.

Estimated inputs:

Forest Soils/Land Capability Specialist	12 mm
Forestry Plantations/Land Use Specialist	12 mm
Tropical Agronomist	12 mm
Sociologist	6 mm
Rural/Forest Economist	6 mm

TOTAL	48 mm

Estimated Cost:

Fees, expenses and equipment	US$	1,000,000

Executing Agency: Ministry of Forestry through FIPI