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Energy Sector Management Assistance Programme

January 1994

Vietnam

Rural and Household Energy Issues and Options

Report No. 161/94

JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) was launched in 1983 to complement the Energy Assessment Programme, established three years earlier. ESMAP's original purpose was to implement key recommendations of the Energy Assessment reports and ensure that proposed investments in the energy sector represented the most efficient use of scarce domestic and external resources. In 1990, an international Commission addressed ESMAP's role for the 1990s and, noting the vital role of adequate and affordable energy in economic growth, concluded that the Programme should intensify its efforts to assist developing countries to manage their energy sectors more effectively. The Commission also recommended that ESMAP concentrate on making long-term efforts in a smaller number of countries. The Commission's report was endorsed at ESMAP's November 1990 Annual Meeting and prompted an extensive reorganization and reorientation of the Programme. Today, ESMAP is conducting Energy Assessments, performing preinvestment and prefeasibility work, and providing institutional and policy advice in selected developing countries. Through these efforts, ESMAP aims to assist governments, donors, and potential investors in identifying, funding, and implementing economically and environmentally sound energy strategies.

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FUNDING

ESMAP is a cooperative effort supported by the World Bank, UNDP and other United Nations agencies, the European Community, Organization of American States (OAS), Latin American Energy Organization (OLADE), and countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

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Abbreviations and Acronyms

ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
EHV	Extra High Voltage
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization (UN)
GDP	Gross Domestic Product
HCMC	Ho Chi Minh City
LPG	Liquefied Petroleum Gas
LSS	Living Standards Survey
LV	Low Voltage
LRMC	Long Run Marginal Cost
MV	Medium Voltage
MVAR	Megavolt amperea reactive
NRECA	National Rural Electric Cooperative Association
ODA	Overseas Development Aid
PC1	Power Company 1
PC2	Power Company 2
PC3	Power Company 3
RE	Rural Eelectrification
RWEDP	Regional Wood Energy Development Program
SIDA	Swedish International Development Agency
TFAP	Tropical Forestry Action Program
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
USAID	United States Agency for International Development
VBA	Vietnam Bank of Agriculture
WFP	World Food Program

Currency Equivalents

The Vietnamese currency is the Dong. The exchange rate used in this report is US$1 = 10,000 Dong.

Weights and Measures

Gj	Gigajoule (10^9 joules)
GWh	Gigawatt-hour (1,000,000 kilowatt-hours)
ha	hectare
kgoe	kilogram of oil equivalent
kTOE	thousand tons of oil equivalent
kV	Kilovolt (1,000 volts (V))
kVA	Kilovolt-ampere (1,000 volt-amperes (VA))
kW	kilowatt
kWh	kilowatt-hour (1,000 watt-hours)
l	liter
m	meter (39.37 inches (in))
MW	Megawatt (1,000 kilowatts (kW) = 1 million Watts)
MWh	Megawatt-hour (1,000 kilowatt-hours)
m^3	Cubic meter (1.31 cubic years = 35.35 cubic feet)
MJ	Megajoule (10^6 joules)
mtoe	million tons of oil equivalent
MW	Megawatt
t	Ton (1,000 kilograms (kg) = 2,200 lbs)
TPA	tons per annum
W	Watt

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FOREWORD

This report is one of the outputs of a technical assistance project in Vietnam executed by the joint World Bank/UNDP Energy Sector Management Programme (ESMAP) and financed by the Swedish International Development Authority (SIDA). Aside from examining in greater depth rural and household energy issues to complement the World Bank's Energy Sector Investment and Policy Review, the project also conducted two training activities for local energy and power sector planners, one on the use of the WASP model and the other on oil and gas reserve evaluation and management. A survey of household energy consumption in some parts of the Red River Delta as well as a survey of energy prices in Hanoi, Danang and Ho Chi Minh City were executed jointly with staff of the Energy Institute in mid-1992, enabling hands-on training in energy survey design and methods. Finally, the project supported the travel to Washington of three senior Government staff to participate in the review of the sector report draft.

The study benefited immensely from the support of the Energy Institute, who provided valuable background materials and general assistance during the course of the study. Aside from Dr. Tran Quoc Cuong, Director, Energy Institute staff who provided technical contributions included First Deputy Director Dang Ngoc Tung, Dr. Phan Van Thanh, Mr. Nguyen Duy Thong and Mr. Vu Van Thai.

The World Bank/ESMAP team consisted of Ernesto Terrado (task manager), Noureddine Berrah, Winston Hay and Fredric Jouve (rural electrification); Paul Ryan, Keith Openshaw, Kevin Fitzgerald (household energy and traditional fuels), Voravate Tuntivate (survey methodology), Michel Del Buono and Jakob Grosen (macroeconomic issues). Tam Quan Le also contributed to the rural electrification analysis. The final report was written by Ernesto Terrado, Kevin Fitzgerald, Keith Openshaw and Winston Hay.

EXECUTIVE SUMMARY

1. Vietnam's transformation to a market-oriented economy has slowly improved macroeconomic conditions and achieved a certain degree of economic stability in the country. To sustain economic growth, the recently completed World Bank review of Vietnam's energy sector has identified key policy reforms and investments that need to be made in the oil and gas, coal and electricity subsectors. Issues related to household energy consumption and traditional fuels were found to be much harder to analyze because of the lack of reliable data, the dynamic nature of household energy demand and the fact that the issues straddle not only energy but agriculture, forestry and environment, as well. Nevertheless, there is no question that they deserve equal attention because of the striking dominance of household demand and biomass fuel supplies in the overall energy balance, a consequence of the still highly rural nature of the economy.

2. The principal objective of the present study is to examine in greater detail issues related to traditional fuels, rural electrification and energy consumption patterns in households and rural industries and, as appropriate, to provide the Government with specific recommendations on policies, programs and other interventions that could effectively address them.

HOUSEHOLD ENERGY DEMAND PATTERNS

3. Due to its geography and history, Vietnam comprises diverse living environments which differ substantially with respect to agro-ecological conditions, resource endowments and socio-economic structures. Consequently, rural and residential energy usage patterns differ substantially across agro-ecological zones. Table 1 below, prepared from preliminary returns of the 1993 Living Standards Survey, permits useful analysis of the distinct patterns of energy consumption between urban and rural areas of the various agro-ecological regions :

Table 1. Vietnam 1992 Primary Cooking Fuel(1), Electrification Rates, and Energy Expenditures (%)

	Rural					*Urban*					
Agro-ecological Region	*North*	*Red River Delta*	*Hanoi*	*Central*	*Me kong Delta*	*North (2)*	*Red River Delta*	*Hanoi*	*Central*	*Me kong Delta*	*Ho Chi Minh*
Primary Cooking Fuel											
Leaves, Straw, etc.	49.1	98.5	70.0	60.2	7.8	17.7	3.3		17.7		
Wood	49.7	1.0	8.7	39.8	90.7	51.0	38.3	12.5	51.0	98.4	30.2
Charcoal					1.0	2.1			13.5		40.6
Coal (3)	1.2	0.5	20.7			25.0	55.0	53.1	13.6		
Kerosene					0.5	4.2	3.3	15.6	4.2		28.1
Electricity			0.7					18.8		1.6	1.0
Electric Connection	36.4	72.2	95.3	21.4	16.6	89.6	100.0	100	89.6	67.7	100
Energy Expenditures (% of Total Budget)	2.2	3.5	5.6	3.1	2.7	10.0	11.2	6.9	10.0	4.4	11.0

Source: Preliminary returns from 1993 Living Standards Survey.

(1) This only provides an indication of *Primary Cooking Fuel* at the time of the survey. It does not give information on the importance of other fuels. For example, in rural areas except the Mekong Delta, leaves and straw are given as the primary fuels but leaves and straw may be nearly as important in most of these areas, and more so just before harvest when crop residues are scarce. This could explain why crop residues appear to be so dominant in the preliminary returns of the Living Standards Survey. It is possible that the final analysis of the Survey may yield a somewhat different picture.

Regional Differences

4. Rural Household Fuel Usage. Reflecting the degree of stress placed on the agricultural and forest resource bases across the country, the data indicate that rural households use leaves, grass and crop residues as the primary cooking fuel in all regions except the Mekong Delta. Shortages of immediately accessible fuelwood are prevalent for rural people in the North and central regions, and especially in the Red River Delta. Only in the North does wood play an equal role to forms of biomass lower on the fuel ladder. In a notable exception, rural cooking fuel usage patterns in the Mekong Delta are dominated by fuelwood. This result appears to indicate that there is no problem with wood supply in the Mekong Delta, a finding supported by field visits to rural households in the area.

5. Data gathered in this study seem to indicate that substantially more rural households are connected to electric service than estimated by official figures, up to about 35 percent nationwide as opposed to the 14 percent official estimate. This discrepancy is probably due a gross underestimation of multiple connections in the official tally and different definitions used for "rural" and "urban".

6. Urban Household Fuel Usage. The transition from traditional rural fuels to conventional fuels as a function of urban living conditions can be seen clearly in Table 1. Though some urban households still use sawdust, husk, or agricultural residues as their principal fuel in the central (and possibly north) provincial urban centers, the bulk of cooking services are provided by fuelwood. Perhaps a reflection of an abundant biomass resource endowment, wood is almost universally chosen as the primary cooking fuel in the provincial urban centers of the Mekong Delta. The transition into coal in the north and charcoal in central towns is clearly evident. In urban areas of the Red River Delta outside of Hanoi, wood is still a major fuel, but has been displaced by coal as the primary cooking fuel of most households. Traditional fuels have been almost entirely displaced in Hanoi by coal, kerosene and, notably, electricity.

7. Electricity was the major cooking fuel in *Hanoi* city in 1989. This is not surprising given universal access to electricity, the convenience of cooking with electricity, and the low electricity tariffs at the time. Presently, coal is the cheapest cooking fuel and appears to be making a major penetration in the residential sector market in Hanoi. Most household coal in Hanoi is consumed as briquettes and coal patties. In *Danang* city, fuelwood is the dominant household fuel marketed. Most of the fuelwood for sale in the city comes by boat through a large wholesale market at the port. According to the traders, roughly 70 percent of the wood comes from plantations with the rest coming from natural standing forests.

8. Not unlike their rural neighbors, over 60 percent of urban households in the Mekong Delta collect fuelwood . This indicates that urban households throughout the delta are at an early stage in the urban fuel transition: biomass fuels are plentiful and immediately accessible for collection. The woodfuels trade to supply urban households in provincial towns of the Mekong Delta does not appear to be nearly as substantial as the woodfuels trade to meet urban demand in the Red River Delta, central regions, and in Ho Chi Minh City where over 80 percent of urban households that use fuelwood purchase it. Urban households in the Mekong Delta appear to spend little on fuels, largely a benefit they obtain by collecting woodfuels from the accessible woody biomass resource base. This economic benefit is appropriate as long as this usage pattern is not depleting the resource base. Though the impact of urban fuelwood use in the Mekong Delta cannot be determined from existing data, the evidence that most households gather their fuelwood is no cause

for alarm. Conversely, the impact on the resource base of the substantial trade in fuelwood and charcoal for the metropolitan area of Ho Chi Minh City should be investigated.

9. In *Ho Chi Minh City*, the transition towards modern fuels is relatively more advanced than in other urban areas of the Mekong Delta. Unlike the situation in the North, coal plays little role as a household fuel in the south. Furthermore, crop residues are only used to a limited extent. Most households in HCMC have access to electricity. For cooking, households use fuelwood and charcoal, kerosene, some electricity, and LPG has recently been introduced. Many households have installed cooking facilities for different fuels which gives them the option to choose between, for example, electricity, bottled gas or fuelwood, depending on relative prices and availability.

10. HCMC has an extensive woodfuels supply system, run entirely by private business. The traders report that for many years the primary fuelwood supply sources were natural forests of neighboring provinces Dong Nai, Tay Ninh, and Song Be. Now much of this resource has been depleted and most wood comes from Thuan Hai and Lam Dong, about 150 km from the city, and from other provinces even further distant in the Northeast of the Mekong Delta Region. Various grades of charcoal are produced in Can Ro Duyen Hai District only 30 km from the city, in the mangrove areas of the Mekong Delta further south, and in the neighboring provinces of Thuan Hai, Lam Dong, and other areas in the Southern Highlands 150 km and further from the city. The coal market in the city is small. It is not possible with existing information to establish a causal relationship between woodfuels use in Ho Chi Minh City and forest degradation in neighboring provinces. However, the evidence reported by fuelwood traders indicates that the forest resource in the Northeast of the Mekong Delta Region is being mined.

ENERGY PROBLEMS IN THE RED RIVER DELTA

11. The Red River Delta is the most densely populated and intensively cultivated region of Vietnam. The widespread use of rice straw for fuel has caused concern that continued practice may lead to severe depletion of soil nutrients. In addition, there is serious concern that demand for wood by rural households in small towns in the delta may be mining the modest forest resources in the immediate area and neighboring North Midlands provinces.

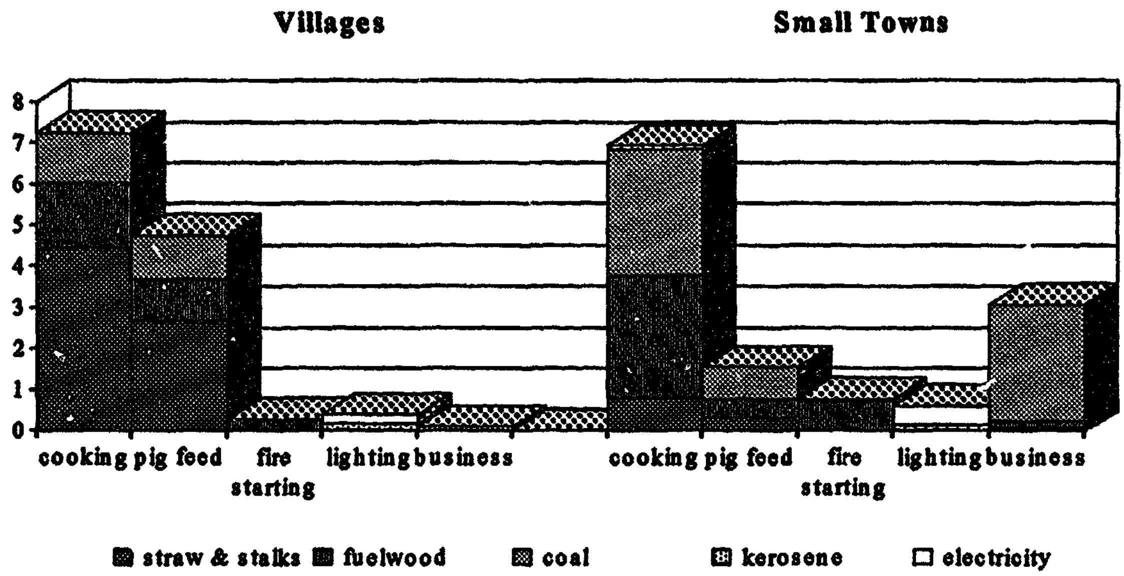
Patterns of Fuel Use and Energy Expenditures

12. Figure 1, obtained from results of special surveys conducted by this study in 12 towns and 4 villages in the delta, shows the average amount of various fuels consumed by each major end-use in sample households in delta villages and towns. Cooking end-uses dominate in village households, where straw and stalks are the major fuel, and in small town households, where fuelwood and coal are used in roughly equal proportion. In village households, the practice of boiling plant stalks, other residues, and rice as fodder for pigs uses almost as much energy as cooking household meals. Household enterprises are the second major end-use of energy in small town households -- a demand met mostly by coal.

13. The share of cooking energy delivered to the pan by each fuel for households in villages and in small towns is displayed in Figure 2. The transition from traditional to conventional fuels as a function of income and location is evident. Over one-half of the cooking energy needs of village households is met by rice straw and other agricultural residues, but coal is making major inroads in higher income village households. Fuelwood which is partly gathered appears to be a transition fuel between rice straw which is entirely gathered and coal which is entirely purchased. Of the 60

percent of village households that use fuelwood, 40 percent gather it themselves and over half of those who gather fuelwood obtain it from their own land or common land very close to home. Households in small towns purchase almost all of their fuel. Rice straw is a significant cooking fuel only in the poorest households. Coal and purchased wood provide the bulk of cooking services in small towns. Even electricity has begun to be used for boiling water in electric kettles and cooking on hot plates in wealthier town households.

Figure 1. Red River Delta: Fuel Use by End-Use (kgoe/cap/month)



Source: 1992 Rural Energy Survey in the Red River Delta.

14. From the survey results, the end-use costs of purchased cooking fuels in villages and towns of the Red River Delta were estimated and are presented in Table 2.

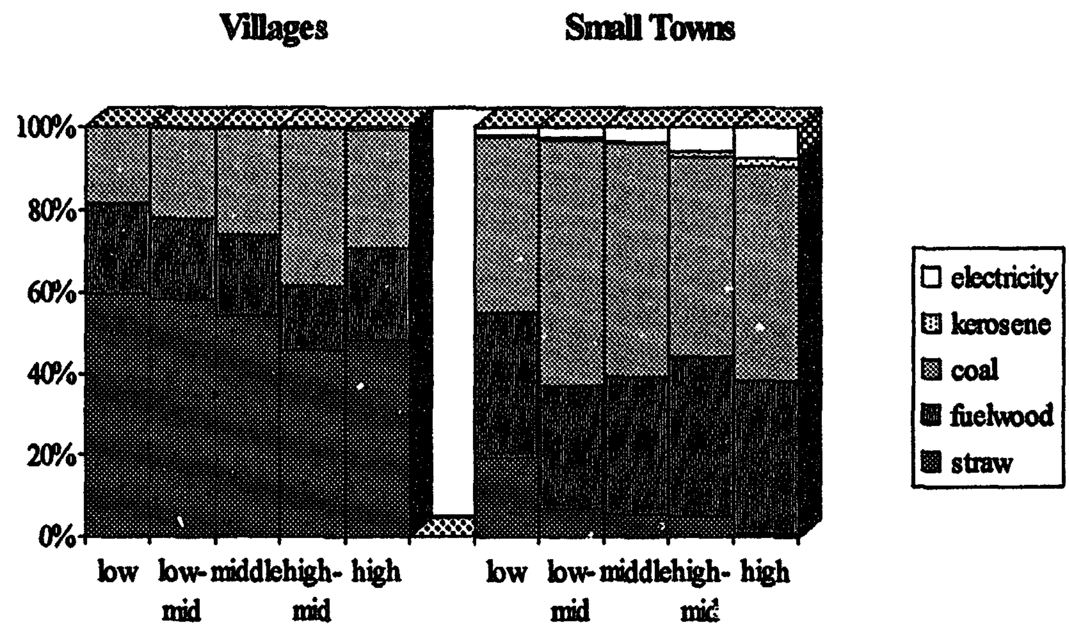
Table 2. End-Use Prices of Cooking Fuels

	Prices (Dong/Delivered MJ)	
	Village	Town
Coal	26	33
Wood	77	99
Kerosene	185	177
Electricity	236	229

Source: 1992 Rural Energy Survey in the Red River Delta.

Coal is substantially cheaper than any other purchased fuel on an end-use basis: 1/3 the cost of wood; 1/7 the cost of kerosene; and 1/9 the cost of electricity. With these existing fuel prices, it is not surprising that coal has displaced fuelwood as the second most important cooking fuel in villages and is the dominant cooking fuel in small towns where almost all fuels are purchased. The relatively high price of wood reflects its scarcity and indicates that these small towns are well advanced in the transition to conventional fuels. If this indication is correct, the share of end-use cooking services provided by coal can be expected to increase as wood becomes increasingly scarce and incomes rise, perhaps even displacing crop residues as the most important cooking fuel for village households. At existing prices, neither kerosene nor electricity can be expected to be adopted as important fuel for cooking at any time in the near future in the delta.

Figure 2. Red River Delta: Fuel Shares of Delivered Cooking Energy by Income Quintile



Source: 1992 Rural Energy Survey in the Red River Delta.

Extensive Use of Agricultural Residues

15. Indicative estimates of fuel use by rural households in the Red River Delta implied by the survey show that only 40 percent of total annual rice straw production is being used as a fuel in household stoves. Far from placing excessive demands on the agricultural resource base, this pattern of usage may be an integral component of a sustainable production relationship that has been in practice for centuries in the Red River Delta. Anecdotal evidence indicates that rice straw has been used as a fuel in rural homes of the Red River Delta for many centuries and that much of the ash is returned to the field as a fertilizer. Hence, it appears that at the implied levels of usage, crop residues are supplied on a sustainable basis and provide cooking services to households that would otherwise require a substitute fuel.

16. While the above discussion may allay concern over depletion of paddy soils due to the use of rice straw as a household fuel, the analysis indicates that concern over depletion of the modest forest resources of the delta and neighboring North Midlands provinces may be warranted. Estimates of fuelwood consumption in urban and rural households of the Red River Delta substantially exceed estimates of annual woody biomass yield in the delta and North Midlands combined (See Chapter 4, Table 4.4).

ISSUES IN RURAL ENERGY SUPPLY

Woodfuel Supply: Review of the Data

17. On the basis of previous work, the present study made estimates of the growing stock and yield of woody biomass on all types of land formations in the country.[1] These estimates, summarized in Table 3 below, show that nearly 85 percent of the growing stock and 50 percent of the annual yield originate in the natural forests.

18. The supply sources for urban households and the non-household sectors are medium diameter trees, logging waste and wood industry residues which mainly come from the forests and plantations not more than 100 kilometers from the demand centers. It is estimated that commercial or traded woodfuel accounts for about one-third of wood energy demand, but it is concentrated in small supply zones which may be being over-cut.

Table 3. Vietnam: Estimated Growing Stock and Annual Yield for Above Ground Woody Biomass

Land type	*Area* ('000 ha)	*Wood for Fuelwood and Charcoal* stock ('000 tons)	annual yield ('000 tons)
Agricultural land	6,016	11,562	1,544
Natural forest	8,687	465,384	18,616
Plantations	628	16,157	4,039
Degraded forest	9,750	36,858	9,214
Miscellaneous	6,634	18,955	4,739
Urban & Roads	1,326	1,894	190
Total	33,041	550,809	38,342

Source: Mission Estimates.

Deforestation Issues

19. Over the last 50 years the area of natural forest has been reduced by more than thirteen million hectares, from 22 million ha. to 8.7 million ha. In the same period, 600,000 ha. of plantations have been established, bringing the net loss of forest lands to nearly thirteen million hectares. If it is assumed that deforestation is confined to the loss of 5 million hectares over the last half century, then the cause of this deforestation could be attributed to agricultural clearing, for the population has grown by 50 million during that period and each person consumes crops from at about 0.25 ha. to survive. Again, many areas of forest were affected by the spraying of herbicides during the last war in the 1960s and 1970s and many are recorded as still being sterile. It is possible that some of these lands and others that may have been classified as degraded forest land have sufficiently recovered to be now classified as forests. Clarification of these issues is required for before an accurate estimation of wood supplies can be made.

20. The annual sustainable yields of woody biomass, crop residues and other forms of biomass in each region of Vietnam were estimated for this study (Annex VII). These supply estimates are compared against existing regional consumption patterns (estimated in Annex VI). The results (see Chapter 4, Table 4.4) indicate that for the country as a whole, sustainable supply appears to be in

1 See Annex VII for a review of previous estimates and the assumptions used here.

excess of demand. However, the North Midlands and the Red River Delta regions may have considerable deficits. It is in these northern regions where an inventory of tree resources is most urgently required, coupled with a demand survey. Also, there are areas in the Northern Highland region where the forest capital is probably being extracted, such as in the Hoa Binh catchment area that supplies wood to Hanoi and Vandien. In the southern regions, the critical areas where the tree capital is most under stress are the Mekong Delta and northeast of the Mekong Delta. Areas in the Mekong Delta, particularly the coastal mangrove and *Melaleuca* forests are being harvested and are possibly being over-cut to meet urban and export pulpwood demand.

21. The woody biomass imbalance indicated in Table 4.4 for the Mekong Delta is striking. Given that wood is the most common cooking fuel in rural and urban areas throughout the delta and that most rural households gather their wood, it may be that in the Mekong Delta and in other regions, there are considerably more trees outside of the forests than has been assumed in the estimates used here.

Assessing the Impact of Plantation Programs

22. Vietnam has had a very ambitious plantation program since re-unification of the country in 1975. However, the success of the program has been somewhat patchy, because of lack of maintenance, poor soils, wrong species or variety choice, lack of skills and poor motivation in the population. Over one million hectares of block plantations were planted between 1975 and 1989, but only about 600,000 ha. were considered successfully established.[2] Notwithstanding this record, given the rapid deforestation rate in Vietnam, the consensus is that plantation efforts should be expanded and innovative methods for providing incentives to tree planters developed. The most successful programs, such as those of the World Food Programme (WFP), have been attached to discrete projects or where there was emphasis on providing incentives to manage the plantation after the trees have been planted.

23. Table 4.4 indicated some of the wood short areas, such as in both deltas and in midlands areas around Hanoi and Ho Chi Minh City. This is where further plantation efforts should be concentrated. Other priorities should be areas of degraded land that form the water catchment of river systems with actual or potential hydro energy projects on them, including the catchment area for the Da river that comprises 2.7 million ha. within four provinces of north-western Vietnam. The protection of this catchment area is vital to safeguarding the massive investment in the Hoa Binh hydro electric plant. Tree planting initiatives, especially in the context of agro-forestry, would not only provide watershed protection but could also meet some of the market shortfalls for wood products in the North Midlands and Red River Delta regions.

24. While tree planting efforts continue to be important, emphasis should also be placed on increased stocking and improved management of existing forests, plantations and scattered tree resources, and ensuring that there is or will be a market for the trees that have been planted already.

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[2] Tropical Forestry Action Plan, May 1992.

Issues Related to Other Rural Energy Supply Options

25. Agricultural Residues. The estimated production of crop residues of 44 million tons (37 million tons in wood equivalent terms) is just slightly more than the estimated annual production of woody biomass (35 million tons). While this indicates a considerable potential for using crop residues as fuel, these residues are usually more bulky than wood and on average contain 15 percent less energy per unit weight. Therefore, they are commonly consumed very close to the supply source. A national surplus of residues, for example, is not relevant to a localized scarcity of fuels in the Red River Delta due to transport constraints. While densification may address the transport problem, it adds to the final cost of the fuel. Experience in other developing countries indicates that densified residues have never achieved significant commercialization and widespread use. The extensive use of agricultural residues, particularly rice straw, in Vietnam's rural areas shown by the survey data clearly indicate acute scarcity of wood in those areas rather than a preference for residues.

26. Coal. The demand for coal in the residential and industrial sectors is expected to increase between 4 and 6 percent per year and it is anticipated that the demand for "rural" coal in the northern areas will increase on a similar scale. Although the increased use of coal in households is inevitable, there are a number of drawbacks to using this fuel. First it is difficult to light, and like biomass, it is hard to control the heat output in a domestic stove. Once lit, the tendency is to keep the stove burning all day, damping it down when not in use. However, this action produces excess carbon monoxide which is a highly toxic gas, can be fatal for humans and other animals, and gram for gram is about six times more harmful as a "greenhouse" gas than carbon dioxide. Of greater environmental concern are the low height particulate emissions from burning coal in an open domestic stove. Technologies to improve combustion efficiencies of coal stoves and reduce emissions should be investigated.

27. Renewable Energy. Vietnam has a small ongoing program for renewable energy development, mainly carried out by the Energy Institute, the Energy Center of Power Company 2 (PC2) and some universities. Wind applications that are designed to serve a niche market in remote areas appear to be gaining some commercial acceptance and should be encouraged. The Institute of Energy, the Energy Center and the other agencies engaged in renewable energy development should review the results of their work so far, with a view to clarifying goals, prioritizing the work program in the medium term and redirecting some of the staff and resources to activities that have more immediate relevance. Two programs would appear to have the highest priority, namely: mini- and micro-hydro and improved stove design and dissemination. If bilateral financing can be obtained, the potential for photovoltaic applications should also be investigated. The small hydro group should build internal skills to assess rural demand for electricity and incorporate demand in site selection procedures. In addition, the unit should concentrate on training end-users in operations and management of small hydro stations. The improved cook stoves program should begin to pursue commercialization steps more actively.

RURAL ELECTRIFICATION

28. Rural electrification growth from 1975-1990 is summarized in Table 4. Although these official figures appear to indicate that considerable progress has been made in rural electrification in recent years, a closer look at investment statistics for the three power companies during those years indicates that the electrification effort mostly involved connecting households in areas already

covered by the medium voltage network rather than extension of service to originally unelectrified areas.

Table 4. Rural Electrification Growth, 1975-1990

Year	Irrigation Pumps (GWh)	Rural Industries (GWh)	Rural Households (GWh)	Total (GWh)	Percentage of National Demand	Electrified Rural Population/Total Rural Population
1975	119	30	37	186	8.5%	2.5%
1985	223	75	75	373	9.7%	5.5%
1989	329	141	150	620	10.9%	11%
1990	398	210	192	800	12.8%	13.9%

Source : The Energy Institute (1991) and mission estimates.

29. When new medium voltage lines are built, the first priority is still the connection of irrigation/drainage pumps to the grid in order to extend cultivated areas and increase their productivity. Connection of households and rural industries remains a by-product of this main line of development. An exception is the supply to mountain regions where, for social and political reasons, the Government places importance on connecting households.

30. The most recent activities in rural electrification were the launching of pilot rural electrification projects in the last 5 years, 8 in the North of Vietnam, one in the center (a sub-district in the Highlands), and one in the South (Song Be District in Long An province). The pilot projects were identified and recommended by the provincial authorities and evaluated at the Central Government level. The main criterion appears to be that at least 50 percent of households in the concerned community were willing to pay the required contribution (household contribution covers the cost of the low voltage system, the line to the house, internal wiring and meter). Overall, however, only 40 percent of the physical and financial targets have been met, mainly because of lack of funds. These pilot projects represent the major investments in rural electrification in recent years, but it is likely they will not be repeated. In the future, potential consumers will be required to pay the full cost.

Constraints to Rural Electrification

31. Supply Shortages and Power Losses. For the South and Central regions, it is clear that a successful rural electrification program cannot be implemented before the current *severe supply problems* are solved. The construction of a long extra high voltage (EHV) line that would connect the Northern grid, with surplus generating capacity, to the shortage-constrained regions of the Center and the South should be a major step in this direction.

32. For all regions, costly *technical and non-technical losses* in electricity distribution, and end-use inefficiencies in both urban and rural areas should first be remedied. These losses exacerbate the poor financial position of the power companies and reduce the amount of funds available for new investments, including rural electrification. Inefficiencies on the distribution side include low system power factor, transformer inefficiencies and poor quality of cables.

33. The biggest contributors to inefficiencies on the end-use side are electric motors, which are manufactured locally and designed to comply with a power factor requirement of 0.7 at nominal output, and electric pumps for irrigation and drainage that represent a major load in rural areas (about 50%). The typical efficiency of the irrigation pumps at nominal output is said to be 80 percent. In all the sites visited, the pumps were oversized compared to the head they supply.

34. In some places, such as certain areas of Haiphong, the high level of fraud and theft has led to losses above 40 percent. Non-technical losses should be given major attention by the power companies, since the motivation for fraud will increase in the coming years with the planned increases in tariffs and consumption levels. A major contributing factor is that most of the installed meters are inaccurate and unreliable, causing significant revenue losses to the power companies. It is estimated that some 300,000 meters per year would be needed to equip newly connected customers and gradually replace the old meters. This would cost approximately US$10 million annually.

35. Institutional Constraints. Although the provincial authorities are consulted by the Central Government in the design stage of the projects, final decisions regarding rural electrification investments remain centralized, often leading to rigidities in the technical approaches, delays in decision making and low motivation at the local level. Responsibilities for planning are split among several government agencies, leading to lack of uniformity in technical standards and project evaluation criteria. The regulatory framework for rural electrification is not clearly defined: ownership of systems (networks and/or generating equipment) built with private financing or mixed public and private financing is not clear. No general procedure is followed for tariff setting in cooperatives or in privately-owned isolated networks, which would be a fundamental step to ensure protection of the end-users and fair returns on investments for the financiers. These and current laws restricting the right to produce electricity for the public grid to the three power companies limit the likelihood of increased involvement of private financing in rural electrification schemes.

36. Scarcity of Financing. Lack of financing is a general constraint on the three regional power companies. This has limited the development of supply sources, notably in the South and Center, and the rehabilitation of transmission and distribution networks all over the country. The bulk of financing resources in the subsector is now earmarked for the 1500 km 500 kV transmission line, due to be commissioned in 1994. The estimated cost of the interconnection project has been revised upward from $220 million to $520 million. In light of this development, the amount of money available for rehabilitation of existing networks and extension of electricity services in suburban areas would be very limited.

Rural Electrification Planning

37. Electrification Targets. The official targets for electrification for the coming years remain ambitious, aiming at an average of 300,000 new household connections per year (see Table 5). These targets will be increasingly difficult to meet since the easiest parts have been or are already being done.

Table 5. Rural Electrification Targets

	1990 (achieved)	1995 (planned)	2000 (planned)
Rural Population with Electricity (percent)	13.9%	25%	35%
Rural Population with Electricity (million)	7.26	14.25	21.93
Supply to Irrigation and Rural Industry (GWh/year)	660	1118	1464
Supply to Households (GWh/year)	340	1000	1700

Source: The Energy Institute (1991).

38. Investment Requirements. Indicative estimates of the investment necessary to electrify 80 percent of the rural population in the (i) Red River Delta, (ii) Mekong Delta and (iii) center-south coastal areas (near Da Nang and Hue) have been made by the present study. This 80 percent target would be reached if all 300,000 new rural household connections per year were concentrated in these three areas over a 12 year period. These areas were selected for analysis because they are the regions where electrification by extension of the regional grids is likely to be the most economic alternative, population densities are high, and the regions' economies are the most likely to benefit strongly from the availability of electricity. Investment needs are likely to exceed US$3 billion, for the distribution networks alone, broken down into about US$1.9 billion for MV systems and US$1.3 billion for LV systems. The regional breakdown would be about US$350 million for the Red River Delta region, US$2.1 billion for the Mekong Delta and US$850 million for the Central region. An investment program of this magnitude would lead to an overall electrification rate of about 40 percent, corresponding roughly to the plans prepared by the Ministry of Energy.

39. Given the supply shortages and system losses, institutional constraints and scarcity of financing presented above, the magnitude of the investments required to extend electricity service to 300,000 new rural households each year indicates that it is very unlikely that official targets will be met. It points to the imperative of exploring innovative financing arrangements that involve private capital participation. A bright side is that potential electricity consumers appear willing to pay the high costs of rural electrical service. Presently, electricity end-users often pay more than the official tariff and even more than the marginal cost because of the common practice of resale of electricity in both urban and rural areas.

Establishing a Framework for Rural Electrification

40. Rural Electrification Model. As mentioned earlier, pilot R.E. projects based on joint public/private financial participation have been promoted by the Government in recent years. However, there have also been a number of successful projects based on cooperatives. Unlike the normal experience in the U.S., these cooperatives are not specifically electric cooperatives, but most often agricultural, extending their activities to provide other services of benefit to their members. Some version of this system could be made the model for an expanded rural electrification program.

41. Institutional Coordination. The bulk of the planning. design, decision-making and operations should be decentralized. To take advantage of the community-based structures, the

Provincial authorities should be allowed to play a major role in screening sites, coordinating feasibility studies, defining institutional/financing schemes and supervising implementation.

42. Since it is clear that financing the program through public funds alone will not be feasible, an enabling environment must be provided to maximize private financing participation. This will be achieved only if there is a clear and stable regulatory framework and assurance of fair returns on investments through transparent tariff setting rules. The regulatory framework must set: (i) clear and appropriate rules on private generation and distribution, system ownership and tariff setting, (ii) standardized planning and selection methodologies and (iii) technical standards adapted to the rural environment.

43. Technical Standards. The optimal design of rural systems is typically a trade-off between cost and system performance, including quality and reliability of supply. There is a wide range of design options to reduce the cost of rural extensions while maintaining quality and reliability of supply at acceptable standards. Economic options for reducing costs should be analyzed at the national level and guidelines should be established (cable sizes, standard transformer sizes, pole-mounted transformers, 35/15 or 35/0.4 transformation, construction of single-phase extensions, wood poles, etc.).

44. Screening of Projects. To ensure optimal use of funds that the Government may finally decide to devote to rural electrification, the screening of proposed projects should follow a uniform national procedure, developed by considering locally validated data. Guidelines should therefore be prepared for each province to review potential rural electrification projects in the near to medium term, for instance, over the next 10 years.

45. The screening process at the national level should allow the central Government to prioritize the overall group of R.E. projects and prepare a medium term (5 to 10 years) national rural electrificationinvestment program. Province-based agencies would then be given the responsibility for implementing the various components of the master plan, including involvement of private investors. At the national and provincial levels, care should be taken to coordinate such actions with similar plans developed for infrastructure or agriculture projects.

CONCLUSIONS AND RECOMMENDATIONS

46. Some of the problems that emerge in the present analysis are due to the excessive use of biomass fuels. Others are due to the inevitable "household energy transition" that occurs as a result of modernization, urbanization and general economic growth. As households increasingly purchase most of their fuels, income, prices and distribution policies largely determine residential fuel choice and use. The resulting demand mix can severely strain the supply system for certain fuels or put the poor at a disadvantage.

Household Energy and Traditional Fuels

47. The problematic situation in the *Red River Delta* and the measures that are indicated by analysis of the available data exemplify the type of policies that Government must consider for the subsector nationwide.

48. First, the heavy use of wood in the towns of the delta over the decades has apparently contributed significantly to the denudation of the immediate landscape and, as wood sources shifted

farther into the highlands, has contributed to the serious erosion of watershed areas, including those protecting the Hoa Binh reservoir. If it goes unchecked, this trend can lead to severe wood supply shortages, degradation of the highland areas, and a shortened life of the hydroelectric power plant. The solution not only involves the obvious and necessary reforestation of the catchment area but requires an understanding of the likely shifts in household fuel choices in the delta towns.

49. Establishing multipurpose tree plantations in the low lying areas near heavy population concentrations of the North Midlands and Red River Delta regions plus densely populated areas of Hoa Binh province will be directly relevant to addressing the above issue. It is recommended that a project along this line be given high priority in the immediate term. The project, with the combined objectives of watershed protection and expansion of fuelwood supplies, could initially cover about 575,000 hectares in the provinces of Hoa Binh, Yen Bai and Son La at an estimated cost of $30 million spread over 10 years (see Annex IX). The mian efforts will be to get more agr-forestry trees on-farm and to plant multipurpose trees in degraded forest land. This will complement or could be made an integral part of a comprehensive watershed management project already proposed by the Tropical Frestry Action Plan, covering 4.7 million hectares in six watershed areas.

50. Second, the extensive use of rice straw and other agricultural residues in villages in the Red River Delta has raised questions about environmental sustainability and household welfare. Crop residues, almost entirely collected, account for about half of cooking energy in these households--a figure that seems alarmingly high--and reflects ready availability and much lower average cash incomes compared to households in the towns. The present study concludes, with some caveats (see Chapter 3, paras 12-14), that the practice is probably sustainable and that no direct interventions to curtail rice straw use need be made. However, the larger issue of a deteriorating quality of life of households in these villages remains and must be addressed. In the energy transition "ladder", the shift to crop residues--which are bulky, inconvenient, and need continuous tending of fires-- represent a *descent*, as residues have never been a fuel of choice but of necessity in all parts of the world. It is clear that Government policy must be to encourage a shift to affordable, higher grade fuel substitutes.

51. The surveys confirm that coal is already the next most used fuel in village households in the delta (30% of cooking share) and appears to be the most suitable substitute to crop residues in this context. Thus, programs that facilitate the distribution of coal in the Red River Delta (e.g., improved transport infrastructure) would benefit households of both villages and towns. Since coal price is already low, no other intervention would be needed. However, considering the expected increase in coal consumption not only in the delta but in other northern parts of Vietnam in the medium term, efforts must be directed at further enhancing consumer acceptance and alleviating adverse environmental impacts. This means improving the quality of the briquettes by way of reduced smoke, increased heating value and ease of lighting. It is recommended that expert technical assistance be provided to both large-scale and informal sector makers of coal briquettes to improve their production methods.

52. In the *Mekong Delta* and areas to the northeast, estimates made in this study (Chapter 4, Table 4.4) indicate the possibility that the wood resource base is being mined, with demand in excess of two times the sustainable supply. In contrast to the Red River Delta, wood is the principal cooking fuel in both rural and urban households of the delta, including Ho Chi Minh City that has an extensive commercial woodfuels market. Wood traders in HCMC report that most of the wood supply to the city now comes from provinces 150 km away to the northeast and that the sources of supply have shifted outward substantially over the past ten years. Survey data suggests

that a large part of household woodfuels in the delta are still being collected. Therefore, there may be more *trees outside the forests* (in private lands, for example) than is normally assumed, in the Mekong Delta and possibly in other regions, as well. Due to the prominent role of woodfuels in the energy economy of the south, it is recommended that high priority be given to the conduct of surveys and inventories to establish reliable information on sustainability of the resource, with particular attention to determining the quantity of sustainable woody biomass supply outside the forests.

53. For the *nation* as a whole, woodfuels already constitute over a third of *all* traded energy and must be considered an important commercial fuel. The woodfuel industry is a significant source of employment, especially in rural areas. Trading and distribution of woodfuels appear to be working efficiently and prices are wholly market determined. Government intervention in the sector does not appear to be needed and in fact has the potential to be disruptive. The role of Government should be merely to *monitor* the sector to ensure that overall operations adhere to the objective of resource sustainability.

54. Except for electricity tariffs which are still below marginal costs, the prices of major household fuels do not appear to be distorted by subsidies. There are a few specific cases that may need to be re-examined. As one element in the rural energy supply policy, approximately 200,000 tons of coal fines are distributed annually at subsidized prices to villages in mountainous areas of 13 provinces with the objective of protecting highland forests from excessive fuelwood demand. This policy costs the government about US$1 million annually. Though the estimates made by the present study are very rough, they indicate that there is *no fuelwood deficit* in the Northern or Southern Highlands. If this is confirmed, the policy may be having the effect of discouraging the production and use of woodfuels which, for convenience and environmental reasons, is a better fuel. It is recommended that this policy be reviewed.

55. There is a potentially important role for *improved cook stoves programs* as a demand management tool for woodfuels. However, the only way to make a dent in wood consumption is to deploy large volumes of improved stoves, especially in resource stressed areas. It is recommended that the Government's improved cook stoves program be expanded and re-directed along commercial lines, initially targeting middle class households in urban areas. Efforts must also be directed at improving the efficiency and emission characteristics of coal stoves.

56. With a few notable exceptions, *renewable energy technologies* still have a long way to go in Vietnam before widespread, practical applications become a reality. More attention should be given by the Government to prioritization of its research and development projects, and lessons must be drawn from more extensive experience in other countries in this field. Household biogas systems, for example, have not proved to be economic in many countries and are largely impractical as an energy supply option. Wind and photovoltaic technologies, on the other hand, may find economic "niche" applications and should be encouraged where consumers are willing to pay the price. Within the Government's renewable energy development program, it is recommended that the highest priority be directed at mini/micro hydro development and deployment and at photovoltaic system applications for rural areas.

Rural Electrification

57. The first priority of rural electrification in Vietnam remains the connection of irrigation/drainage pumps to the grid in order to expand cultivated areas and increase their

productivity. This is an important program and should be continued. Extending connections to households and rural industries is also a worthy goal for Vietnam over the coming years, despite the burden on public finances which would result. Several *important preparatory investments, actions and studies,* however, must be made before a major, properly-phased rural electrification plan can be implemented.

58. There are two major prerequisite investments, both also cited by the Energy Sector Investment and Policy Review report. First, supply conditions in the South and Central regions must be improved, since no rural electrification program can be implemented if adequate supply is not secured. The EHV line now being installed should help to overcome the current capacity and energy shortfall, but rehabilitation of existing thermal units and timely construction of new capacity would also be required. Second, the existing MV and LV system must be rehabilitated, to improve operational efficiency and quality of service to the consumers. The activity should give priority to installation of capacitors on feeders with high reactive power demands, and reconductoring of heavily loaded feeders. These investments should be accorded the highest priority.

59. Three important activities must first be implemented. First, non-technical losses in seriously affected areas, such as Haiphong, must be reduced. This will require the launching of an inspection program of individual consumer installations, with priority being given to larger consumers. A comprehensive program to replace defective meters, should be developed and implemented. Second, national planning guidelines and standards for distribution systems should be developed. Application of such standards, along with loss reduction and improvement of the quality of supply, are necessary to achieve optimum system efficiency. Third, the Government must develop and establish a policy on rural electrification which will allow rational and consistent prioritization of rural electrification projects on a nationwide basis. The policy should define (a) appropriate regulatory and institutional frameworks; (b) methodologies for forecasting and economic evaluation of alternative supply locations and options; and (c) technical standards of design, construction and operation.

60. As an immediate step, it is recommended that external technical assistance be sought to: (i) conduct loss reduction studies, and (ii) to help develop a coherent rural electrification policy. The studies should be conducted not only for their specific outputs but also to help develop local planning capabilities.

Institutional Coordination

61. The broad institutional reforms proposed for the energy sector by the World Bank's Energy Sector Review, including the strengthening of the Energy Institute, also will benefit the programs identified for the rural and household energy subsectors. Two supporting recommendations specific to the subsectors should additionally be considered. First, given the importance of biomass energy to energy planning and the cross-sectoral nature of the issues associated with it, there may be need for special coordination, through a committee, of activities and responsibilities of the various ministries involved in this field, namely, energy, agriculture and forestry. Each of these agencies deal with separate aspects of biomass production and utilization, and a case can be made for a more coordinated planning and monitoring of activities in this area. For example, the recommended comprehensive inventory of supply and demand for woodfuels in households and rural industries and the periodic monitoring of the situation in highly stressed areas, cannot be effectively carried out by just one of these agencies.

62. Second, the ministries of energy, water resources and agriculture have interrelated interests and responsibilities for rural electrification. Therefore, a future comprehensive rural electrification program would be more effectively coordinated by an inter-ministerial body, perhaps a "Rural Electrification Committee", rather than by a line agency directly attached to one of the ministries. This body should be given the responsibility of developing guidelines and regulations for the program, and preparing inputs to the Government's budget planning process for electrification.

I. OVERVIEW

Introduction

1. Since the adoption of the policy of "renovation" (doi moi) in 1986, Vietnam's centrally planned economy is undergoing a gradual transformation to a more decentralized market-oriented structure. The reform programs have improved macroeconomic conditions and helped achieve a certain degree of economic stability. For the remaining part of the 1990s, growth in real Gross Domestic Product (GDP) is projected within a range of 5 to 10 percent per year, with the higher growth rates occurring if the US embargo is lifted, official development assistance and foreign investment inflows expand, and the reform program is consolidated and further strengthened. Rapid development of the energy sector is recognized as key to economic recovery and growth. he World Bank recently conducted an Energy Sector Investment and Policy Review to assist Vietnam in identifying investment priorities and policy reform needed in the petroleum, coal, and power sectors. Although issues in the rural and household energy sectors were recognized as significant, they were only broadly addressed in that study.

2. Examination of these issues is highly important in Vietnam as the country is still basically a rural society. Rural dwellers comprise 80 percent of the population and are heavily dependent on wood and other biomass fuels. Wood is a major fuel even in the urban areas, especially in the South and central regions. The rapid decline in forest cover, due primarily to clearing for agriculture, may lead to severe supply constraints for rural and urban households. Official figures indicate that only 14 percent of rural households have access to electricity, although this varies widely by region. Technical and financing constraints hamper the pursuit of a rural electrification program that would contribute to rural economic development. The causes of deforestation and the options facing households are difficult to analyze because of the highly dynamic nature of household energy demand and a general lack of reliable data on traditional fuel supplies and consumption trends. The present study is designed to complement the Energy Sector Investment and Policy Review by analyzing rural and household energy supply and usage in more detail, identifying priority issues and recommending appropriate policy options and investments.

The Land and Population

3. Vietnam is among the poorest countries in Asia. GDP per capita is roughly US$200, although many social indicators correspond to those of countries with a much higher per capita GDP. The 1989 Population Census found that 88 percent of the population of 64.8 million aged 10 years and above are literate, life expectancy at birth is about 65 years, and the infant mortality rate is about 44 per thousand.

4. The total land area of Vietnam is 33 million hectares of which about 7 to 14 million hectares are covered with forest (detailed land use classifications are presented in Chapter 4). The population is growing at about 2.1 percent per year and is projected to reach 70 million in 1993. The population growth rate has been reduced from about 3 percent per year in the 1970s. Vietnam is the third most densely populated country in Southeast Asia with an average density of 195 persons per km^2. Population densities vary widely across regions with highest densities in the Red River Delta (784 persons/km^2) followed by the Mekong River Delta (359 persons/km^2) and the Southeast (333 persons/km^2). Population density in the Central Highlands was only 45 persons/km^2 in 1989 but is growing rapidly at more than 5 percent per year as a result of Government resettlement programs and in-migration. Due to its geography and history, Vietnam

comprises diverse living environments which differ substantially with respect to agro-ecological conditions, resource endowments and socio-economic structures. Consequently, rural and residential energy usage patterns differ substantially across agro-ecological zones.

Changing Patterns of Energy Demand

5. The transformation process that the country is undergoing is causing sweeping social and economic changes in the cities and the countryside, where new opportunities for income generation are opening up to households, cooperatives and enterprises, and increased expectations associated with modernization are raising new demands on the infrastructure and energy delivery systems. The changes most likely to affect rural and household energy demand patterns are those occurring in the agricultural, industrial and household sectors.

Agriculture

6. Although agriculture is likely to grow at a relatively high rate, by the year 2000 its share in GDP and employment are projected to be substantially lower than today. Agricultural growth will mainly come from increased commercialization and specialization. With farmers having the freedom to pursue any profitable activity they wish, the dominance of rice is likely to be reduced while production of higher value crops and products will increase. Production increasingly will be commercialized. While production in the past largely was directed at satisfying subsistence needs and Government requirements, farmers will in the future produce for the market. Commercialization of the production systems will have the consequence that the agricultural sector will have less capacity to absorb surplus labor than in the past through underemployment in the collective production system. A major out-migration from agriculture is therefore likely which increases the need for employment generation in rural industries and in urban areas.

7. These changes in the agricultural sector will affect energy demand and supply. First, the market-orientation will result in increased demand for transport to bring produce to market. Secondly, mechanization of production methods will occur as a natural result of specialization. These two trends will increase demand in rural areas for oil products.

8. Third, investments in irrigation systems are likely to increase as a result of introduction of improved incentives. This will raise rural electricity demand for irrigation pumps. Furthermore, future demand growth is likely to require a more individualized distribution network. In the past under the collective production system, farmers within a large area applied the same production methods and crop patterns (in the delta regions, mainly for rice). Irrigation systems could therefore be designed with one large pumping station serving a uniform irrigation need within a large area. Under the household production system, crop patterns are likely to be more diversified and the irrigation systems will have to be adapted to serve differing needs of the farms. This may call for many smaller pumps and more distribution points in the rural distribution network. It is noteworthy that electricity consumption of the agricultural sector (for irrigation) experienced an average annual increase of 15 percent between 1985 and 1990, despite a general shortage of generating capacity and a limited distribution network in rural areas. This rapid demand growth is expected to continue and may even accelerate in response to structural changes in agriculture.

Rural Industries

9. As a consequence of the reform program, the structure of Vietnam's industrial sector is likely to undergo a major transformation during the 1990s. The past inward-looking strategy

emphasizing heavy industries has been replaced with an emphasis on the production of light consumer goods and export oriented industries. Although the state owned heavy industries will continue to grow at a high rate to satisfy the materials requirements of expanding light industries and the service sector (steel and cement for building construction), their share of total industrial output is likely fall significantly by the year 2000. By the end of the decade the industrial sector may be characterized by: (i) some large scale heavy industries--partly state owned; (ii) a number of export processing zones with light industries producing consumer goods for export; (iii) a number of medium/large scale consumer industries producing for the domestic market; and (iv) thousands of small scale enterprises in rural and urban areas producing mainly for nearby local markets. Adequate statistics on the small-scale enterprises sub-sector are not available but observation and other informal evidence indicates that it is growing rapidly, especially in the South.

10. It is Government policy to increase income and employment opportunities in rural areas through promotion of cooperative, private, and household owned and operated rural industries. Decree No. 10, recognizing the rural household as the key economic unit, has stimulated investments in a number of small scale rural industries. A primary means of rural industrialization in Vietnam will be private and cooperative investments in small scale industries. The main role of Government in this situation will be to facilitate the development of these ventures through provision of essential infrastructure and credit.

11. Rural enterprises in Vietnam are disadvantaged compared to urban enterprises in terms of access to credit, markets and basic infrastructure. A recent sample survey[3] found that 95 percent of urban enterprises had electricity compared to only 58 percent of the rural enterprises. Electricity supply is generally much better in the North than in the South. Furthermore, the unreliable public supply in the South forces many enterprises to invest in their own generators, if they can afford it. The survey found that enterprises having electricity were more mechanized, and had a higher value added per worker and a healthier financial position than enterprises without electricity. Many enterprises without electricity, using hand tools only, were financially very weak and produced a value added so low that it did not contribute in any significant way to raising incomes.

12. Investment in rural electrification will contribute to the development of rural industries. However, electrification is not sufficient in itself to ensure their success. Many rural enterprises with electricity also have a low level of technology and mechanization primarily due to shortage of investment funds. Most rural enterprises are today established from savings of the household or the cooperative whereas credit from the banking system plays a negligible role. This suggests that the benefits of future rural electrification programs can be greatly enhanced if they are combined with credit programs in support of rural enterprise development.

13. A significant number of small-scale, mainly informal rural industries will continue to be major consumers of biomass fuels and coal rather than electricity. These include mineral based industries (brick and tile making, lime burning, ceramics, etc.) and those that process food and agricultural products. The expansion of the economy is likely to increase energy demand of these industries that, as of 1990, already used as much energy as the formal industrial sector (see Annex 8). The upsurge in building construction in the last few years, for example, has rapidly increased the demand for bricks and consequently the energy consumption of the rural brickworks. It will be

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3 Small Enterprises in Vietnam, ILO/ARTEP, September 1992.

important to ensure that the intensive use of woodfuels and coal by these industries do not lead to supply constraints and environmental problems in the future.

The Household Sector: Urban and Rural Growth Trends

14. The 1989 Population Census enumerated 12.9 million households with an average household size of 4.84 -- down from 5.22 in 1979. The number of households increased at an annual average rate of 3.09 percent between 1979 and 1989, while total population increased at an average annual rate of 2.28 percent. The mid-range population projection predicts that the number of households will double (reaching 25.8 million) over the 25 year period ending in 2014.

15. This development in household size and numbers has a number of implications on household energy demand. First, the demand for connecting to the public electricity grid will grow much faster than the population (other factors kept constant). Secondly, since smaller households tend to favor modern fuels for cooking, the projected trend in household size and numbers will stimulate the transition towards modern fuels.

16. Urbanization has been subject to different trends over the last 20 years. During the war, people in the southern provinces moved to the cities to avoid the fighting and to earn a living while people in the North migrated to rural areas to escape the bombing. Consequently, at the end of the war, the urban population constituted about 31 percent of total population in the South and roughly 12 percent in the North. After re-unification, people were repatriated to the rural areas and the urban population declined in absolute and relative terms, to 19.2 percent in 1979. During the 1980s, the "natural" urbanization trend was counteracted by Government resettlement programs moving people from large cities and the densely populated plains to the central highlands and the southeast. As a consequence, the proportion of urban population increased only slightly to 20.1 percent in 1989. The major migration trends during the 1980s included a net out-migration from the Red River Delta (including Hanoi) and from the Central Coast into the Central Highlands, the Southeast, and Ho Chi Minh City (HCMC)[4].

17. Although Government will continue its policy to counteract a large inflow to the major cities such as Hanoi and HCMC, the economic reform program will tend to enforce the factors that encourage migration to urban areas. An increasing number of resource-poor rural households are likely to be further marginalized and will have to seek employment in urban areas where the major part of services sector development and investments in light labor intensive industries is expected. In face of this trend, the Government plans to establish several urban growth centers as alternatives to Hanoi and HCMC. The share of the population living in urban areas is expected to increase significantly during the 1990s, reaching 30 percent by the turn of the century. As urban dwellers meet more of their energy needs with modern fuels, increased urbanization will enhance the transition to modern fuels.

18. The socio-economic conditions of rural households have been subject to dramatic changes over the last 50 years. Land reforms during 1953-1957 returned land to peasants and resulted in a major increase in agricultural production. Collectivization was started in 1958 in the North and in 1976 after reunification in the South. Collectivization involved a departure from a thousand year old tradition where the family was the key economic unit in the rural society. Cooperatives were established in the form of production brigades where the management had power to control and

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4 Vietnam Population Census - 1989, Detailed Analysis of Sample Results, Chapter 5.

allocate the household's labor and production. Collectivization met with a number of problems in the South. In 1981 a first step in the direction of recognizing the household as the key economic unit was taken with Party decree No. 100 on family output contracts. This had initially a positive impact but full recognition of the family household as the key economic unit was only achieved in 1988 with Politburo Resolution No. 10 which reduced the cooperative to a service unit supporting its farmer members with inputs, advice, etc.

19. The recognition of the household as the key economic unit, with freedom to pursue any profitable activity, has stimulated an increase in agricultural production and investments in rural industries. However, it has also resulted in increased social differentiation and its consequent impact on the type of fuels used (purchased or collected, traditional or modern) by the distinct household groups. This differentiation is likely to become even more pronounced during the 1990s, as more and more of the better-off rural households become involved in the market economy and develop cash incomes, while resource-poor households become more marginalized. The extent of this phenomenon varies markedly by regions in Vietnam. The dynamics of the energy transition of households, its regional variations and its policy implications are examined in Chapter 2.

II. HOUSEHOLD ENERGY DEMAND PATTERNS

Introduction

1. The composition of sectoral energy demand has been estimated for Vietnam. As shown in Table 2.1, the residential sector consumes over 80 percent of final energy in the country and traditional fuels account for over 80 percent of final energy consumption. While this aggregate data highlight the dominant role of households and traditional fuels in the overall energy economy, it does not provide information on patterns and trends in energy consumption that could guide policies to protect the resource base and ensure continued supplies of affordable fuel to the residential sector. Using new evidence and the results of previous studies conducted by the Ministry of Energy between 1987-90, this chapter presents a first attempt to examine regional variations in household fuel use patterns on a more than anecdotal basis[5]. The analyses examine differences between fuel use in rural and urban households as distinct groups, and then focus on emerging patterns in the major cities of Hanoi, Ho Chi Minh City and Danang, where the transition to modern fuels is relatively advanced and provides insight into the dynamics of interfuel substitution.

Table 2.1. Vietnam 1990 Final Energy Consumption by Sector ('000 TOE) (1)

	Electricity	*Petroleum*	*Coal (2)*	*Subtotal*	*Charcoal*	*Fuelwood*	*Crop Res*	*Subtotal*	*Total*
Transport	4	1,001	23	1,028	0	0	0	0	1,028
Industry	240	1,006	893	2,139	2	715	357	1,074	3,213
Service etc.	51	380	53	484	14	46	0	60	544
Household (3)	230	224	767	1,221	372	9,531	9,952	19,870	21,091
Total	525	2,611	1,736	4,872	388	10,292	10,309	21,004	25,876

Notes: (1) Does not include losses in power generation, transmission & distribution, petroleum distribution, or transformation of wood into charcoal.

(2) There is wide variation in heating values between the types of coal traded in Vietnam. Total coal consumption by end-use sectors in 1990 was 2.55 million tons with an average heating value of 28.8 MJ/kg. Consistent estimates of the quantity and energy content of fines, coal slurry, and power station ash that is sold for household and small scale industrial use are not available. It is reported that a substantial amount of coal ash (with 70% carbon content) from power stations is sold to make briquettes. High carbon content in ash indicates that power station coal fired boilers must be very inefficient.

(3) Includes fuels used for boiling pig food.

Sources: World Bank 1992 Annex 1.02 and see mission estimates for residential biomass fuels Annex VI, Table 3 (adjusted for 1990 by taking 96% of '92 figures).

2. The main source of new data for the present report is the Living Standards Survey (LSS) now being conducted by the General Statistical Office. The LSS collects detailed income and expenditure information from households in a random sample of urban and rural communes nationwide. Since only 20 percent of the sample communes had reported by the time of this writing; the preliminary data can not yet be formally generalized to the population of any region or to the nation. Nevertheless, these are the only randomly obtained data available on fuel choice and expenditures at the household level across the diverse agro-ecological zones in Vietnam and the indicative results appear to be consistent with anecdotal evidence and other sources of information. Findings based on the partial sample results are summarized in Table 2.2. They permit a

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5 Limitations on resources and time did not permit the conduct of a national survey during this ESMAP study, although a focussed survey was done in some parts of the Red River Delta in recognition of the severity of the situation in that area. The analyses drew substantially from the results of past studies by the Energy Institute that are described in Annex III.

preliminary analysis of the distinct patterns of energy consumption between urban and rural areas of the various agro-ecological regions.

Table 2.2. Vietnam 1992 Primary Cooking Fuel, Electrification Rates, and Energy Expenditures (%)

	Rural					*Urban*					
Agro-ecological Region (1)	*North*	*Red River Delta*	*Hanoi*	*Central*	*Me kong Delta*	*North (2)*	*Red River Delta*	*Hanoi*	*Central*	*Me kong Delta*	*Ho Chi Minh*
Primary Cooking Fuel											
Leaves, Straw, etc.	49.1	98.5	70.0	60.2	7.8	17.7	3.3		17.7		
Wood	49.7	1.0	8.7	39.8	90.7	51.0	38.3	12.5	51.0	98.4	30.2
Charcoal					1.0	2.1			13.5		40.6
Coal (3)	1.2	0.5	20.7			25.0	55.0	53.1	13.6		
Kerosene					0.5	4.2	3.3	15.6	4.2		28.1
Electricity			0.7					18.8		1.6	1.0
Electric Connection	36.4	72.2	95.3	21.4	16.6	89.6	100.0	100	89.6	67.7	100
Energy Expenditures (% of Total Budget)	2.2	3.5	5.6	3.1	2.7	10.0	11.2	6.9	10.0	4.4	11.0

Notes: (1) See notes to Table 2, Annex V for a listing of provinces in each agro-ecological region.

(2) No urban clusters are reported in the Northern Highlands or North Midlands in this early return from the Living Standards Survey (these preliminary results are based on early returns of only 20% of sample clusters). The figures in this table for urban households in the North are based on the fuel use patterns of urban Central households with an appropriate modification for the split between coal and charcoal.

(3) Coal or charcoal was one category in the Living Standards Survey. This table assumes that households using coal or charcoal as a primary cooking fuel in the north use mostly coal, in the South use mostly charcoal, and in the central regions are evenly split.

Source: Annex V based on preliminary returns from the 1993 Living Standards Survey.

Regional Differences

Rural Household Fuel Usage

3. Reflecting the degree of stress placed on the agricultural and forest resource bases across the country, the data indicate that rural households use leaves, grass and crop residues as the primary cooking fuel in all regions except the Mekong Delta. Shortages of immediately accessible fuelwood are prevalent for rural people in the North and central regions, and especially in the Red River Delta. Only in the North does wood play an equal role to forms of biomass lower on the fuel ladder. In a notable exception, rural cooking fuel usage patterns in the Mekong Delta are dominated by fuelwood. This result appears to indicate that there is no problem with wood supply in the area, a finding supported by field visits to rural households.

4. If the early patterns reported in Table 2.2 are any indication, it appears that substantially more rural households are connected to electric service than estimated by official figures. Over the nation as a whole, these returns indicate that roughly 35 percent of rural households have electric service as opposed to the 14 percent official estimate. Electric service appears to have reached almost every rural home in and around Hanoi and to have made substantial penetration throughout the Red River Delta. Northern Highlands and North Midlands are mid-way through the process of rural electrification. The share of rural households with electric service drops off dramatically in the service areas of PC3 and PC2, in the Central, Southern, and Mekong Delta provinces. The percent of rural households that share their electric meter with at least one other household appears to be substantial, ranging from 12 percent in the Mekong Delta to 50 percent in central regions (see

Annex V, Table 2). Shared metering may be one factor in explaining the divergence between official estimates of rural electrification and the substantially higher rates implied by these preliminary figures. Another factor may be the different definitions used for rural and urban areas.

5. The data indicate that rural households spend only a small fraction of their household budgets on fuels, suggesting that most fuel is collected. Low fuel expenditures by rural households in the Mekong Delta is notable: even with very high wood use, it appears that much of this wood is collected from the household's own sources. Over 80 percent of the households sampled in the Mekong Delta that use fuelwood report that they collect their wood. A similar share of rural households that use fuelwood in the North and central regions gather their own fuelwood (see Annex V, Table 2).

Urban Household Fuel Usage

6. The transition from traditional rural fuels to conventional fuels as a function of urban living conditions can be seen clearly in Table 2.2. Though some urban households still use sawdust, husk, or agricultural residues as their principal fuel in the central (and possibly North) provincial urban centers, the bulk of cooking services are provided by fuelwood. The transition to coal in the North and charcoal in central towns is clearly evident. Perhaps a reflection of an abundant biomass resource endowment, wood is almost universally chosen as the primary cooking fuel in the provincial urban centers of the Mekong Delta. The bulk of cooking services in Ho Chi Minh City are met by wood, charcoal, and kerosene, each supplying roughly one third. In urban areas of the Red River Delta outside of Hanoi, wood is still a major fuel, but has been displaced by coal as the primary cooking fuel of most households. Traditional fuels have been almost entirely displaced in Hanoi by coal, kerosene and, notably, electricity.

7. Urban households appear to spend a strikingly large share of their household budgets on fuels. As the figures reported in Table 2.3 are averages, the cost of fuels may represent a severe financial burden to the urban poor in most areas of Vietnam. This is important as one goal of fuel pricing policy is to reduce the financial burden of energy use on poor urban households.

8. Hanoi and the Mekong Delta provide notable exceptions to these tight financial constraints on urban households. This is due to primarily the low cost of the principal urban cooking fuels used in each area: coal in Hanoi and fuelwood in the Mekong Delta. As the prices of these fuels are not explicitly controlled by government, they reflect market conditions. Coal prices were decontrolled as of 1988. Since then production levels have dropped dramatically reflecting mainly diminished demand from the coal-fired power sector as new hydro-power capacity from Hoa Binh came on line. Current production levels are roughly 4 million tons per annum while installed capacity is close to 10 million TPA. As a result, prices on the type of coal used in households (mostly fines that are shaped into briquettes and patties) have remained low since 1988, benefiting urban households in the North and the Red River Delta.

9. Not unlike their rural neighbors, over 60 percent of urban households in the Mekong Delta collect fuelwood (see Annex V, Table 2). This indicates that urban households throughout the delta are at an early stage in the urban fuel transition: biomass fuels are plentiful and immediately accessible for collection. The woodfuels trade for supply of urban households in provincial towns of the Mekong Delta does not appear to be nearly as substantial as the woodfuels trade for urban demand in the Red River Delta, central regions, and in Ho Chi Minh City where over 80 percent of urban households that use fuelwood purchase it. Urban households in the Mekong Delta appear to

spend little on fuels, largely a benefit they obtain by collecting woodfuels from the accessible woody biomass resource base. This economic benefit is appropriate as long as this usage pattern is not depleting the resource base. Though the impact of urban fuelwood use in the Mekong Delta cannot be determined from existing data, the evidence that most households gather their fuelwood is no cause for alarm. Conversely, the impact on the resource base of the substantial trade in fuelwood and charcoal for the metropolitan area of Ho Chi Minh City should be investigated.

Fuel Use in Hanoi

10. The situation in Hanoi was examined by two Government surveys in the past: i) a survey of nearly 10,000 households and household enterprises in Hanoi city conducted in late 1989; and ii) surveys of households and household enterprises in all 12 major towns in Hanoi province were conducted from 1985 through 1989. Note that these towns had at least 10,000 residents and are formally classified as urban (see Annex I). Survey results are available only in the highly summarized form presented in Table 2.3. While crop residues and coal provided the bulk of cooking services to small town households in Hanoi province, electricity was the major cooking fuel in Hanoi city in 1989. This is not surprising given the universal penetration of electricity, the convenience of cooking with electricity, and the low electricity tariffs at the time. What is surprising is the small share of cooking services provided by coal in Hanoi city, since it was the cheapest cooking fuel. However, until January, 1989, electricity was even cheaper than the end-of-the-year price in Table 2.3 and since the choice of cooking fuel is a long-term decision, these cooking fuel shares also reflect relative fuel prices in 1987 and 1988. If the cooking fuel shares of households in Hanoi city and the major towns in the province are weighted by populations, the cooking fuel shares that result show that coal provided 41 percent, while electricity provided 21 percent and kerosene 11 percent of cooking energy demand in urban households of Hanoi province in 1989. The more recent evidence presented above indicates that in response to electricity price increases and low coal prices, coal has continued to penetrate the urban residential market in Hanoi province.

Table 2.3. Hanoi: 1989 Household/Service Cooking Fuel Use

Fuel	*Total Cooking Fuel Use*	*Units*	*Delivered Cooking Energy (GJ)*	*Cooking Energy Share (%)*	*Price (Dong/unit)*	*Price (Dong/ delivered MJ)*
Major Towns in Hanoi Province						
Crop Residues	400,000	Tons	648,000	35.2%		
Fuelwood	36,550	Tons	99,416	5.4%		
Coal	198,800	Tons	1,005,928	54.6%		
Kerosene (1)	4,198	m^3	66,111	3.6%		
Electricity (1)	9,185	MWh	23,146	1.3%		
Hanoi City						
Fuelwood	2,362	Tons	6,426	0.9%	250	91.9
Coal	16,435	Tons	83,160	11.1%	55	10.9
Kerosene	11,948	m^3	188,179	25.2%	667	42.3
Electricity	186,038	MWh	468,816	62.8%	41-82-120	16.25 – 47.5

(1) Quantities of kerosene and electricity for small town households are total non-lighting fuel use for households/ service.
Source: Total cooking fuel use and fuel prices from Sectoral Energy Demand in Vietnam, June 1992.

Fuel Use in Ho Chi Minh City

11. In Ho Chi Minh City, the transition towards modern fuels is relatively advanced. Unlike the situation in the North, coal plays little role as a household fuel in the South. Furthermore, crop residues are only used to a limited extent. Most households in HCMC have access to electricity. For cooking, households use fuelwood and charcoal, kerosene, some electricity, and LPG has recently been introduced. Many households have installed cooking facilities for different fuels which gives them the option to choose between, for example, electricity, gas or fuelwood depending on relative prices and availability. LPG was recently introduced to the market in HCMC and has within a short time gained some popularity. The LPG which is being marketed at present is imported. In the future the South plans to have its own production of LPG based on gas from off-shore oil fields. This domestic supply is expected to bring down prices and increase consumption so that LPG may become a major household fuel. A gas pipeline from the Bach Ho oil field to HCMC is at present under construction and a LPG plant is planned for completion in 1995. The high rate of increase in population and per capita incomes will contribute to a further rapid transition towards modern fuels by HCMC households.

Household Energy Markets

12. To gain insight into sources of supply and retail prices of fuels for households in major urban areas, fuel merchants in Hanoi, Danang, and Ho Chi Minh City were surveyed in 1993. Table 2.4 summarizes the findings on market prices as well as the calculated cost to households on end-use basis.

13. In *Hanoi*, coal emerges as the cheapest cooking fuel and appears to be making a major penetration in the residential sector market. Most household coal in Hanoi is consumed as briquettes coal patties. Sources of fuelwood for urban markets in Hanoi province are examined in Chapter 3. In *Danang* city, fuelwood is the dominant household fuel marketed. Most of the fuelwood for sale in the city comes by boat through a large wholesale market at the port. According to the traders, roughly 70 percent of the wood comes from plantations with the rest coming from natural standing forests. The main wood supply sources are the districts of Thanh Binh, Dai Loc and Chu Lai from 45 to 90 km from Danang. Charcoal is reportedly produced in Phu Khanh and Quy Nhon provinces 350 km south of Danang on the coast. Coal briquettes, made and distributed by the Central Region Coal Company, were introduced only four years ago in Danang and their use is increasing rapidly, especially since the most recent electricity price increase in 1992. Coal traded in Danang is brought by boat from Quang Ninh in the North and by truck from Nong Son mine about 85 km from the city.

14. In *Ho Chi Minh City*, fuelwood, charcoal and kerosene are the principal cooking fuels marketed. HCMC has an extensive woodfuels supply system, run entirely by private business. There are fuelwood traders in every district of the city and a large wholesale market at the harbor. The traders report that for many years the primary fuelwood supply sources were natural forests of neighboring provinces Dong Nai, Tay Ninh, and Song Be. Now much of this resource has been depleted and most wood comes from Thuan Hai and Lam Dong, about 150 km from the city, and from other provinces even further distant in the Northeast of the Mekong Delta Regions[6]. Greater distances have led to increasing fuelwood prices and a consequent fall in demand. Another reason for substitution out of wood is that it is not a convenient fuel for kitchens in the modern, multi-

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6 Ho Chi Minh City Fuelwood Market Survey, Institute of Energy, December, 1992.

story, multiple family buildings that are becoming more common in Ho Chi Minh City. Spot sample surveys show that wood is still the major household cooking fuel in the city, but it is not as dominant as it once was. Various grades of charcoal are produced in Can Ro Duyen Hai District only 30 km from the city, in the mangrove areas of the Mekong Delta further south, and in the neighboring provinces of Thuan Hai, Lam Dong, and other areas in the Southern Highlands 150 km and further from the city. The coal market in the city is small even though coal is the lowest cost cooking fuel on an end-use basis.

Table 2.4. End-use Prices of Cooking Fuels in Major Urban Areas

	Hanoi	*Danang*	*Ho Chi Minh City*
Prices per unit			
Fuelwood (kg)	310	280	340
Charcoal (kg)		1,100	1,450
Coal fines (kg)	170	280	240
Coal Briquette (kg)	250	375	340
Kerosene (l)	3,100	2,450	2,400
LPG (kg)			10,000
Electricity (kWh)	450	450	450
Prices/Delivered MJ			
Fuelwood	114	103	126
Charcoal		147	193
Coal fines	34	55	47
Coal Briquette	63	95	86
Kerosene	197	156	152
LPG			362
Electricity	179	179	179

Conversion factors used: fuelwood 16MJ/kg @ 17% stove efficiency; charcoal 30MJ/kg @ 25%; coal fines 23MJ @ 22%; coal briquette 18MJ/kg @ 22%; kerosene 35 MJ/liter @ 45%; LPG 46MJ/kg @ 60%; electricity 3.6 MJ/kWh @ 70%.
Source: 1993 Survey of Fuel Markets in Major Urban Areas.

15. According to market prices in early 1993, wood is slightly higher priced in Ho Chi Minh City than in Hanoi and Danang. This reflects the fact that it is transported over longer distances than wood for Danang and may also include an income effect on prices as people with higher incomes in Ho Chi Minh City may be willing to pay higher prices for a fuel they value. Fuelwood prices have risen to the point that the average retail fuelwood price is now more than twice the price of coal on an end-use basis. Despite this differential, the coal market in the city is small. As readily accessible natural stands are depleted and fuelwood prices rise even further, kerosene (a convenient fuel for urban cooking) and coal (the cheapest fuel) can be expected to become important household fuels in the city. It is not possible with existing information to establish a causal relationship between woodfuels use in Ho Chi Minh City and forest degradation in neighboring provinces. However, the evidence reported by fuelwood traders indicates that the forest resource in provinces of the Northeast of the Mekong Delta Region are being mined.

Demand Management with Improved Cook Stove Programs

16. Since cooking accounts for about 85 percent of total residential sector energy consumption, it is logical to consider an improved cook stoves program as a means to reduce demand for the major cooking fuels, particularly wood. In principle, the scope for fuel savings is tremendous, given the very low efficiencies of typical wood cook stoves in Vietnam. Experience from cook stove programs in other countries over the years have shown that more efficient stoves

do not necessarily translate into reduced fuel demand. Instead, it is not uncommon for much of the benefits of improved efficiency to be obtained in terms of enabling households to do more cooking, improving the kitchen environment (e.g., smokeless stoves, chimneys, etc.) and saving time. However, carefully administered programs to disseminate improved stoves have resulted in improved welfare and some fuel savings. Another important argument is that, considering the magnitude of potential benefits, the cost of launching an improved cook stoves program dissemination is small, both in absolute terms and in comparison with alternative fuel saving programs, such as biogas.

17. Improved stove programs started in Vietnam in the early '80s. Three government institutes have been involved: the Institute of Energy, the Forest Science Institute of Vietnam, and the Hanoi Architectural Institute. The State Commission for Science and Technology plays a coordinating role between the ministries and coordinates activities in all regions. Outside assistance has come from such donor agencies as FAO's Regional Wood Energy Development Programme (RWEDP), based in Bangkok, and the Swedish International Development Agency (SIDA).

18. The present program in Vietnam is small and probably ineffective. The Institute of Energy appears to be the lead agency for the program and has a small stove unit. The unit is undertaking research into improved stoves design and is implementing a limited dissemination effort, more or less confined to the area around Hanoi. It is unclear whether the improved stoves are simply given away free or if part of the cost is paid by the recipients. What is certain is that because of the limited budget and the non-commercial nature of the dissemination approach, only a small number of stoves could be distributed. While there is a demonstration effect to this effort, the gross benefits are negligible. Only a commercial approach can make the project self-sustaining and capable of disseminating a large volume of stoves. Experience worldwide indicate that Government can play a key role in promoting public interest in improved stoves and in encouraging commercial dissemination efforts[7].

19. Programs that involve artisans early in the stove design process and include standardized parts that can be easily produced without specialized dies or procedures stand a better chance of success. The role of small informal stove makers in various parts of Vietnam is important as they are the traditional suppliers to the community.

20. Lessons learned elsewhere also indicate that programs should be highly selective of their markets, identifying areas where fuelwood is normally purchased, prices are high and distances to free supply sources are great. Efforts aimed at benefiting chiefly the poor unfortunately are the most difficult to sustain because the poor normally cannot afford the higher purchase price of improved stoves (often two to three times the price of traditional ones). It may be best to initially target middle-class households that are undergoing the fuel transition and have cash. Apart from the cost of "stove fairs" and other promotional activities that need to be borne by the Government, subsidies should be avoided as they distort incentives for both users and artisans. A well-designed, self-sustaining program for disseminating large volumes of higher efficiency cook stoves could have a significant impact on household welfare and on total household fuel demand.

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7 A comprehensive review of international experience in this field was conducted by ESMAP and published in 1993. See for example, Barnes, et al, "The Design and Diffusion of Improved Cooking Stoves", *The World Bank Research Observer*, vol.8, no.2 (July 1993), pp 119-41.

Projecting Residential Sector Energy Demand

21. Although the data collected in this study provides a good picture of the current structure of residential energy demand and an idea of the direction of the energy transition in the various regions, it is not detailed enough to construct a formal model for projecting energy demand in the subsector. In rural areas, local "free" resource availability and the population density of the community appear to play important roles in determining fuel choice and use along with relative prices and incomes. In urban areas, availability of fuels in the marketplace, prices, and incomes largely determine fuel use. Demand estimates should account for the effect of income on fuel choice, especially since the income elasticity of demand for traditional biomass fuels is generally negative, and strongly so in urban areas undergoing the fuel transition. Fuel usage patterns could change dramatically, especially in urban areas, with the structural changes in the economy and increases in per capita incomes that are expected over the next 20 years. Without a formal model based on results of a comprehensive and generalizable household energy demand survey, it is not possible to evaluate the potential effects of pricing reform, the introduction of coal to rural areas in the North as a substitute for wood, removing the kerosene distribution requirement, changes in rural electrification policy, placing restrictions on the use of electricity for cooking, and other interesting policy questions.

22. Assuming rural usage patterns stay as they are and the rural population grows at 1.7 percent per year, the annual demand for biomass energy by households will rise from 21 mtoe to nearly 25 mtoe by 2002. This is likely to put further strains on the natural resource base. This suggests that efforts to place the formulation of policy on a sounder footing through the systematic gathering of more detailed information about the subsector should be a priority of government.

23. Meanwhile, there is immediate cause for concern for resource-stressed rural areas, particularly parts of the Red River Delta. The excessive use of low-grade biomass residues as household fuels in the Delta raises serious questions about the environmental sustainability of the practice and the larger issue of the deterioration of the quality of life of people in this highly populated region. The present study has identified the Red River Delta as having the highest priority for more detailed analysis of the situation. These issues are analyzed further in Chapter IV.

Policy Implications of Household Energy Transition

24. As urban households purchase most of their fuels, income, prices and distribution policies largely determine urban residential fuel choice and use. Because the costs of stoves is relatively small, households can shift between between wood, charcoal, coal and kerosene relatively rapidly. The transition to bottled gas or electricity for cooking is a longer term substitution as the appliances needed require substantial financial outlays. Many urban homes have stoves for more than one fuel, allowing them to shift in response to seasonal or longer term changes in fuel prices and availability.

25. Actual substitution trends and responses of households to changing conditions are difficult to gauge due to lack of data, but some inference can be made from the urban patterns in presented in Table 2.2 and what is known of the urban household fuel transition in other countries. Ongoing research on the transition from traditional to conventional fuels in urban areas in many developing countries indicates that government policies have a marked influence on the way a country goes

through the transition.[8] Income, fuel price, and availability are the major determinants of urban household fuel choice and use. Much of the benefits of subsidized prices on conventional fuels used by the poor are generally obtained by middle and higher income households as they are able to consume larger quantities of the subsidized fuel. Conversely, a general subsidy on all household fuels does serve to lower the cost of energy use to the urban poor. Evidence from almost 50 urban areas in 12 developing countries has established that the prices of traditional fuels track prices of conventional fuel substitutes. Hence, if the objective of residential energy pricing policy is to reduce the energy expenditure burden on poor households, conventional fuels should not be taxed. Fuel distribution policy has an independent impact on fuel choices. Restrictions on conventional fuel imports serve to limit their adoption to higher income households. In countries that allow the market to determine imports, conventional fuels penetrate more rapidly into middle income households than in countries that limit imports. A market-based approach to residential energy sector planning in which fuel imports are not restricted and prices are set according to cost appears to be equitable because households of all income levels benefit.

26. The distributional implications of fuel pricing policies and the effectiveness of energy policies designed to protect forest resources are clearly important issues for policymakers in Vietnam as the urban economy undergoes the transition from traditional to conventional fuels. As one element in the country's rural energy supply policy, approximately 200,000 tons of coal fines are distributed annually at subsidized prices to villages in mountainous areas of 13 provinces. This policy costs the government about US$1 million annually with the objective of protecting highland forests from excessive fuelwood demand. Though the estimates in Chapter 4 are very rough, they indicate that there is no fuelwood deficit in the Northern or Southern Highlands. However, there may be severe localized shortages that are not evident in the aggregate regional figures. Moreover, 200,000 tons of coal is a substantial amount, but is small in comparison to existing quantities of fuelwood used in these two highland regions. A program of coal distribution might be effective if the coal were distributed to those communities that would otherwise deplete the surrounding resource base. However, as stated above, existing data does not allow this to be done in a consistent and comprehensive fashion. A priority should be placed on assessing the effectiveness of this policy in the communities that receive subsidized coal as an integral part of the expanded household survey efforts and studies of urban woodfuel supply systems.

27. Petrolimex is required to supply all rural households with a ration of 1.7 liters of kerosene monthly at urban prices. This policy is designed to raise rural living standards by providing an affordable lighting fuel. No estimates were available on how much this policy costs the government. If the actual rate of rural electrification is closer to 35 percent (as reported above) than the [illegible] percent reported by the electricity supply companies, one would expect that a substantial share of rural kerosene use would be diverted for non-lighting end-uses, such as cooking and fire-starting. Though existing data cannot address this question, it would be important to assess the extent to which lighting kerosene is diverted to other uses in electrified rural homes.

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[8] Barnes, D., The Urban Energy Transition in Developing Countries (draft manuscript), June 1993.

III. ENERGY PROBLEMS IN THE RED RIVER DELTA

Introduction

1. The Red River Delta is the most densely populated and intensively cultivated region of Vietnam. The patterns of energy use presented in Chapter II show that a large share of the available rice straw is used as a fuel for meeting rural cooking needs and for boiling pig food[9]. The widespread use of rice straw for fuel reflects low cash incomes[10] and scarcity of immediately accessible woody biomass. This has caused concern that continued practice may lead to serious depletion of soil nutrients. In addition, there is serious concern that demand for wood by rural households in small towns in the delta may be depleting the modest forest resources of the delta and neighboring North Midlands provinces. Over 11 million of the Red River Delta's 13.5 million residents live in villages or small towns classified as rural. As such, even modest demand for wood by rural households may result in a substantial drain on what is left of the standing forests near towns.

2. To address these issues, a survey of fuel use and supply sources in rural households in four Red River Delta provinces was conducted by the present study. Four hundred households in villages and 1200 households in small towns of 600-1000 residents were surveyed. The sample villages and towns were selected to reflect the varied resource conditions throughout the delta. Though sample villages and towns were not selected randomly, and hence cannot be formally generalized to the entire rural population of the delta, some key data, such as the average electrification rates and incomes of households, obtained in this survey are very close to those of the rural Red River Delta households in the preliminary returns from the Living Standards Survey.[11] As such, the sample does not appear to be substantially biased and results can be cautiously interpreted as indicative of rural fuel use in the delta. Key summary tables of survey results are presented in Annex IV. In addition to this survey of household fuel use, fuelwood traders in Vandien town (15 km south of Hanoi towards Hoa Binh) and Sontay town (42 km west of Hanoi) were interviewed to assess the sources of their fuelwood. Though these are urban towns, the sources of traded fuelwood in neighboring small towns are expected to be similar.

Patterns of Fuel Use and Energy Expenditures

3. The average amount of each fuel used for each major end-use by sample households is displayed in Figure 3.1. Cooking end-uses dominate in village households, where straw and stalks are the major fuel, and in small town households, where fuelwood and coal are used in roughly equal proportion. In village households, the practice of boiling plant stalks, other residues, and rice as fodder for pigs uses almost as much energy as cooking household meals. Household enterprises

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9 The very large share of pig feed boiling in the end use figures is similar to ESMAP findings in southern China.

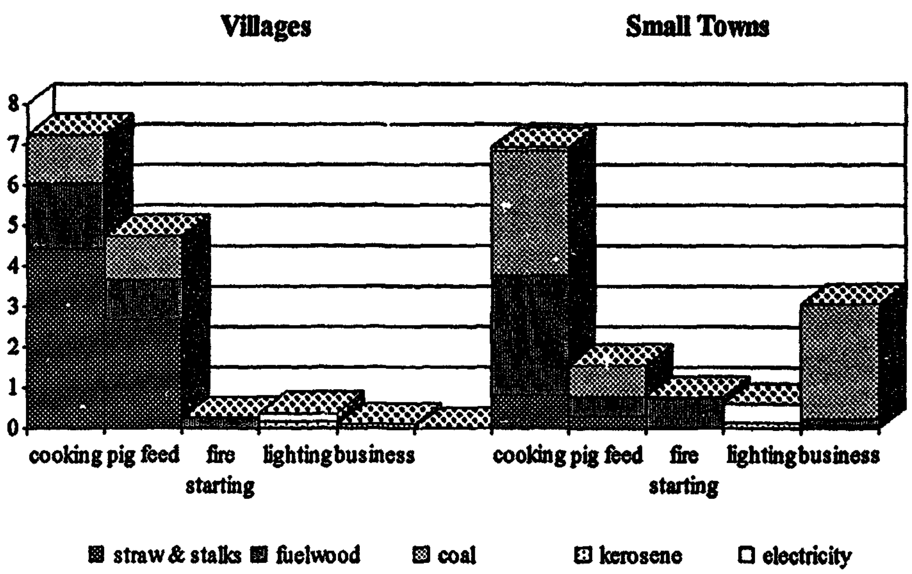
10 Preliminary returns from the Living Standards Survey indicate that rural per capita cash incomes in the Red River Delta outside of the immediate vicinity of Hanoi and in northern regions are substantially lower than in central and southern Vietnam.

11 Mean monthly per capita expendures for rural households in the Red River Delta from the partial Living Standards Survey sample was 85,500 Dong with 84% of households electrified. Surveyed households in this survey had mean monthly per capita expenditures of 64,000 Dong in villages and 102,000 Dong in small towns with 91% of village households electrified and 99% of town households electrified.

are the second major end-use of energy in small town households--a demand met mostly by coal. Over 40 percent of all coal used in the surveyed households in small towns was used in household enterprise (1992 Rural Energy Survey in the Red Rive Delta, Table A4.19). Estimates of energy consumption in rural areas that do not account for these end-uses could be significantly lower than actual levels.

4. In addition to cooking, boiling pig food, and household enterprise, a substantial amount of wood is used as tinder to start coal stoves, especially in small towns. Since coal briquettes are difficult to light without kerosene or wood as kindling, wood is a complementary fuel to coal in this use. The choice of fuelwood for starting coal fires is far more prevalent than kerosene in both village and town households and hence fuelwood appears to be the preferred kindling fuel. For this reason it may not be possible to completely displace fuelwood demand with coal. Sample averages in both villages and small towns indicate that just over one kg of wood is necessary to light every 10 kg of coal briquettes (1992 Rural Energy Survey in the Red Rive Delta, Tables A4.4 and A4.19). Of the 82 percent of households in small towns that use fuelwood, almost 35 percent use it *only* for starting coal fires.

Figure 3.1. Red River Delta: Fuel Use by End-Use (kgoe/cap/month)

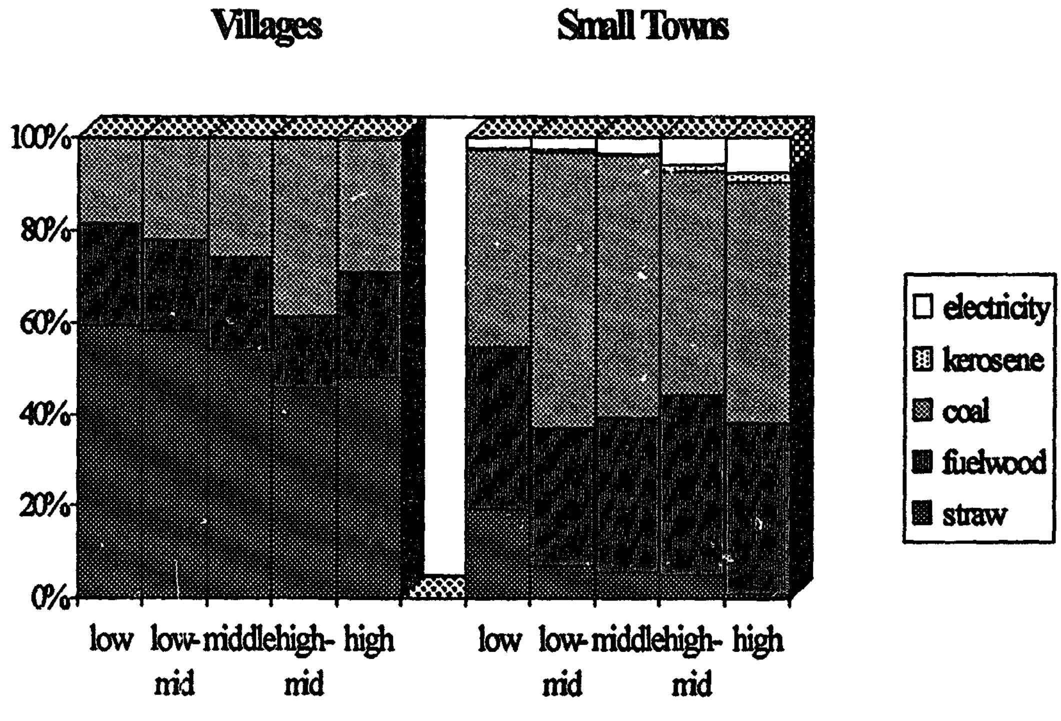


Source: 1992 Rural Energy Survey in the Red River Delta (Tables A4.4 and A4.19).

5. Survey findings on lighting fuel choice and use raise some interesting questions. While 91 percent of sample households in villages are electrified, 98 percent report using kerosene for lighting, using, on average, 1.2 liters/month for lighting (1992 Rural Energy Survey in the Red Rive Delta, Tables A4.3 and A4.4). Kerosene is used for little else in these villages. A similar pattern emerges from the small town sample where there is nearly universal access to electricity, but fully 75 percent of households report that they still use kerosene for lighting. Despite higher electrification levels, households in small towns that use kerosene for lighting use just as much kerosene for lighting, 1.2 liters/month, as their village neighbors (1992 Rural Energy Survey in the

Red Rive Delta, Tables A4.18 and A4.19). Roughly half the kerosene consumed by households in these small towns is used for lighting. Though 1.2 liters of kerosene over one month does not provide a great deal of light, the question remains of why kerosene is consumed at all for lighting in electrified households? It is not because electricity is new to the area: the median household has had electricity service for 5 and 12 years in villages and small towns, respectively. It is also not because households cannot afford fixtures and light bulbs: average installed lighting capacity is 85 Watts in village homes and close to 200 Watts in small towns. However, over 60 percent of residents in both villages and small towns feel that the electricity service is unreliable and continued use of kerosene for lighting is probably a reflection of an unreliable standard of electrical service.

Figure 3.2. Red River Delta: Fuel Shares of Delivered Cooking Energy by Income Quintile



Source: 1992 Rural Energy Survey in the Red River Delta (Tables A4.5 and A4.20).

6. Turning now to the major household energy end-use, the share of cooking energy delivered to the pan by each fuel for households in villages and in small towns is displayed in Figure 3.2 (Also see Table 3.1, below, for heating values and stove efficiencies). The transition from traditional to conventional fuels as a function of income and location is evident. Over one-half of the cooking energy needs of village households is met by rice straw and other agricultural residues, but coal is making major inroads in higher income village households. Fuelwood which is partly gathered appears to be a transition fuel between rice straw which is entirely gathered and coal which is entirely purchased. Of the 60 percent of village households that use fuelwood 40 percent gather it themselves and over half of those who gather fuelwood obtain it from their own land or common land very close to home (1992 Rural Energy Survey in the Red River Delta, Table A4.8). Households in small towns purchase almost all of their fuel. Rice straw is a significant cooking fuel only in the poorest households. Coal and purchased wood provide the bulk of cooking services

in small towns. Even electricity has begun to be used for boiling water in electric kettles and cooking on hotplates in wealthier town households. Given the relative convenience of electricity for quick cooking tasks, some use of electricity is to be expected. Even though "white good" appliances are expensive in relation to other household expenditures, small town households have had enough time (median 12 years of electrical service) to accumulate electrical cooking appliances. However, since coal is so much cheaper than electricity, in contrast to the situation in Hanoi electricity is not expected to become a major cooking fuel in rural households of the Red River Delta.

7. As shown in Table 3.1, coal is substantially cheaper than any other purchased fuel on an end-use basis in villages and towns of the Red River Delta: 1/3 the cost of wood; 1/7 the cost of kerosene; and 1/9 the cost of electricity. With these existing fuel prices, it is not surprising that coal has displaced fuelwood as the second most important cooking fuel in villages and is the dominant cooking fuel in small towns where almost all fuels are purchased. In fact, the overall cooking fuel shares shown in Table 2.3 vary directly with access to residues from the family fields, access to wood supplies for collection, and the prices of marketed fuels. The relatively high price of wood reflects its scarcity and indicates that these small towns are well advanced in the transition to conventional fuels. If this indication is correct, the share of end-use cooking services provided by coal can be expected to increase as wood becomes increasingly scarce and incomes rise, perhaps even displacing crop residues as the most important cooking fuel for village households. At existing prices, neither kerosene nor electricity can be expected to be adopted as important fuel for cooking at any time in the near future.

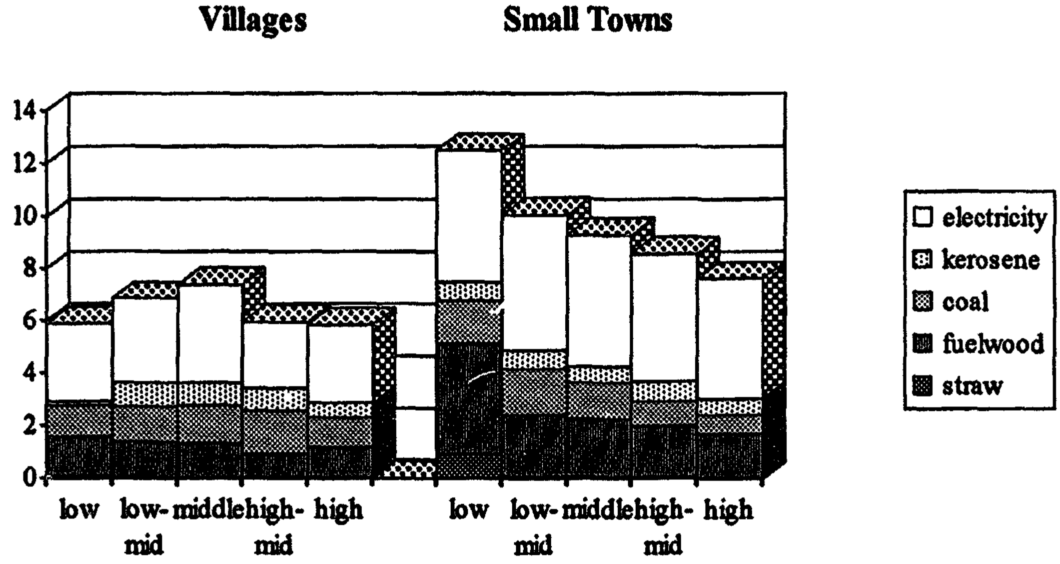
Table 3.1. End-use Prices of Purchased Cooking Fuels and Shares of Cooking Services Delivered

Fuel	*Price (Dong/unit)*	*Heating Value (MJ/unit)*	*Stove Efficiency (%)*	*Price (Dong/ delivered MJ)*	*Cooking Energy Share (%)*
Villages					
Crop Residues (kg)	--	13.5	12	--	53.2%
Fuelwood (kg)	210	16	17	77	20.0%
Coal (kg)	131	23	22	26	26.6%
Kerosene (lt)	2916	35	45	185	0.0%
Electricity (kWh)	595	3.6	70	236	0.2%
Small Towns					
Crop Residues (kg)	--	13.5	12	--	7.4%
Fuelwood (kg)	245	16	17	99	35.3%
Coal (kg)	168	23	22	33	52.0%
Kerosene (lt)	2789	35	45	177	0.9%
Electricity (kWh)	577	3.6	70	229	4.3%

Source: 1992 Rural Energy Survey in the Red River Delta.

8. The ready availability of rice straw as a "free resource" and some access to wood supplies keeps spending on fuels by village households between 6 and 7 percent of household income, without much variation across income groups(see Figure 3.3). This burden is not excessive in comparison to other countries in the region. If freely available wood supplies diminish in the future, an increasing financial burden of purchased fuel and a downward shift into rice straw and other agricultural residues can be expected. Substitution possibilities by coal appear attractive as coal now provides over 25 percent of cooking services for a relatively small financial cost. Almost half of fuel expenditures in village households is for modest electricity consumption of 20 kWh/month/household which is used mostly for lighting (1992 Rural Energy Survey in the Red River Delta, Table A4.4)--indicating a high value placed on electricity service.

Figure 3.3. Red River Delta: Fuel Expenditures (% of Income) by Income Quintile



Source: 1992 Rural Energy Survey in the Red River Delta (Tables A4.6 and A4.21).

9. Even though the average cash income of surveyed households in small towns was twice that of village households (1992 Rural Energy Survey in the Red River Delta, Tables A4.1 and A4.16), since most of their fuels are purchased, small town households spend 7.5-12.5 percent of their incomes on fuels, with the poorest households bearing the highest relative burden.

10. Expenditures on coal are remarkably low, given that coal provides over half of cooking energy requirements in town households. According to results displayed in Figure 3.3 households in small towns spend only 1.3 percent of their cash incomes on coal without much variation across income groups. Small town households spend twice as much on wood as they do on coal even though wood provides a substantially smaller share of cooking services. Expenditures on fuelwood and rice straw present a substantial financial burden to poor households in small towns of the Red River Delta. The share of family incomes spent on wood and rice straw falls monotonically with income. Substitution possibilities by low cost coal as a means to lower the energy burden on poor town residents in the Red River Delta appear attractive. However, as a substantial amount of coal is consumed in middle and higher income households, subsidizing coal to provide an affordable cooking fuel for the poor could be extremely costly in national terms. Coal was distributed in plan and prices were set in four regions until 1988, after which distribution and prices have been largely decontrolled. The current low retail prices of coal fines and briquettes that present such attractive substitution possibilities are determined by market conditions (a review of current pricing policy is presented in Annex II).

11. Small town households in all income groups spend about 5 percent of their incomes on electricity, providing an average consumption of 60 kWh/month/household for some substantial uses in addition to lighting. This indicates that households of all income groups value the services provided by electricity and are willing to pay a substantial amount relative to their incomes to consume these services. Counting only fuel expenditures for necessary cooking services, the excessive energy burdens on household budgets mentioned above diminish to more reasonable

levels ranging from 2.5 percent of household incomes in the highest income group to 7.5 percent in the poorest households in small towns.

Issues Related to Extensive use of Agricultural Residues

12. The use of rice straw as a predominant rural household fuel in the Red River Delta as portrayed in Figure 3.1 has raised concern that continued practice could deplete soil nutrients and lead to lower agricultural productivity in this very fertile delta region. Indicative estimates of biofuel use by households in the Red River Delta (partly based on the Rural Energy Survey) are compared to estimates of annual sustainable yield (Chapter 4, Table 4.4, based on mission estimates in Annex VII).

13. These figures indicate that only about 40 percent of total annual rice straw production is burned in household stoves in the Red River Delta. Far from placing excessive demands on the agricultural resource base, this pattern of usage may be an integral component of a sustainable production relationship that has been in practice for centuries in the Red River Delta. Anecdotal evidence cited in the next chapter indicates that rice straw has been used as a fuel in rural homes of the Red River Delta for many centuries and that much of the ash is returned to the field as a fertilizer. Indeed, the reason that fields are burned after harvest in many parts of the world is to return the nutrients to the soil more quickly and to improve the workability of the soil. Another reason rice paddies are burned is that they must hold water; straw would make the soil permeable. Hence, it appears that at the implied levels of usage, crop residues are supplied on a sustainable basis and provide cooking services to households that would otherwise require a substitute fuel[12]. If the annual production of rice straw were not consumed in households stoves, much of it would be burned in the fields, thereby losing the economic benefit of the cooking services these residues could have provided. Any intervention designed to reduce the use of rice straw as a household fuel that resulted in a larger share being burned in the fields instead of in the home would incur a proportional economic loss.

Fuelwood Demand and Sources of Supply

14. While the above discussions may allay concerns over depletion of paddy soils due to the use of rice straw as a household fuel, the figures in Table 4.4 also indicate that concern over depletion of the modest forest resources of the delta and neighboring North Midlands provinces may be warranted. Estimates of fuelwood consumption in urban and rural households of the Red River Delta substantially exceed estimates of annual woody biomass yield in the delta and North Midlands combined. Survey data also show that roughly 40 percent of village households that use wood collect it. Of these, 60 percent collect wood from their own land or nearby commons land not more than 2 km away and the remaining 40 percent collect wood from state or forest land as far away as thirty km (1992 Rural Energy Survey in the Red River Delta, Table A4.8). However, fully 60 percent of households in villages that use wood purchase it and 2/3 of these households buy stemwood (1992 Rural Energy Survey in the Red River Delta, Table A4.8). Nearly all households that use wood in small towns buy it at market, with 85 percent of these households purchasing stemwood (1992 Rural Energy Survey in the Red River Delta, Table A4.23). Hence, stemwood is the preferred form of fuelwood in the market system and the market is the dominant

12 It must be emphasized that this finding is based on the rather tenuous assumption that the 1992 Rural Energy Survey is generalizable to the rural population of the Red River Delta. An energy survey on a generalizable sample frame must be designed and carried out to confirm this finding.

source of fuelwood for households in small towns and villages of the Red River Delta (1992 Rural Energy Survey in the Red River Delta, Tables A4.23a and A4.8a).

15. The main fuel markets in Hanoi, Vandien town, and Sontay town (both near Hanoi) were interviewed for this study to assess recent trends from the perspective of fuel merchants and to determine sources of fuelwood for urban centers in the Red River Delta. Sales of coal to households is growing quickly in Hanoi while sales of kerosene have fallen dramatically from over 30,000 tons per annum before 1990 to roughly 5,000 TPA in 1992. According to wood traders, the market for fuelwood in Hanoi has also fallen drastically as wood cannot compete with coal at existing prices. It has been shown (Tables 2.4 and 3.1) that both in Hanoi and in rural areas of the Red River Delta, fuelwood is 3 times as expensive as coal on an end-use basis. What little fuelwood is sold in Hanoi comes from sawmills and the Hoa Binh forest reserve. Traders in the Vandien town market (15 km from Hanoi) report a similar substitution of household coal for fuelwood. Most of the fuelwood sold in this market comes from the nearby Hoa Binh forest reserve. There is some concern with deforestation of the watershed around the Hoa Binh Hydroelectric Project (see Chapter 4) and these results from spot surveys of traders in two nearby urban markets indicate that the Hoa Binh catchment may be a major fuelwood supply area. A more detailed study of the fuelwood market structure around Hoa Binh and the forest resource management practices within the catchment area should be carried out at some point, especially given that severe erosion may reduce the capacity of the Hoa Binh reservoir and shorten the useful life of the Hoa Binh hydroelectric scheme.

16. Sontay town is located close to the Bavi mountainous area which is the source of all fuelwood traded in the market. Fuelwood is sold at market by collectors who travel to the mountains to collect the wood and by transporters who buy the wood along the road and take it to market. Fuelwood is priced substantially lower here than in the other centers because it is sold not as split stemwood, but as branches of various sizes. Small branches are sold for less than 200 Dong/kg while larger branches sell for up to 300 Dong/kg. As coal sells for the same prices here as in Hanoi (shipped from the mine by river boats and barge), small branch wood is only twice as expensive as coal fines. The impact of the fuelwood trade around the Bavi mountainous area on the standing forests is an open question.

17. Without more detailed estimates of local resources and traded quantities, it is not possible to determine with any clarity where the existing resource base is threatened and where it is being used sustainably. Generalizable fuel usage surveys and detailed market studies, along with the biomass resource surveys proposed in Chapter 4, are the necessary first step in defining the problem with enough accuracy to design policies that will lead effectively to sustainable patterns of resource use. Such studies appear to be in line with the objectives of the Red River Delta Master Plan[13] that is now being formulated. One of the key objectives of this early phase of the project is to formulate a master plan for sustainable socio-economic development in the Red River Delta. A survey of household energy usage patterns (similar to the one conducted for this study) based on a stratified random sample of communes in the Red River Delta that include interviews of merchants in fuel markets associated with each commune, and that traces woodfuel back to its source for each commune could shed much light on the questions raised above and give a solid basis for planning toward sustainability in the delta. Such an integrated study would ideally be

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13 UNDP funded (VIE/89/034), executed by IBRD in coordination with the Ministry of Science, Technology, and Environment.

executed by the master plan team in coordination with Institute of Energy staff that were involved with previous household energy surveys.

IV. ISSUES IN RURAL ENERGY SUPPLY

Introduction

1. As shown in the previous chapters, wood is presently the fuel of choice by households in most parts of Vietnam and is a major component of the total national fuel mix. Despite the household transition to modern fuels occurring as a result of modernization, it is likely that wood and crop residues will continue to be a dominant fuel in the next 2-3 decades. This chapter reviews available information on wood supplies, deforestation and ongoing plantation programs in order to assess the question of sustainability. Crop residues and coal, on the other hand, have become major household fuels in certain parts of the country, often not by choice but by necessity. It is also important to determine whether the trend for increased use of these wood substitutes will not have adverse impacts on the environment and household welfare. Electricity is not yet a significant fuel in rural areas and is not expected to displace biomass or coal for the major energy end-use, namely cooking. Electricity supply issues are mainly those related to finding ways to expand rural service connections under an environment of scarce public finances. These issues are discussed in Chapter 5.

Table 4.1. Vietnam: Land Area By End-Use ('000 hectares)

Land Type		*Land Area*
Agricultural land		6016
Rice land	3757	
Irrigation canals	174	
Other food crops	1273	
Commercial crops- sugar etc.	236	
Commercial crops- tea etc.	576	
Forest land		19065
Natural closed forest	8687	
Planted forest	628	
Degraded forest land	9750	
Miscellaneous land		6634
Urban land and roads		1326
Total Land		33041

Source: Official Statistics (see Table 1, Annex VII).

Wood Supplies: Review of the Data

2. Table 4.1, above, presents the area of Vietnam according to land use categories. Fully half the land area of Vietnam is classified as either degraded forest land (30%) or as miscellaneous land (20%). Some of the miscellaneous land is used for grazing (an estimated 324,000 ha.) and some of the degraded forest land is used for agriculture, including shifting cultivation. The fact that little information is available about land use or the actual or potential carrying capacity of the land for this large part of the country makes biomass assessment difficult.

3. Land classifications for each of 8 agro-ecological regions (based on geographical location and population density) are given in Annex VII, Table 1. Obtaining accurate information about land use and forest cover type is only the first, but necessary, step to determine the quantity and quality of the woody biomass resource base. It is vital to determine the growing stock and yield of

trees, bamboos, bushes and shrubs on all types of land if an assessment is to be made of the sustainability of woody biomass in different areas. Without such information, it is difficult to formulate plans and strategies targeted at optimal management and use of the renewable resource base. Because wood energy is a high bulk (and low cost) product, the supply source must be near the demand center for the product to be used. Thus, a wood surplus in the highland regions of Vietnam is of no use to the delta farmers who are looking for fuel. This is why biomass assessments must be detailed and area specific.

4. Measurements of standing stock and annual yield for the different types of land in Vietnam are generally not available. Despite the lack of reliable growth and yield data, however, estimates of the growing stock and yield of woody biomass on all types of land formations in the country have been made on the basis of previous work.[14] These estimates, a summary of which is presented in Table 4.2, below, were built up from regional totals and made for each land classification and each agro-ecological zone. They have not been broken down to the provincial or district levels because they are meant to show the possible areas of shortages so that an inventory could focus on these areas. Nearly 85 percent of the growing stock and 50 percent of the annual yield come from the natural forests. These areas give a lower percentage annual yield in relation to their standing stock than trees on other land types because they are on a much longer rotation than other tree formations.

5. The supply sources for urban households and the non-household sectors are medium diameter trees, logging waste and wood industry residues which mainly come from the forests and plantations not more than 100 kilometers from the demand centers. It is estimated that commercial or traded woodfuel accounts for about one-third of wood energy demand, but it is concentrated in small supply zones which may be being over-cut; only an inventory of these areas could clarify the situation and enable the formulation of responsive policy.

Table 4.2. Vietnam: Estimated Growing Stock and Annual Yield for Above-Ground Woody Biomass

	Area	*Wood for Fuelwood and Charcoal*	
		stock	*annual yield*
Land type	*('000 ha)*	*('000 tons)*	*('000 tons)*
Agricultural land	6,016	11,562	1,544
Natural forest	8,687	465,385	18,616
Plantations	628	16,157	4,039
Degraded forest	9,750	27,857	6,965
Miscellaneous	6,634	27,954	6,987
Urban & Roads	1,326	1,893	190
Total	33,041	550,809	38,340

Source: Mission Estimates (see Tables 2 and 3, Annex VII).

14 See Annex VII for a review of previous estimates and the assumptions used here.

Forestry and Energy

Deforestation Issues

6. Over the last 50 years the area of natural forest has been reduced by over thirteen million hectares, from 22 million ha. to 8.7 million ha. Over the same period, 600,000 ha. of plantations have been established, bringing the net loss of forest lands to just under 13 million hectares. Some open question exist about land classification in Vietnam. Why are 19.1 million ha. classified as forest land if there are only over 9 million ha. of forests ? What is growing on land classified as degraded and how much of it is settled? What is the status and use of 6.6 million ha. of miscellaneous land of which only 0.3 million ha. have been identified as grazing land? There must be some activity on this land, but it is not recorded in official statistics. Without a clearer picture of current land uses and proposed plans it is impossible to monitor land use changes.

7. If it is assumed that deforestation is confined to the loss of 5 million hectares over the last half century, then the cause of this deforestation could be attributed to agricultural clearing, for the population has grown by 50 million during that period and each person consumes crops from at least 0.1 ha. to survive. However, many areas of forest were affected by the spraying of herbicides during the last war in the 1960s and 1970s and many are recorded as still not yet recovered. The Vietnamese National Conservation Strategy Plan (page 17) states that 1.7 million hectares of land were still affected by herbicides in 1985. The percentages of affected forests and cropland are not stated. In addition, some forested areas were cleared with bulldozers, others were defoliated with flame throwers and napalm, and yet others had saturation bombing applied. Some of this land may fall into the miscellaneous category and others into degraded forest land. If the latter assumption is correct, then a part of the former degraded forest land must have sufficiently recovered to be now classified as forests. This is not unusual, because forest areas, if left after cutting, will generally recover. This illustrates the dynamics of land use changes as degradation of once productive lands is rarely permanent if left idle.

8. The TFAP reports that only 9 percent of the forests are classified as "rich" (more than 150 m^3 timber per ha.), 31 percent of natural forests are classified as "medium" (timber stock of 80 to 150 m^3 per ha.), and 38 percent are classified as "poor" with a timber stocking density of less than 80 m^3 per ha. The remaining 22 percent is reported as "young" with no stocking volume given. The same report indicates that "rich" forests are declining at about 1.5 percent per year. This deterioration of the forest composition must be caused by over-cutting for wood products, but it is most likely for sawlogs and veneer logs rather than for fuelwood. There are probably many areas throughout Vietnam where local forests have been cleared for fuel and timber products or this process is underway. These areas can be located only by examining local supply and demand situations.

9. Estimated 1992 demand for the various wood products is shown in Table 4.3. Fuelwood commands the largest market share, even for "traded" roundwood commodities. An estimated 86 percent of demand for roundwood is for fuelwood (82%) or charcoal wood (4%) of which 5 percent is sawmill waste. However, this includes much self collected fuelwood for own use. If this is excluded, the estimated traded woodfuel amounts to 9.28 million tons or 68 percent of commercial wood products -- 58 percent fuelwood and 10 percent charcoal wood. Sawlogs and veneer logs account for 21 percent of demand, but this includes 12 percent of the total which is sawmill waste and already included under woodfuel. Poles, posts and pit-props, not all of which

are traded, are the next most important group and account for 20 percent of consumption, with the remaining 3 percent being pulpwood. Thus, fuel is the dominant end use of wood and, even if it is not the major cause of overall deforestation, it is important to examine whether it is causing stress on local resources.

10. In Vietnam, woodfuels already constitute over a third of *all* traded energy and must be considered an important commercial fuel. The woodfuel industry is a significant source of employment, especially in rural areas. Using average market prices in 1992, the market value of commercial fuelwood and charcoal traded in 1992 is about Dong 4 trillion (US$400 million), roughly 3 percent of estimated 1992 GDP. The annual employment generated in the preparation, distribution and marketing of these fuels is estimated to be in excess of 100,000 full time jobs, over 60 percent in rural areas. The ongoing economic reforms will probably further stimulate the woodfuels trade throughout the country, even as consumption of modern fuels also continues to increase.

Table 4.3. Vietnam 1992 Estimated Wood Demand by Product
Units: million tons (m^3) air dry - 15% moisture content dry basis

Wood Demand	*Weight*	*Volume*
Sawnwood (sawn) (1)	1.14	(1.60)
Ply & veneer wood (round)	0.04	(0.06)
Pulpwood (round)	0.35	(0.53)
Poles, posts & pit props	2.78	(3.90)
Fuel & charcoal wood (2)	27.93	(39.10)
Total Wood Demand	32.24	(45.19)
Sustainable Supply	38.34	(53.89)

Notes: (1) Finished product. It is assumed that waste from sawlogs is used as fuel and is included in that total. Estimated waste production ≈1.70 mill. tons.

(2) An estimated 9.28 mill. tons of fuelwood (7.97 mill t.) and charcoal wood (1.31 mill t.) were traded in 1992. This is 68% of the commercial wood products market, with poles etc. accounting for another 20%.

Source: Mission Estimates.

Localized Deforestation by Fuelwood Cutting

11. Using the estimation methodology presented in Annex VII, the annual sustainable yields of woody biomass, crop residues and other forms of biomass in each region of Vietnam were estimated. These estimates are compared against existing regional consumption patterns (estimated in Annex VI) in Table 4.4. This overview of regional supply of total biomass and existing demand for biomass as fuel is based on very little firm data from within the country, and uses information and experience from other countries. Therefore, it should be used as a guide, rather than an accurate picture of the situation in the various regions of the country.

12. Table 4.4 gives the supply and demand for crop residues as well as wood energy. This was done because these two types of biomass fuels are close substitutes. This table was compiled on the basic assumption that the demand for crop residues could not exceed supply, but the demand for wood products could, in the short run, by consuming the forest capital stock. However, if both of these types of biomass fuels are scarce, then rural people will and do burn grass, leaves and dung. Reflecting this, the constraint on crop residues demand was relaxed and the end column, which gives an estimate of grass, leaves and weeds production, was added.

13. For the country as a whole, sustainable supply appears to be in excess of demand. This is still the case after acccunting for other wood products demand, such as for sawlogs, veneer logs, pulpwood, poles, posts and pit props, estimated at 4.31 million tons of round wood in Table 4.3. Wood from protected forests is included in the supply, but the two highland areas, the areas with the most protected forests, have considerable surplus of wood and, therefore, this inclusion will not affect the overall picture.

Table 4.4. Vietnam 1992 Household Fuel Supply and Consumption for Cooking and Boiling Pig Food ('000 tons)

	Wood for Fuelwood and Charcoal				*Leaves, Straw, etc.*	*Straw & Stalks*	*Leaves & Grass*
	Demand			*Supply*			
Region	*Urban*	*Rural*	*Total*	*Total*	*Demand*	*Supply(1)*	*Supply(1)*
Northern Highlands	357	4,114	4,474	9,167	7,022	2,520	37,265
North Midlands	97	1,189	1,288	748	2,025	1,372	2,813
Red River Delta	313	1,140	1,453	424	2,259	5,996	1,946
North Central	373	2,707	3,081	6,080	7,022	3,794	20,565
Southern Highlands	245	1,171	1,415	8,808	3,069	1,349	25,880
South Central	648	1,781	2,429	5,456	4,779	4,188	18,529
N.E. of Mekong Delta	2,042	2,816	4,857	3,546	1,364	2,716	7,696
Mekong Delta	1,270	8,239	9,508	4,114	3,991	22,413	8,208
Vietnam	5,339	22,590	27,930	38,342	38,188	44,348	122,902

Source: Mission Estimates (see Annexes VI and VII).

(1) These figures are estimates of total production that includes: (a) production of cereals and other food crops, (b) annual growth of grass, weeds and leaves of all crops not included under (a). The estimates are based on the *Net Primary Production Potential* for the various climatic zones in Vietnam. Much of this production, of course, is used as animal feed for both domestic and wild animals, and some are not used and decompose naturally. But some are used as an energy source. The table indicates that this demand is substantially less than the total annual production.

14. Looking at the regions of wood shortages, it is seen that the North, the North Midlands and the Red River Delta have considerable deficits. It is in these northern regions that an inventory of tree resources is most urgently required, coupled with a demand survey as proposed in Chapter 2. Also, there are areas in the Northern Highland region where the forest capital is probably being extracted, such as in the Hoa Binh catchment area that supplies wood to Hanoi and Vandien referenced in Chapter 2, and similar surveys should be carried out in those areas.

15. In the southern regions, the critical areas where the tree capital is most under stress are the Mekong Delta and northeast of the Mekong Delta. The survey of fuel markets in Ho Chi Minh City reviewed in Chapter 2 indicated that the large demand from residents and from other urban and woodfuel using industries in HCMC are largely supplied by sources northeast of the city. Areas in the Mekong Delta, particularly the coastal mangrove and *Melaleuca* forests are harvested and may be being over-cut to meet urban demand as well. Little is known of the current status and impact of the woodfuels trade on these resources and on forest resources throughout the South that supply wood to meet energy demand in coastal zones from Ho Chi Minh to Danang. Therefore, inventories and demand surveys are needed in these regions.

16. The woody biomass imbalance indicated in Table 4.4 for the Mekong Delta is striking. Given that wood is the most common cooking fuel in rural and urban areas throughout the delta and that most rural households gather their wood, it may be that in the Mekong Delta and in other regions, there are many more trees outside the forests than has been assumed in the method presented above and in Annex VII. The TFAP report assumed that scattered trees on farm land

and rural roadsides would give a sustainable supply of 8 million tons of wood each year, whereas this report assumes about half of the above figure, namely 4.4 million tons. This divergence of reasonable estimates underscores the importance of obtaining an accurate picture of supply and demand.

Assessing the Impact of Plantation Programs

17. Vietnam has had a very ambitious plantation program since re-unification of the country in 1975, both with block plantations and the planting of scattered trees. Several international agencies are assisting with the replanting program, including the World Food Program (WFP). However, the success of the program has been somewhat patchy, because of lack of maintenance, poor soils, wrong species or variety choice, lack of skills and poor motivation in the population. These factors mainly affected the plantation program, but scattered trees also suffered from poor species choice and a lack of extension training.

18. Because much planting was relegated to poor and degraded sites, an inherent lack of soil fertility hampered seedling growth. This could and should have been remedied by undertaking soil testing and applying the appropriate quantities of fertilizer and lime at the time of planting. Spending upwards of US$500 per hectare[15] to establish a government plantation, with only about a sixty percent chance of success, indicates that much more effort, money and time could have been spent on the technical aspects of plantation establishment. According to an FAO Agricultural Officer based in the region,[16] the application of fertilizers to degraded sites will give a much greater response than a similar application to "agricultural" land.

19. Over one million hectares of block plantations were planted between 1975 and 1989, but only about 600,000 ha. were considered successfully established.[17] The most successful programs have been attached to discrete projects or where there has been an incentive to manage the plantation after the trees have been planted. Successful plantations attached to projects include the 30,000 ha. Vinh Phu pulp and paper mill plantations and the 20,000 ha. mangrove plantation near Ho Chi Minh city, established in an area destroyed by chemical defoliants. Incentives to manage have been a hallmark of activities of the World Food Programme (WFP) which has established nearly 100,000 hectares of plantations between 1986 and 1993.

20. Nearly 6,000 million trees have been planted in scattered formations outside the forest between 1961 and the present day.[18] If all the trees were properly established, allowing for 20 percent mortality, then the equivalent of over 2 million hectares will have been planted to date. Thus, scattered tree plantings may amount to three times the area equivalent of plantations. Trees planted with the ownership vested in the planter have a greater chance of survival than "public" trees. Persistent problems with poor species choice, unsuitable land preparation practices, and lack of maintenance and management skills, all of which hamper the survival of the young trees, may

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[15] The Forest Service stated that their establishment and tending costs, including overhead, are about $500/ha. To re-establish the mangrove areas destroyed during the war in Ho Chi Minh province cost $700/ha. However, the World Food Program costs are only about $100/ha, excluding expatriate assistance.

[16] Personal communication with Dr. Siegfried Lampe, FAO, Bangkok.

[17] Tropical Forestry Action Program, May 1992.

[18] Tropical Forestry Action Program, May 1992.

have led to results less impressive than those assumed here. However, no survey of these plantings has been undertaken.

21. The government has vested nearly five million hectares of forest land in rural people with plans to allocate another two million hectares. Much of this land is degraded and, therefore, more difficult to establish than non-degraded land. All these vested areas should have management plans, but many plans are compiled by people with little experience in appropriate species choice and appropriate management practices. Nevertheless, experience to date has been favorable.

22. While tree planting efforts are still important, emphasis now should be placed on standing stock and improved management of existing forests, plantations plus scattered tree resources, and ensuring that there is or will be a market for the trees that have been planted already. Several publications[19] state that pure fuelwood plantations are uneconomic, because they are competing with a free wood resource which is collected from the natural forests, degraded forest land, and miscellaneous areas. While this statement is true if plantation wood is from the same area, it may not hold if plantations are grown closer to market than sources of collected wood in natural forests. In this case, plantation wood could compete with a "free" remote resource. The savings in transport costs can be invested in a fuelwood plantation and be competitive with "free firewood". Thus, if the difference in distance between a natural forest and a plantation is 80 km, other things being equal, then with a road transport cost of Dong 1,000 per ton per km (US$0.1 per t/km), plantation wood can be grown at a cost of up to Dong 80,000 per ton (US $ 8/t) and still compete with a "free" supply of wood that is 80 km or more further away from the market. If the mode of transport is by boat then this break-even distance would be about 240 km, for boat transport costs are about one-third of trucking costs per ton/km.

23. An FAO analysis found that the mangrove plantations about 10 km from Ho Chi Minh city appear to be profitable for fuelwood even at the current very high interest rates (30% p.y.).[20] This illustrates the point about location being critical when comparing the cost of most goods, especially bulky goods like fuelwood. Of course, the market for other wood products, such as poles, pulpwood and sawlogs is usually more lucrative than the market for fuelwood and charcoal wood. But wood that is sold for higher value end uses usually generate some waste wood which is sold as fuelwood. A small but significant share of rural households in the Red River Delta purchase their fuelwood as offcuts and sawdust from sawmills (1992 Rural Energy Survey in the Red River Delta, Tables A4.8a and A4.23a).

24. Table 4.4 indicated some of the wood-short areas, such as in and near both deltas, as well as many urban areas, especially the large cities of the North and South. If land with few alternative uses is available near demand centers in these areas, this is where plantation efforts should be concentrated. There are also areas of degraded land that form the water catchment of river systems with actual or potential for hydro energy projects. In most cases these watersheds need protection and trees could be one of the best protection covers. But as stated previously, improved management of existing tree resources should be given as much, if not more emphasis. The Da river system has a water catchment area of 2.7 million hectares within four provinces of north-western Vietnam. This catchment system is having considerable erosion problems which could shorten the Hoa Binh Dam life considerably. The protection of this catchment area is vital to guarantee the electricity supply and to safeguard a massive investment for Vietnam, estimated to be

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19 Tropical Forestry Action Program, May 1992 and Christophersen, K.A., 1991.

20 "Fuelwood Supply Analysis" prepared by K.M. Gray for TFAP, May 1992.

at least US$3,000 million. Tree planting initiatives, especially agro-forestry and other multpurpose farm trees, would not only do this, but they could meet some of the market shortfalls for wood products in the North Midlands and Red River Delta regions. Therefore, planting initiatives in this whole area, especially in Hoa Binh province, should be intensified.

Issues Related to Other Energy Supply Options

Agricultural Residues: Practical Potential as Fuelwood Substitutes

25. Agricultural residues are produced in substantial quantities in Vietnam. Using general conversion factors and crop production statistics from the Statistical Yearbook, an idea of residue production can be obtained. Table 4.5 presents such estimates of 1992 crop residue production for Vietnam. The estimated production of crop residues of 44 million tons (37 million tons in wood equivalent terms) is just slightly more than the estimated annual production of woody biomass (35 million tons). This indicates that there is a considerable potential for using crop residues as fuel.

Table 4.5. Vietnam 1992 Estimated Production of Crop Residues

Residue	*Quantity ('000 tons, air dry)*
Rice straw	29150
Rice husk and bran	7774
Maize straw, cobs and bran	1240
Other food crops	1675
Baggase and sugar cane tops	1782
Coconut shells and husks	2327
Other crop residues	400
TOTAL	44348

Source: Mission Estimates (see Table 4, Annex VII).

26. However, agricultural residues from non-woody plants are usually more bulky than wood and on average contain 15 percent less energy per unit weight. Therefore, for energy purposes they have to be consumed very close to the supply source. A national surplus of residues, for example, is not relevant to a localized scarcity of fuels in the Red River Delta due to transport constraints. Crop residues cannot be stored for long periods without disintegrating. As they usually burn quickly with an intense flame, the fire has to be attended constantly. For these reasons, crop residues are not a preferred household fuel. The extensive use of agricultural residues, particularly rice straw, in Vietnam's rural areas shown by the survey data clearly indicate the scarcity of wood in those areas.

27. Several technologies are available for densifying bulky residues, ranging from simple hand operated presses to mechanized systems. While densification may address the transport problem, it adds to the final cost of the fuel. Experience in other developing countries indicate that densified residues have never achieved significant commercialization and widespread use. Considering the "free good" character of residue use in Vietnam, it is likely that its collection as needed and its use without densification will be the only way it will continue to be utilized in wood scarce areas.

28. Agricultural residues have many alternative uses, such as animal feed, composting/mulching, and building material for roofs and walls. About 10 million tons of crop residues are presently used as animal feed. Where there is a surplus, stubble that is left in the field may be ploughed into the soil or may be burnt in order to recover the mineral contents. This latter

is standard practice for rice cultivation where the farmer requires an impermeable soil surface. Several recent reports indicate that using crop residues as fuel deprives the soil of fertilizer.[21] However, as discussed in Chapter 2, existing practice appears to contradict this view. If the ash is returned to the soil after use as a household fuel, then most of the minerals will not be lost. There is anecdotal evidence that rice straw has been used as a fuel in the Red River Delta for centuries and it is common practice to use the ash as fertilizer. Rice husk ash from brickworks apparently is being sold to sugar farmers as a fertilizer. Therefore, it seems logical that Vietnamese farmers will return the ash to the fields, especially as they already apply compost and manure.

Coal as a Household and Rural Industrial Fuel

29. Nearly half of coal demand is consumed in rural areas and it is the most important "modern" fuel in energy terms for rural industries and households. It is also the most widely traded fuel in the rural regions of the North, mainly because it is the cheapest fuel close to the mine head. About 1.78 million tons of coal were consumed by households and small industries in 1990. This figure is expected to increase by 63 percent to 2.90 million tons in 2000.

Table 4.6 Demand for Coal by Households and Small Scale Rural Industries
Units: 000 tons (1)

Sector	*1990*	*1995*	*2000*
Household			
Rural	545	695	886
Urban	585	747	953
Subtotal (2)	1130	1442	1839
Small Industries	652	832	1064
Total	1782	2274	2903

Notes: (1) The energy value of coal assumed in the above figures is 28.8 MJ/kg. However, the actual energy value of the coal fines delivered for households and small industry is only about 23.0 MJ/kg. The coal fines are made into briquettes and patties which may reduce the energy value further to about 16.8 MJ/kg. Thus, in terms of this latter energy value the total demand in 1990, 1995 and 2000 would be 3.05, 3.9 and 4.98 million tons, respectively; (2) This includes coal used to boil pigfeed, an estimated 95,000 tons in 1990, 120,000 tons in 1995 and 155,000 tons in 2000.
Source: Mission Estimates.

30. The projected 63 percent increase in coal demand by 2000 means that its relative share in the energy mix will increase. Therefore, it is important to examine the informal industries using coal and explore ways to improve their end-use efficiencies. Considering the inroads that coal has made in the residential sector, it is likewise important to improve the efficiencies of domestic coal burning stoves. The brick and lime industries are the largest rural industrial users of coal. These industries generally make their own patties or briquettes from a mixture of coal dust and clay. On the other hand, households usually buy manufactured briquettes made to specific sizes to fit the coal stoves in the market.

31. Coal has some drawbacks as a fuel. First it is difficult to light, and like biomass, it is hard to control the heat output in a domestic stove. Once lit, the tendency is to keep the stove burning all day, damping it down when not in use. Of greater concern are environmental impacts of coal use, such as the low height particulate emissions from burning coal in an open domestic stoves and brick/lime kilns. On both environmental and efficiency grounds, stronger controls on the quality of

[21] Koopmans A., 1991 and Gray K., 1991.

coal going to specific users in urban areas should be phased in as soon as possible. Coal washing and screening procedures can remove some of these particulates. The Energy Institute is already working on ways to improve the ignition properties of coal and coal briquettes and to find inexpensive ways to screen out particulates from the material.

Renewable Energy Supply Options

32. Vietnam has a small ongoing program for renewable energy development, mainly carried out by the Energy Institute, the Energy Center of PC2 and some universities. Efforts include the design and installation of mini- and micro-hydropower stations in mountainous areas, the design and installation of biogas digesters, and the development of solar and wind energy applications for crop drying, water pumping and power supply in remote areas. As in other countries, the goal is to expand the energy sources available to rural households and relieve pressure on the forests and the agricultural resource base.

33. Although it is recognized that most of these technologies are not economic at this time, there is a high social value placed on providing lighting, radio, and television to households in remote areas as a means to raise their standard of living and improve their cultural life.[22] Thus, the government subsidizes by 25 to 50 percent [23]the end-users of technologies that are still under development (wind, solar, and biogas) The subsidies are intended to encourage early adoption of technologies that serve as demonstration units.

34. Small Hydro-power. Small hydro-power applications have a long history in Vietnam. Small hydro-power as a local supply source for rural electrification in remote and mountainous areas has been a priority technology for government sponsored research and development in Vietnam since 1955. Since 1970, plans for installation of small hydropower stations have been developed for provinces with appropriate hydrology throughout the country. All small hydropower equipment was imported before 1975 (mainly from China), but since then a small domestic capability to manufacture turbines, generators, regulators, and transformers has emerged in Vietnam.

35. The hydrological resources of Vietnam have been well researched and documented. The economic potential for small hydro-electric applications in Vietnam is estimated at roughly 1.5 GW. Some 3,000 sites have been identified for small hydropower stations in the range of 1 kW to 10 MW mini-hydro systems.[24] By 1985, 400 small hydro stations were in place with a total installed capacity of 30 MW and delivering 90 - 100 GWh of electricity annually to over one million people in 20 mountainous and highland provinces. Current plans call for installation of 160 new small hydropower stations by the year 2000 with a total installed capacity of 100 MW. This goal appears to require that domestic manufacturing capacity for complete small hydropower stations be expanded.[25] However, there may be quality problems with some of the domestically

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22 Nguyen Van Than (National Renewable Energy Program), 1990.

23 Tran Hong Quan (National Renewable Energy Program), 1990.

24 Ha Tien Luy (Institute of Energy), 1992. The method used for estimating the economic hydropower potential (roughly 1/3 of the total physical potential) was not reported. Evidence in ITDG, 1991 indicates that identification of economic small hydropower sites may often concentrate mostly on technical design and hydrology with little attention paid to estimating demand or identifying applications for the electricity to be generated. In this light, the reported economic potential for small hydropower may be cautiously interpreted as a technically feasible potential.

25 Ha Tien Luy, 1992.

produced equipment. Much of the equipment for new stations is still imported and almost all of the micro-hydro equipment and smaller turbine-generator sets purchased by families and are still imported from China.[26]

36. In addition to these small hydro systems, it is thought that over 3,000 family hydro turbine-generator sets of 1 kW or less are installed throughout Vietnam. Representative costs for equipment, installation and dam construction for a 300 Watt system are roughly 1-1.5 million Dong (1992) and about 0.5-0.8 million Dong (1992) for a 150 Watt system. For the small hydro systems discussed above, equipment costs are roughly 1 million Dong (1992)/installed kW; construction costs vary but average about 1.5 million Dong (1992)/installed kW. Small hydro systems have an average life of 8 years.

37. Though statistics on how many of the installed small hydro systems are still in operation nationwide are not available, evidence from Bac Thai indicates that a large share may be out of service due to lack of technical and financial support.[27] This reflects a planning approach that is focused almost exclusively on technical site identification and installation design with very little attention to training local operators in effective management practices or maintenance skills once the system is in place. In contrast, a 1985 Institute of Energy survey of small hydro stations indicated that most of the 44 larger stations in the country (0.1 to 10 MW) were well managed and were run proficiently. While these larger units are run by authorities that have sufficient support to maintain their systems, it appears that lack of attention to building management skills at local levels for smaller systems may result in reduced benefits that could be obtained from the existing installed capacity. Building local management and maintenance skills should be a priority area for government efforts in small hydro. In addition, planning authorities at national and provincial levels should develop the capability to estimate demand for electricity and compare it to technically feasible supply in identifying sites for new installations. For villages in remote and mountainous areas, mini and micro hydropower represents a valuable resource for rural electrical applications. Efforts to ensure that existing capacity is well managed should be supported. Planning authorities should develop the capability to identify new sites by matching the hydrological potential with estimated demand for electricity services.

38. Biogas. Work on biogas in Vietnam has been conducted by the Institute of Energy in Hanoi, the Energy Center of PC2, the Agricultural University #1, Ho Chi Minh City Polytechnic, Can Tho University, and Committees of Science and Technology in Hai Hung, Dong Nai, and Ho Chi Minh City. There are roughly 1600 digestors with volumes from 3 to 250 m^3 throughout the country. Most are located in Ho Chi Minh City or in the South where the climate is more suitable. Many digestors were subsidized with government funds or by international organizations as demonstration units. The purpose of the installations is to produce a gas that can be used for cooking and lighting as well as an effluent that can be used as a fertilizer. Data on the cost of the units are not available so it is not possible to determine their economics. It is also not known how many of the installed 1,600 digestors are in operation today, but it has been reported that some of the digestors operate badly and some do not work at all, especially those with large capacities.[28] This situation is not unique to Vietnam. Although household biogas has had some success in countries of South Asia and China, experience in other countries, including those in Southeast Asia, have not been positive. Households with highly subsidized

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26 ITDG, 1991 (for Bac Thai province).

27 ITDG, 1991.

28 Lam Minh Triet (HCMC Polytechnic), 1990.

demonstration units, as in Vietnam, had little incentive to manage and maintain the digestors. Despite the apparent interest in this technology, it is doubtful whether it can be considered a practical energy supply option. As a means of conserving fuelwood, promoting improved cook stoves is probably a less capital intensive and more cost effective approach.

39. Wind and Solar Applications. With mean wind speeds of 3 m/sec, the wind regime of Vietnam is not suitable to a large scale wind energy development effort. However, there are local areas in mountainous regions that have a better wind regime and are far from the existing electricity grid. The government has used recent wind speed data and distance from the electricity grid to identify the most promising locations for wind applications throughout the country.[29] There are roughly 400 windmills in the country used for electricity generation and water pumping. A number of low speed, low cost windmill designs for electricity generation and for water pumping are now being developed at the Research Center for Thermal Equipment and Renewable Energy at the Ho Chi Minh Polytechnic to operate at wind speeds of 3 m/sec or above.[30] The Center now makes 100 W and 150 W units that sell for around US$200 (at cost, without battery). Even at this fairly high price, the Center has sold about 100 units to families and private entrepreneurs mostly on high plateaus who use the wind generators to charge 12 Volt car batteries, suggesting general satisfaction with the product. The Center has also sold about 30 wind water pumps (at cost) with designs tailored to different lifts and wind regimes. There is not much current activities on photovoltaics. PV applications for remote areas would seem to have practical potential in Vietnam and may be worth a higher priority in the program.

40. The Center also has an active research program to develop solar crop drying platforms for the Mekong Delta. The wet climate of the delta leads to a sizable share of fruits and other crops spoiling each year. A number of low cost portable designs are being field tested for effectiveness in meeting farmers' crop drying needs. Of the renewable energy applications being developed by the center, only several windmill designs appear to have immediate market potential. The Center is currently working on setting standards for mass production in preparation for wider commercialization.

Priority Areas for Renewable Energy Development in Vietnam

41. Given the scarcity of public resources, it is important to be highly selective when determining where to focus development efforts on renewable energy technologies in Vietnam. External financing from bilaterals have been used to do R&D work on a number of applications such as wind generators and pumps and this approach should be maximized. Wind applications that are designed to serve a niche market in remote areas appear to be gaining commercial acceptance and should be encouraged. The Institute of Energy, the Energy Center and the other agencies engaged in renewable energy development should review the results of their work so far, with a view to clarifying goals, prioritizing work programs in the medium term and redirecting some of the staff and resources to activities that have more immediate relevance. Two of the Energy Institute programs would appear to have the highest priority, namely: mini- and micro-hydro and improved stove design and dissemination. The small hydro group should build internal skills to assess and incorporate rural demand in site selection procedures. The improved cook stoves program should begin to pursue commercialization steps more actively (see Chapter 2).

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29 Dinh Xuan Hung (Institute of Energy) 1990.

30 Nguyen Van Hoai (HCMC Polytechnic), 1990 and Duong Thi Thanh Luong (HCMC Polytechnic, 1990.

V. RURAL ELECTRIFICATION

Background

1. Between 1954 and 1975, the major electrification objective of the Government in the northern part of the country was to provide for basic services that would sustain economic activities in urban and suburban areas. In the South, three cooperatives, patterned on the model of the U.S. National Rural Electric Cooperative Association (NRECA) cooperatives and mostly financed by USAID were launched in the late sixties, serving up to 10,000 customers each. In 1975, the assets of these cooperatives were consolidated with those of the power utilities into state assets. Between 1975 and 1985, after the end of the war, the bulk of investment in the Vietnam power subsector was targeted at rehabilitation and construction of generation and transmission systems. Although pronounced as a priority, rural electrification did not really gain any momentum until 1985, when reforms were undertaken in the rural economy and new supply and transmission facilities were gradually established. Electrification projects during this period consisted mainly of electrifying major towns in the provincial districts.

2. Table 5.1 summarizes rural electrification growth from 1975-1990.[31] These official figures appear to indicate that considerable progress has been made in rural electrification in the recent years, with more than 1.7 million new rural people connected to the electricity supply between 1989 and 1990 :

Table 5.1. Rural Electrification Growth, 1975-1990

Year	Irrigation pumps (GWh)	Rural Industries (GWh)	Rural Households (GWh)	Total (GWh)	Percentage of national demand	Electrified rural population/total rural population
1975	119	30	37	186	8.5%	2.5%
1985	223	75	75	373	9.7%	5.5%
1989	329	141	150	620	10.9%	11%
1990	398	210	192	800	12.8%	13.9%

Source : The Energy Institute (1991) and mission estimates.

3. However, a closer look at investment statistics for the three power companies during that year indicates that the electrification effort mostly involved the densification of electricity service in areas already covered by the medium voltage network and does not include extension of service to originally unelectrified areas. While installed capacity in distribution transformers has increased by an amount corresponding to the supply of these new customers, the number of km of medium voltage lines (below 35 kV) and the installed capacity in 35kV transformers supplying the MV lines remained almost constant. Most of the new customers were therefore (i) inhabitants of towns and suburbs, and (ii) inhabitants of villages close to existing electric pumping stations. Most of the investments involved in this network development are attributed to local/private financing, which

[31] Although preliminary returns from the Living Standards Survey seem to indicate that the national electrification rate could be up to 35%, the official figure is only 14%. It is possible that the discrepancy is due to differing definitions of urban and rural in the estimates, a gross underestimation of the extent of multiple connections, or a combination of both factors.

corroborates statements made by the power companies that their present involvement in rural electrification is quite small.

4. The responsibility for rural electrification lies with the Ministry of Energy, which decides on the overall investment program in the electricity sector and on the rural electrification investments proposed by the provincial authorities. There is at present no national planning for rural electrification. The decisions are made by the Ministry of Energy on a project by project basis based on the availability of funds in (i) the power companies (national and provincial power departments), (ii) the provincial authorities (provincial People's Committee) and (iii) the local authorities (village People's Committee). The different departments of the power companies are responsible for the preparation of the analysis on the technical and economic feasibility of each project (See Annex X).

Pilot Projects

5. To find approaches to rural electrification that do not rely only on central government funds, pilot projects were launched in the last 5 years. These projects involved new financing schemes involving participation from the central government, local authorities and private consumers (see Table 5.2, below, which shows some of the northern projects).

6. Eight such projects have been selected by the Government in northern Vietnam, one in the central part (a sub-district in the Highlands), one in the South (Song Be District in Long An province). The financing arrangements for these projects are as follows: The central, Government, through the appropriate Power Company, provides the funds for the 35 kV lines and the main 10 kV feeders. The 10 kV spurs are paid for by the local authorities (province and district) and contributions are raised from households at the cooperative (subdistrict) or village level to pay for the low voltage system. The typical contributions from households are 0.8 to 1 million Dong. The households buy meters (300,000 Dong, installation included) and pay for (or install themselves) the service drops (typical cost of 500 Dong/m). Loans are sometimes available, from the Vietnam Bank of Agriculture (VBA) for people who are interested in electricity supply but cannot afford the up-front cost. However, VBA's financial resources are very limited and it cannot cope with the demand. Current interest rates amount to 3 percent per month.

7. In the pilot projects, the portion financed by the Central Government averages 40 percent of the total cost of the project. Technical design is done by the Provincial and District bureaus of the power companies. The construction works are carried out by one of the government-owned power construction companies under supervision of the local branch of the power company. Extension and maintenance of the local low-voltage grid, and bill collection are under the purview of a team paid by the local association of shareholders (rural commune or electricity cooperative). The cooperative buys electricity at a bulk rate. The resale rate to the end-consumer varies widely as there are no controls on tariff levels by the local branch of the Power Company and the local authorities.

8. The pilot projects were identified and recommended by the Provincial authorities and evaluated at the Central Government level. The main criterion appears to be that at least 50 percent of households in the concerned community were willing to pay the required contributions. Overall, however, only 40 percent of the physical and financial targets have been met, mainly because of lack of funds. These pilot projects represent the major investments in rural

electrification in recent years, but they will not be repeated. In the future, potential consumers will have to pay the full cost.

Table 5.2. Examples of Rural Electrification Pilot Programs

	Bach Sam	Nghia Tru	Minh Khai	My Tho
Existing Capacity (kVA)	80	180	200	180
New Installed Capacity (kVA)	360	880	539	420
Forecast Demand (kW)	365	910	331	352
Existing Substation	1	1	2	1
New Installed Substation	3	5	7	3
New 10 kV Lines (km)			2.5	3
New 35 kV Lines (km)	1.2			
New Low Voltage Lines (km)	7	14	9	5
Number of Meters	1137	1800	1109	823
Financial Participation				
from Government (million Dongs)	203	600	337	234
from Local Authorities (million Dongs)	248	288	322	175
fr. Private Source (households) (million Dongs)	163	600	160	118

Source: Power Company # 1.

Constraints to Rural Electrification

Supply Constraints

9. For the South and central regions, it is clear that a successful rural electrification program cannot be implemented before the current severe supply problems are solved. The immediate priority in these regions will therefore be to secure sufficient generating capacity to supply the existing and potential demand with acceptable reliability. The Government of Vietnam is undertaking the construction of a 500 kV line that would connect the northern grid, with surplus generating capacity, to the shortage-constrained regions of the Center and the South. Scheduled for commission in 1994, this line should solve the supply problem in these two regions in the medium term if its operation does not present any major technical problem.

Power Losses

10. For all regions, costly technical and non-technical losses in electricity distribution, and end-use inefficiencies in both urban and rural areas should be remedied first. Inefficiencies on the distribution side include :(a) low system power factor; (b) transformer inefficiencies; and (c) poor quality of cables.

11. The power factor on the distribution systems of the three power companies is very low: values between 0.6 and 0.8 are currently encountered in suburban and rural areas. Investments are urgently needed to alleviate this problem, which causes significant energy losses, high voltage drops and frequent outages of overloaded equipment. For PC1, annual investment requirements on distribution networks for reactive compensation equipment (about 60 MVAR) is estimated to amount to approximately US$1 million. The low voltage problem, caused in part by low consumers power factors, is aggravated by widespread use of voltage boosters at consumer premises. These devices improve voltage conditions at the premises at which they are installed, but themselves impose additional reactive power demand on the system and, further, since the load they serve will remain relatively constant with variations in system voltage, exacerbate voltage conditions for other consumers on the line.

12. The transformers presently installed on the distribution systems are highly inefficient and often oversized, particularly in rural areas, mainly due to outdated manufacturing techniques. The characteristics of these transformers indicate that their loss levels correspond to the international standards of the sixties. The power companies should carry out systematic monitoring of the loads on the distribution transformers and replace those that are improperly sized. It may be necessary initially to import the 10 or 20 KVA transformers needed to supply clusters of houses in rural areas, as these sizes are not presently available in the Vietnamese market. Locally manufactured transformers were designed to comply with outdated Russian standards. Replacing them as soon as possible with more efficient, imported models is clearly economic. Neighboring developing countries, notably China, are now manufacturing transformers of acceptable quality levels and at costs that are similar to the current costs in Vietnam (see Annex XI).

13. Replacement of existing high loss transformers in the system, if spread over a five-year period, will probably require some US$15 million per year. In the medium term, electrical equipment factories in Vietnam should be encouraged to upgrade the efficiency of their products, by imposition of increasingly stringent Government standards and by encouraging joint ventures with more technologically advanced foreign manufacturers.

14. Significant losses also stem from the low quality of the cables generally used in the system. Currently, the power companies do not impose minimum standards on the state-owned cable manufacturing companies. Low voltage connections, installed by private households or cooperatives, do not follow any official standards and are often uneconomically small in size and pose safety hazards to personnel.

End-Use Inefficiencies

15. Various <u>inefficiencies on the end-use side</u> add to the magnitude of technical losses. Electric motors manufactured locally are designed to comply with a power factor requirement of 0.7 at nominal output. These motors, used as pumps or used in rural industries, represent 70 percent of the rural consumption. This low power factor causes additional losses, both on the supply and end-use sides, and voltage drops and increases the operating cost of the system. Some branches of the power companies reportedly apply power factor penalties for large customers (above 100 kVA), but no provision for such a penalty is made in the official tariff, and meters for reactive power consumption are only installed in very large industries.

16. Electric pumps for irrigation and drainage represent a major load in rural areas. Only two models of electrical pumps are manufactured in Vietnam for installation in irrigation stations: (i) a

"small" pump, (rated at 33 kW at an output flow of 1000 cubic meters/h and 4 to 6 meters head) and (ii) a large pump (rated at 75 kW at 4000 cubic meters/h and 9 to 10 meters head). The typical efficiency of these pumps at nominal output is said to be 80 percent. In all the sites visited by the mission, the pumps were oversized compared to the head they have to supply, further reducing their efficiency and decreasing the power factor (which is already low by design). Since these pumps account for about 50 percent of the rural electricity consumption, it is clear that this situation needs to be addressed urgently. Considerable gains in system efficiency could be achieved by (i) proper sizing of pump and motor, (ii) equipment design modifications at the factory, (iii) installation improvements and (iv) optimized irrigation system design. Measures to address points (i), (iii) and (iv) could be undertaken within a relatively short time frame. Site-by-site analysis of pump installations should lead to the identification of economic opportunities for rehabilitation of installations and irrigation systems. Point (ii) requires longer term measures, such as technology transfer from foreign manufacturers.

Non-technical Losses

17. The present situation regarding <u>non-technical losses</u> is highly mixed. While meter reading and billing are generally well organized (their efficiency would be improved further if more advanced computer tools and software were made available), collection and fraud detection efficiency vary widely for different areas. In some places, such as certain areas of Haiphong, the high level of fraud and theft (losses are above 40%) has led the power company to seek the help of police and justice authorities. In places where customer management is handled at the local level, the problem is almost nonexistent. In the whole country, difficulties are encountered in recovering accounts receivable from institutional customers such as public enterprises or local authorities (water pumping). This problem could be mitigated by appropriate arrangements with the government agencies, such as budgetized pre-payment procedures. Non-technical losses should be given major attention by the power companies, since the motivation for fraud will increase in the coming years with the planned increases in tariffs and consumption levels.

18. A factor that contributes to non-technical losses is that most of the installed meters are inaccurate and unreliable, causing major revenue losses to the power companies. It is estimated that some 300,000 meters per year would be needed to equip newly connected customers and gradually replace the old meters. This would cost approximately US$10 million annually.

19. Both technical and non-technical losses exacerbate the poor financial position of the power companies and reduce the amount of funds available for new investments, including rural electrification.

Institutional Constraints

20. Although the provincial authorities are consulted by the Central Government in the design stage of the projects, final decisions regarding rural electrification investments remain centralized, often leading to rigidities in the technical approaches, delays in decision making and low motivation at the local level. The way in which load forecasts are prepared is a good example of this centralized approach: The departments of the Ministry of Energy in Hanoi decide nationwide targets for household consumption. For 1995, the standard demand (and energy) values are 700W/household in rural areas (150 kWh/capita/year) and 1500 to 2000W/household in urban areas (400 kWh/cap/year). These centrally derived figures do not appear to be based on any systematic study of the actual context in the subject communities and may lead to over- or

underdesign of the networks in certain areas. In addition, the power companies have an unbalanced central role in rural electrification projects, and their natural bias favors classical electrification from the grid. Possibilities for alternative electrification schemes, such as decentralized generation by diesel, mini/micro hydropower or individual photo-voltaic systems are therefore not given adequate attention.

21. Responsibilities for planning are split among several government agencies, leading to lack of uniformity in technical standards and project evaluation criteria. There is no focal institution where important data and lessons could be gleaned from the results of past projects, such as the rate of growth of connections in newly electrified areas, growth of individual demand over the years, and comparisons between actual accomplishments and physical and financial targets.

22. The regulatory framework for rural electrification is not clearly defined: ownership of systems (networks and/or generating equipment) built with private financing or mixed public and private financing is not clear. No general procedure is followed for tariff setting in cooperatives or in privately-owned isolated networks, which would be a fundamental step to ensure protection of the end-users and fair returns on investments for the financiers. These and current laws restricting the right to produce electricity for the public grid to the three power companies limit the likelihood of increased involvement of private financing in R.E. schemes.

23. The *de facto* monopoly of the Government-owned construction companies presently ensures conformity to a single standard for medium voltage extensions. However, as competition is introduced (as it should be) to lower construction costs, the situation will evolve. It is important to start defining and enforcing a set of technical specifications and national standards so that minimal safety and technical requirements will be observed in these networks in the future.

Scarcity of Financing

24. Lack of financing is a general constraint on the three regional power companies. This has limited the development of supply sources, notably in the South and Center, and the rehabilitation of transmission and distribution networks all over the country. The urgent need for new investment is felt particularly in the North where already access to electricity is restricted during the peak hours because of the limited power transmission capacity in the system. The bulk of financing resources in the subsector is now earmarked for the 1500 km 500 kV transmission line, due to be commissioned in 1994. The estimated cost of the interconnection project has been revised upward from US$220 million to US$520 million. This implies that the amount of money available for rehabilitation of existing networks and extension of electricity services in suburban areas in the light of this development would be very limited.

Rural Electrification Planning

Electrification Targets

25. In most areas of Vietnam, the priority given to electrification of pumping/irrigation stations has been well-justified by the economic benefits realized (it allowed for double or triple cropping and helped to move Vietnam from a rice-importing country to the world's third largest exporter of rice). Opportunities for further investments of this type are many: only 10 percent of the irrigable lands enjoy that service in the Mekong Delta region. The high population density (380 inhabitants/km^2) and current low electrification rate in the delta (14 to 18%), suggest opportunities

for highly economic R.E. projects. New irrigation projects may also be pursued as components of projects with wider objectives, such as infrastructure development schemes. An example of such integration is the UNCDF infrastructure project in Da Nang Province, where the electrification component represents 10 percent of the total financing.

26. The opportunities for further increases in rural household connections without construction of new medium voltage lines are now severely restricted. By 1992, it seemed that the type of rural electrification resulting from the establishment of irrigation/drainage pumping stations was reaching its limits and that grid extension had stalled due to lack of financing from the power companies, the central and provincial authorities and the villages. Nevertheless, the official targets for electrification for the coming years remain ambitious, aiming at an average of 300,000 new households connections per year. These targets will be increasingly difficult to meet since the easiest parts have been or are already being done:

Table 5.3.Rural Electrification Targets

	1990 (achieved)	1995 (planned)	2000 (planned)
Rural Population with Electricity (percent)	13.9%	25%	35%
Rural Population with Electricity (million)	7.26	14.25	21.93
Supply to Irrigation and Rural Industry (GWh/year)	660	1118	1464
Supply to Households (GWh/year)	340	1000	1700

Source: The Energy Institute (1991).

Investment Requirements

27. Given the lack of feasibility studies on potential demand, it is not possible at this point to determine the total investment requirements for a rural electrification program. However, indicative estimates of the investment necessary to electrify 80 percent of the population by the year 2000 in (i) Red River Delta, (ii) Mekong Delta and (iii) center-south coastal areas (near Da Nang and Hue) have been made by the present study. These areas were selected for analysis because they are the regions where electrification by extension of the regional grids is likely to be the most economic alternative, population densities are high and the regions' economies are the most likely to benefit strongly from the availability of electricity. If all of the 300,000 new connections each year were concentrated in these 3 areas, the 80 percent target would be reached in 12 years. Though it is unrealistic to assume actual electrification would be constrained to only a few regions, this exercise enables a rough estimation of rural electrification costs. These estimates indicate that investment needs are likely to exceed US$3 billion for the distribution networks alone, broken down into about US$1.9 billion for MV systems and US$1.3 billion for LV systems. The regional breakdown would be about US$350 million for the Red River Delta region, US$850 million for the Mekong Delta and US$2.1 billion for the central region.

28. This estimate was made by extrapolating the results of a prefeasibility study made for the Plain of Rushes for supply extensions to the most densely populated rural areas. The figures must be treated with caution and do not include the costs of: (i) development of corresponding sources of supply, (ii) construction of transmission network (above 35 kV) and (iii) consumer connections and meters. An investment program of this magnitude would lead to an overall electrification rate of less than 40 percent, corresponding roughly to the plans prepared by the Ministry of Energy.

The magnitude of investment requirements points to the imperative of exploring innovative financing arrangements that involve private capital participation.

Table 5.4 Indicative Cost Estimates for Reaching Rural Electrification Targets Over 12 Years

	Households (millions) 1992	2004	% Electrified 1992[a]	New Connections for 80% electrification by 2004	Indicative Costs (US $million)
Red River Delta	2.25	2.75	70%	625,000	350
Center-South Coastal	1.00	1.30	20%	800,000	850
Mekong Delta	2.50	3.20	15%	2,185,000	2100
Totals				3,610,000	3300

Note (a): From partial returns of Living Standards Survey (1993).

Rural Consumers: Willingness to Pay

29. There is evidence that electricity consumers are willing to pay high rates that may cover the costs of rural electric service. Presently, electricity end-users often pay more than the official tariff and even more than the marginal cost because of the common practice of resale of electricity in both urban and rural areas.

30. The practice works as follows: in order to limit the level of their investment in the low voltage systems and minimize the workload of the customer management staff, the power companies have sanctioned the use of secondary meters. The house which is closest to the grid (in rural areas, the one closest to the pumping station) is provided with a "main meter". The owner is then authorized to resell electricity to his neighbors, at a price that is largely not controlled by the local branch of the power company. The low voltage network from the main house to the neighbors is installed by the individuals concerned at their cost. The practice is widespread, with departments and branches of the power companies having typically 5 secondary customers for every main customer. This practice is also common in the rural cooperatives.

31. The price paid by the secondary customers as a result of this arrangement varies widely. The official household customer price is 450 Dong/kWh (i.e. about US$0.045/kWh), but prices ranging from 480 Dong/kWh to 1200 Dong/kWh to the end consumer have been observed during the present study. This may be compared to the LRMC for low voltage systems of 600 Dong/kWh, as estimated by the World Bank's Energy Sector Review study. This indicates that the willingness and ability to pay, even in rural areas, is higher than the official rate and that many rural households are able to afford the up front additional costs of electric meters and service drop installation. (See Annex XII).

Rural Electrification Model

32. As mentioned earlier, pilot R.E. projects based on joint public/private financial participation have been promoted by the Government in recent years. However, there have also been a number of successful projects based on cooperatives. Unlike the normal experience in the U.S., these cooperatives are not specifically electric cooperatives, but most often agricultural, extending their activities to provide other services of benefit to their members. The example of the

Duy Xuyen electricity cooperative established in the late seventies and briefly described below demonstrates the feasibility of this approach in the country, even in a relatively unfavorable environment, and may be a suitable model for Vietnam to emulate in its future rural electrification programs.

33. The Duy Xuyen Cooperative is located 30 km south of Da Nang. The main economic activities in the area are rice growing, forestry (for timber and paper), textile and brick making. The cooperative was formed as an agricultural cooperative to provide services for the growing of crops, processing and marketing agricultural output. Its management team is elected (the head of the cooperative and an assistant). Using a minihydro power plant, the cooperative generates and distributes electricity and collects the revenues. Permanent staff are appointed by the cooperative to perform these tasks. A section headed by a power engineer is in charge of operation and maintenance. The cooperative "exports" electricity to PC3 in the wet season at 900 Dong/kWh (18% of energy) peak, and 480 Dong/kWh (82% of energy) off-peak. In the dry season, electricity is bought from PC3 at 480 Dong/kWh (30% of energy) peak, and 360 Dong/kWh (70% of energy) off peak.

34. The cooperative comprises 2,400 members, of which 2,280 are families. The area served by the cooperative is fully electrified, the total number of inhabitants being 10,358. All members contributed a membership fee of 100 Dong (3kg of rice) at the creation of the electricity cooperative in 1979. The average consumption per family is estimated at 20 kWh/month. The average income is said to be close to 300 $/household/year.

35. The installed capacity of the mini-hydropower plant owned and operated by the cooperative is 1200 kW. Eight hundred kW were installed in 1983, partly self-financed, partly through soft loans from the provincial government. Another 400 kW plant was added in 1990 (total cost 12 million Dong, of which 3 million Dong came from a 3 percent per month loan from the Government). Extensions and service drops are done by the cooperative, assisted in the design by the local branch of PC3. Members provide the work force for some tasks for a fee of 3.5 kg of rice per day. The cooperative is currently upgrading the 4.2 kV system (output from the minihydro) to 10 kV.

Establishing a Framework for Rural Electrification

Institutional Coordination

36. Experience in other countries indicates that a rural electrification program is often best coordinated by an inter-ministerial body, not by a single agency directly attached to one of the ministries concerned. An appropriate body might be a "Rural Electrification Committee", cooperating with the Ministry of Energy, the Ministry of Water Resources and the Ministry of Agriculture. This body should be given the responsibility of defining national policies, guidelines and regulations in the area, and preparing inputs to the Government's budget planning process for electrification.

37. The bulk of the planning, design, decision-making and operating process should be decentralized. To take advantage of the community-based structures, the provincial authorities should be allowed to play a major role in screening sites, coordinating feasibility studies, defining institutional/financing schemes and supervising implementation.

38. Since it is clear that financing the program will not be feasible through public funds alone, the enabling environment must be provided to maximize private financing participation. This will be achieved only if there is: (i) a clear and stable regulatory framework, and (ii) assurance of fair returns on investments through transparent tariff levels. The regulatory framework must set: (i) clear and appropriate rules on private generation and distribution, system ownership and tariff setting, (ii) standardized planning and selection methodologies, and (iii) technical standards adapted to the rural environment.

39. Potential private participants will need to have access to public funds in order to cope with the up front cost of project investments. Future loan funds from international financing agencies need appropriate local channels for project appraisal and disbursements. A possible agency for this purpose is the Vietnam Bank for Agriculture (VBA). VBA was originally a department of the State Bank but was declared an autonomous agency in 1988 and established as a commercial bank in 1990. With 5 regional offices, 52 provincial branches, and 447 district branches, it has a good area coverage.

40. The bank provides 3 types of loans: (i) less than one year, (ii) 1 to 3 years duration, and (iii) "long term" (3 to 5 years). Due to lack of long term resources, it currently provides very little long term lending (2 to 4 % of the total portfolio), but already 30 percent of these long term loans are made to rural cooperatives. VBA is familiar with the concept of credit groups (loans to about 50 households based on group liability, as similarly experienced successfully in Bangladesh). Its customer mix has evolved in recent years: lending to private customers is booming, from 2 percent of total portfolio in 1991 to 25 percent in 1992. If it is appointed to play the lead role in financing rural electrification, strengthening of staff capabilities will be needed, particularly in the administration of credit lines aimed at rural groups and in evaluation of profitability of technical projects.

41. The success of agricultural cooperatives in providing electricity supplies to its members suggests that rural electric cooperatives may be an appropriate medium for increased rural electrification while reducing the extent to which financing from the Government is required. Electric cooperatives could arrange for load surveys and attempt to achieve diversity in consumer demand. Consumer equity contributions would reduce (minimally) the need for Government contributions, but the Government could, in turn, arrange for loans on favorable terms for investments by the cooperatives.

Technical Standards

42. There is striking contrast between the low standard of design and construction employed in the low voltage networks installed by the private consumers or the cooperatives and the uneconomically high standards used for the medium voltage and transformer systems. An example is the extensive use of large cement poles where less expensive wood poles or cement poles of smaller diameters could be used instead. The capacity of the smallest transformer currently installed is 50 kVA, which is much larger than the capacities economically used for rural electrification in other countries. The practice not only requires higher investments[32] but also leads to increased losses.

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[32]In the case where a transformer has to be installed to supply a cluster of 30 to 50 houses with a peak power of 15 kW, if a 50 kVA transformer is installed instead of a more suitable 20 kVA transformer, it will lead to additional

43. Rural grid extensions are currently designed mainly to supply power to irrigation pumps. Connections from these lines to nearby households and villages are done on an *ad hoc* basis, resulting in expensive overall design and technical disadvantages. Lengthy lines often result from this arrangement (up to 4 km low voltage lines, up to 50 km 10 kV lines have been observed) which leads to increased losses, voltage drops and reduced reliability. Increasing the number of household connections will also improve the capacity utilization of the supply systems. The irrigation/drainage pumps are normally used for about 2,500 hours a year maximum, so that increased usage of these facilities will make the investment distribution lines and transformers more economic. Typically, household loads result in an undesirable increase in system evening peaks, but this may be alleviated somewhat by daytime loads originating in cottage industries or similar activities which generally accompany rural electrification.

44. The optimal design of rural systems is typically a trade-off between cost and system performance, including quality and reliability of supply. Past experience in developing countries indicates that the rural customers are willing, at least during a transitional period, to settle for lower service reliability and quality than urban customers. The main uses of electricity in rural areas are (i) irrigation, (ii) small productive activities during the day, and (iii) residential lighting and electronic entertainment in the evening. Service interruptions at times of low demand are therefore easily tolerated. There is a wide range of design options to reduce the cost of rural extensions while maintaining quality and reliability of supply at acceptable standards. Economic options for reducing costs should be analyzed at the national level and guidelines should be established (cable sizes, standard transformer sizes, pole-mounted transformers, 35/15 or 35/0.4 transformation, construction of single-phase extensions, wood poles,etc.).

Screening of Projects

45. To ensure optimal use of funds that the Government may finally decide to devote to rural electrification, the screening of proposed projects should follow a uniform national procedure, developed by considering locally validated data. A national policy should be developed that provides consistent guidelines to each province to identify potential rural electrification projects.

46. Application of the policy would allow prioritization at the national level of the overall group of R.E. projects and enable the preparation of a medium term (5 to 10 years) national rural electrification investment program. The prioritization criteria would be based on the following points: (i) areas with relatively high population densities which are currently unelectrified, (ii) preparation of realistic demand forecasts for such areas, (iii) review of possible supply alternatives (grid extension or decentralized generation with minihydro or diesel-based supply), (iv) selection of least-cost system designs, (v) preparation of feasibility analyses, (vi) identification of feasible institutional/financing arrangements, and (vii) prioritizing the projects to be presented to the Central Government. Province-based agencies would then be given the responsibility for implementing the various components of the investment program, including involvement of private investors. At the national and provincial levels, care should be taken to coordinate such actions with similar plans developed for infrastructure or agriculture projects.

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technical losses of 900 kWh/year. The financial loss for the village will be close to 0.5 million Dong per year per transformer installed, without accounting for the additional investment for larger capacity transformers.

47. Opportunities for economic small hydro projects must be included in the evaluation of supply alternatives. The huge potential in small hydroelectric developments is virtually unused, since only 2 to 3 percent (2.5 MW producing 90 GWh/an) has been exploited to date. Most of this potential is concentrated in areas of low population density and far from the grid. Forty-five percent of the potential sites are located in the northern mountains and midlands, 34 percent in the south-central highlands and 20 percent in the hilly areas of the center-north. Systematic evaluation of such sites needs to be undertaken, as has been done in Bac Thai Province, and correlations established between estimates of the potential demand in surrounding areas, the power and energy potential of the sites and the corresponding investment requirements (including installation of diesels for secondary power, if seasonal variations in site hydrology would not permit year-round power demand to be satisfied from hydro generation). This process will allow identification of economic decentralized generation schemes. (S(Annex XIII).

VI. CONCLUSIONS AND RECOMMENDATIONS

1. The recently completed World Bank review of Vietnam's energy sector has identified key policy reforms and investments that need to be made in the oil and gas, coal and electricity subsectors. Issues related to household energy consumption and traditional fuels were found to be much harder to analyze because of the lack of reliable data, the dynamic nature of household energy demand and the fact that the issues straddle not only energy but agriculture, forestry and environment, as well. Nevertheless, there is no question that they deserve equal attention because of the striking dominance of household demand and biomass fuel supplies in the overall energy balance, a consequence of the still highly rural nature of the economy.

2. Some of the problems that emerge in the present analysis are due to the excessive use of biomass fuels. Others are due to the inevitable "household energy transition" that occurs as a result of modernization, urbanization and general economic growth. As households increasingly purchase most of their fuels, income, prices and distribution policies largely determine residential fuel choice and use. The resulting demand mix can severely strain the supply system for certain fuels or put the poor at a disadvantage. The availability of electricity at low cost (before March 1992), for example, led to the abnormally heavy use of electricity for cooking in cities like Hanoi, and severely taxed the power system. The overutilization of woodfuels has obvious adverse environmental impacts in itself. It is exacerbated if the substitute fuel that emerges as wood supplies vanish, such as rice straw in the Red River Delta, is determined to be better returned to the soil than burned in household stoves.

Household Energy and Traditional Fuels

3. The problematic situation in the *Red River Delta* and the measures that are indicated by analysis of the available data exemplify the type of policies that Government must consider for the subsector nationwide.

4. First, the heavy use of wood in the towns of the delta over the decades has contributed significantly to the denudation of the immediate landscape and, as wood sources shifted farther into the highlands, has contributed to the serious erosion of watershed areas, including those protecting the Hoa Binh reservoir. If it goes unchecked, this trend can lead to severe wood supply shortages, degradation of the highland areas, and drastically shortened life of the hydroelectric power plant. The solution does not only involve the obvious and necessary reforestation of the catchment area but requires an understanding of the likely shifts in household fuel choices in the delta towns. Survey data have shown that, despite the preference for wood as cooking fuel, coal now accounts for 65 percent of total cooking energy. This share is likely to increase since coal costs substantially less than fuelwood per kilogram and per unit of delivered energy. However, since it will not be possible to displace wood entirely, continued supply from *managed* plantations must still be assured.

5. Establishing multipurpose tree plantations in the low lying areas near heavy population concentrations of the North Midlands and Red River Delta regions plus densely populated areas of Hoa Binh province will be directly relevant to addressing the above issue. It is recommended that a project along this line be given high priority in the immediate term. The project, with the combined objectives of watershed protection/farm tree planting and expansion of fuelwood supplies, could initially cover about 575,000 hectares in the provinces of Hoa Binh, Yen Bai and Son La (see Annex IX). The estimated cost is US$30 million spread over 10 years. This will complement or

could be made an integral part of a comprehensive watershed management project already proposed by the Tropical Frestry Action Plan, covering 4.7 million hectares in six watershed areas.

6. Second, the extensive of use rice straw and other agricultural residues in villages in the Red River Delta has raised questions about environmental sustainability and household welfare. Crop residues, almost entirely collected, already account for about half of cooking energy in these households--a figure that seems alarmingly high--and reflects their much lower average income compared to households in the towns. The present study concludes, with some caveats (see Chapter 3, paras 10-12), that the practice is probably sustainable and that no direct interventions to curtail its use need be made. However, the larger issue of a deteriorating quality of life of households in these villages remains and must be addressed. In the energy transition "ladder", the shift to crop residues--which are bulky, inconvenient, and need continuous tending of fires--represent a *descent*, as residues have never been a fuel of choice but of necessity in all parts of the world. It is clear that Government policy must be to encourage a shift to affordable, higher grade fuel substitutes.

7. The surveys confirm that coal is already the next most used fuel in village households in the delta (30% of cooking share) and appears to be the most suitable substitute to crop residues in this context. Thus, programs that facilitate the distribution of coal in the Red River Delta would benefit households of both villages and towns. Since coal price is already low, no other intervention would be needed. However, considering the expected increase in coal consumption not only in the delta but in other northern parts of Vietnam in the medium term, efforts must be directed at further enhancing consumer acceptance and alleviating adverse environmental impacts. This means improving the quality of the briquettes by way of reduced smoke, increased heating value and ease of lighting. It is recommended that expert technical assistance be provided to both large-scale and informal sector makers of coal briquettes to improve their production methods.

8. In the *Mekong Delta* and areas northeast to it, estimates made in this study indicate the possibility that the wood resource base is already being mined, with demand probably almost double the sustainable supply. Unlike in the North, wood is the principal cooking fuel in both rural and urban households of the delta, including Ho Chi Minh City that has an extensive commercial woodfuels market. However, anecdotal and survey data paint conflicting pictures of the status of the resource. Although traders report that most of the wood supply to HCMC now come from provinces 150 km and beyond, survey data suggest that a large part of household woodfuels in the delta are still being collected. One explanation for this inconsistency is that there may be more *trees outside the forests* (in private lands, for example) than is normally assumed, in the Mekong Delta and possibly also in other regions. Due to the prominent role of woodfuels in the energy economy of the South, it is recommended that high priority be given to the conduct of surveys and inventories to establish reliable information on sustainability of the resource, with particularly attention to determining the quantity of sustainable woody biomass supply outside the forests.

9. For the *nation* as a whole, woodfuels already constitute over a third of *all* traded energy and must be considered an important commercial fuel. The woodfuel industry is a significant source of employment, especially in rural areas. Using average market prices in 1992, the market value of commercial fuelwood and charcoal traded in 1992 is about Dong 4 trillion (US$400 million), roughly 3 percent of estimated 1992 GDP. The annual employment generated in the preparation, distribution and marketing of these fuels is estimated to be in excess of 100,000 full time jobs, over 60 percent in rural areas. The ongoing economic reforms will probably further stimulate the woodfuels trade throughout the country, even as consumption of modern fuels continues to increase. Trading and distribution of woodfuels appear to be working efficiently and

prices are wholly market determined. Government intervention in the sector does not appear to be needed and in fact has the potential to be disruptive. The role of Government should be merely to *monitor* the sector to ensure that overall operations adhere to the objective of resource sustainability.

10. Estimates made in this study (Chapter 4, Table 4.3) indicate that, for the nation as a whole today, the annual sustainable supply of woodfuels *probably* exceeds total demand slightly. However, the analysis also reveal areas of significant deficits, some of them already discussed above. It is recommended that these areas be closely monitored to determine if interventions may be needed.

11. Except for electricity tariffs which are still below marginal costs, the prices of major household fuels do not appear to be distorted by subsidies. There are a few specific cases that may need to be re-examined. As one element in the rural energy supply policy, approximately 200,000 tons of coal fines are distributed annually at subsidized prices to villages in mountainous areas of 13 provinces with the objective of protecting highland forests from excessive fuelwood demand. This policy costs the government about US$1 million annually. Though the estimates made by the present study are very rough, they indicate that there is *no fuelwood deficit* in the Northern or Southern Highlands. If this is confirmed, the policy may be having the effect of discouraging the production and use of woodfuels which, for convenience and environmental reasons, is a better fuel. It is recommended that this policy be reviewed.

12. There is a potentially important role for *improved cook stoves programs* as a demand management tool for woodfuels. Substantial development and demonstration work has already been done in Vietnam on higher efficiency wood stoves but dissemination is severely limited. Presently, the units are given away free or with heavy subsidy. The deployment of large volumes of improved stoves, specially in resource stressed areas, is the only way to make a dent in wood consumption. The only way to do this is to take a commercial approach, i.e., involve artisans and large stove manufacturers in a program that would put affordable improved stoves on the market. Initially, the program should target middle class households in urban areas. It is recommended that the Government's improved cook stoves program be expanded and re-directed along commercial lines. Efforts must be also be directed at improving the efficiency and emission characteristics of coal stoves.

13. With a few notable exceptions, *renewable energy technologies* still have a long way to go in Vietnam before widespread, practical applications become a reality. More attention should be given by the Government to prioritization of its research and development projects, and lessons must be drawn from more extensive experience in other countries in this field. Household biogas systems, for example, did not prove economic in many countries and are largely impractical as an energy supply option. Wind and photovoltaic technologies, on the other hand, may find economic "niche" applications and should be encouraged where consumers are willing to pay the price. Within the Government's renewable energy development program, it is recommended that the highest priority be directed at mini/micro hydro development and deployment and at photovoltaic system applications for rural areas.

Rural Electrification

14. The first priority of rural electrification in Vietnam remains the connection of irrigation/drainage pumps to the grid in order to expand cultivated areas and increase their

productivity. This is an important program and should be continued. Extending connections to households and rural industries is also a worthy goal for Vietnam over the coming years, despite the burden on public finances which would result. Observations in other developing countries, and in the areas of Vietnam already electrified, show that electricity is a key ingredient of economic development, through increased agricultural productivity, growth of rural industries and general improvement of the quality of life of the rural population. However, *several important preparatory investments, actions and studies* must be made before a major, properly-phased rural electrification plan can be implemented.

15. There are two major prerequisite investments, both also cited by the Energy Sector Investment and Policy Review report. First, supply conditions in the South and central regions must be improved, since no rural electrification program can be implemented if adequate supply is not secured. The EHV line now being installed should help to overcome the current capacity and energy shortfall, but rehabilitation of existing thermal units and timely construction of new capacity would also be required. Second, the existing MV and LV system must be rehabilitated, to improve operational efficiency and quality of service to the consumers. The activity should give priority to installation of capacitors on feeders with high reactive power demands, and reconductoring of heavily loaded feeders. These investments should be accorded the highest priority.

16. Three important activities must first be implemented. First, non-technical losses in seriously affected areas, such as Haiphong, must be reduced. This will require the launching of an inspection program of individual consumer installations, with priority being given to the larger consumers. The inspections will ensure that the meters are properly installed and functioning correctly, and that consumers are duly registered on the utilities' billing systems. A comprehensive program to replace defective meters, including those which are generically unreliable, should be developed and implemented. Second, national planning guidelines and standards for distribution systems should be developed. Application of such standards, along with loss reduction and improvement of the quality of supply, are necessary to achieve optimum system efficiency. Third, the Government must develop and establish a policy on rural electrification which will allow rational and consistent prioritization of rural electrification projects on a nationwide basis. The policy should define (a) appropriate regulatory and institutional frameworks; (b) methodologies for forecasting and economic evaluation of alternative supply locations and options; and (c) technical standards of design, construction and operation.

17. As an immediate step, it is recommended that external technical assistance be sought to: (i) conduct loss reduction studies, and (ii) to help develop a coherent rural electrification policy. The studies should be conducted not only for their specific outputs but also to help develop local planning capabilities.

Institutional Coordination

18. The broad institutional reforms proposed for the energy sector by the World Bank's Energy Sector Review, including the strengthening of the Energy Institute, will also benefit the programs identified for the rural and household energy subsectors. Two supporting recommendations specific to the subsectors should be considered additionally. First, given the importance of biomass energy to energy planning and the cross-sectoral nature of the issues associated with it, there may be need for special coordination of activities and responsibilities of the various ministries involved in this field, namely, energy, agriculture and forestry. Each of these agencies deal with separate aspects

of biomass production and utilization, and a case can be made for a more coordinated planning and monitoring of activities in this area. For example, the recommended comprehensive inventory of supply and demand for woodfuels in households and rural industries and the periodic monitoring of the situation in highly stressed areas, cannot be effectively carried out by just one of these agencies alone.

19. <u>Second</u>, the ministries of energy, water resources and agriculture have interrelated interests and responsibilities for rural electrification. Therefore, a future comprehensive rural electrification program would be more effectively coordinated by an inter-ministerial body, perhaps a "Rural Electrification Committee", rather than by a line agency directly attached to just one of the ministries. This body should be given the responsibility of developing guidelines and regulations in for the program and preparing inputs to the Government's budget planning process for electrification.

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Annexes

Annex I. Definitions of Urban and Rural

1. This study addresses issues related to energy supply and consumption for (i) households in rural and urban areas; and (ii) agriculture and rural industry. Thus the focus is on energy issues faced by households and rural areas. Unfortunately, there is no clear definition of urban and rural energy consumption within the energy planning structures of Vietnam. The three power companies do not separate rural and urban electricity sales, and some uncertainty prevails as to the definition of "rural electrification". Furthermore, many households have recently started small scale commercial and industrial activities at their residence and it is often difficult to separate energy consumption/demand for such activities from the proper residential energy consumption.

2. ESCAP defines rural electrification in Vietnam as the supply of electricity to all areas outside the cities, major towns, district centres and municipalities (see Foley, p.15). However, this definition does not conform with the administrative structure and definitions used by Government. Administratively Vietnam is divided into a central and a local level. The latter comprises provinces with a relatively high degree of autonomy, and under the provinces there are districts and communes. Large cities such as Hanoi and HCMC have the same status as provinces. In 1990, Vietnam had 44 provinces but in 1991 the National Assembly approved a division of some previously merged provinces, and today Vietnam has 53 provinces and cities with 467 districts and 9,765 communes. The 1989 Population Census defines the urban and rural components of this administrative structure as shown in Table1, below.

Table 1. Urban and Rural Components in the Administrative Structure

Administrative Unit	*Urban Component*	*Rural Component*
CITY (Thành pho)	Quarter + District Town (Quan + Thi tran)	District (Huyen)
TOWN (Thi xa)	Ward (Phuong)	Commune (Xa)
DISTRICT (Huyen)	District town (Thi tran)	Commune (Xa)

Source: Viet Nam Population Census, 1989.

3. It should be noted that district towns are considered to be urban places only if they are the administrative or industrial centre of the district, they have a population of at least 2,000, and 50 percent of their labor force is in non-agriculture. Furthermore, large cities and metropoles such as HCMC also have rural areas within their administrative borders. Applying these definitions, the urban population constituted 20.1 percent of total population in the 1989 Population Census.

4. The problem with such administrative definitions is that they, as well as the administrative structures, change over time. For example between 1979 and 1989 two set of changes with opposite impact took place: Many commune centres (thi tu) with a population of 30,000-40,000 were dissolved and replaced with district towns (thi tran) with populations of 10,000-15,000 and rural commune areas (xa), resulting in a smaller urban population. However, at the same time some district towns were upgraded to towns and some industrial centres were reclassified from communes to district towns which tended to increase urban population.

Table 2. Viet Nam - Spatial Distribution of the Population

	Land Area	*Population 1979*	*Population 1989*	:	*1989 Densities persons/sq.km*	*Annual Growth Rate 1979-89*
	-Percentage Shares -			:		*-Percent-*
Northern Uplands	29.7	15.3	15.9	:	103	2.82
Red River Delta	5.2	21.7	21.4	:	784	2.24
North Central	15.5	13.8	13.5	:	167	2.16
Central Coast	13.7	11.0	10.5	:	148	1.94
Central Highlands	16.8	2.9	3.9	:	45	5.64
Southeast	7.1	11.9	12.3	:	333	2.77
Mekong River Delta	12.0	23.4	22.4	:	359	1.94
Total	100	100	100	:	195	2.1

Source: Viet Nam Population Census, General Statistical Office, Hanoi 1991.

Annex II. Energy Taxes and Subsidies

1. Government influences indirectly and directly the level and composition of energy supply and consumption through its exchange rate policy and through a number of energy taxes and subsidies, by setting prices for electricity and oil products, and by undertaking investments in energy production and supply as well as by taking operational responsibility for such investments. The main national taxes and subsidies are briefly reviewed below. In addition, the practice of setting electricity tariffs and oil product prices the same throughout the country implies considerable cross-subsidization between regions. Consumers in regions where the cost of supplying electricity or oil products is low, are subsidising consumers in regions with high supply costs.

2. The combined impact of all of these measures and interventions is unclear. Available information makes it difficult to assess whether the net transfers from Government to an energy sub-sector, e.g. coal, oil, power, are positive or negative. More research and information are required to improve transparency and to project and assess the impact of Government interventions on the level and composition of energy supply and consumption.

3. Government interventions serve a number of socio-economic objectives. Energy sector policy has important social policy aspects, in terms of ensuring that low income groups can meet their energy requirements. Energy sector policy is also related to environmental policies and strategies, and to fiscal and balance of payments strategies. Some of the objectives to which energy sector policy contributes are occasionally contradictory and there are trade-offs involved. A clear understanding of the objectives and trade-offs is required for proper planning.

4. Vietnam could benefit from a technical assistance program that supports Government in (i) developing an adequate information basis for planning in a market based environment, and (ii) clarifying the objectives and trade-offs of energy sector interventions.

Electricity

Taxes

5. Electricity generation and distribution is taxed in 4 different ways:

- Revenue Tax: 12 percent of gross revenue (total value of output). Treasury received Dong 130 billion in 1991 representing 12 percent of 11 months' revenue (total billed revenue in 1991 was Dong 1,673 billion).
- Resource Tax: 2.4 percent of gross revenue from sale of hydro-power (value of output).
- Capital Tax: 2 percent of fixed and working capital. Fixed capital is revalued every year.
- Net Income Tax: 3 percent of net income/profit of each of the three PCs.

Subsidies

6. An electricity consumption subsidy is provided to state employees as part of their remuneration package; the subsidy may be used for other purposes than electricity consumption. The subsidy increases with the level of salary. No data could be obtained on the total cost to Government of this subsidy.

7. Government provides a substantial subsidy to the sector in the form of investment funds which are extended on grant or concessional terms. The amount of this subsidy is not known. In reality, the Power Companies are considered as operators of Government capital and the profit or losses of the Power Companies are the income or expenditure of Government who sets the tariffs. Thus it is not possible to assess whether Government on a net basis supports or taxes power supply and consumption.

Oil Products

Taxes

8. The main taxes applied on oil porudcts are:

- Import tax: applied as a percentage of c.i.f. costs: petrol 25 percent, diesel 8 percent, kerosene 3 percent.
- Net revenue tax: 14 percent levied as a percentage of the sales price minus total cost up to retail outlet, i.e. a kind of value added tax.

Total revenue income in 1992 from taxes on the oil sector was estimated at Dong 499 billion composed as follows :

	Billion Dong
Import tax	305
Net revenue tax	91
Tax on net income of oil distributors (30-50%)	34
Capital tax on state oil enterprises	29
Other	40
Total	499

Subsidies

9. Government sets the retail prices, which were as follows as of February 1993: petrol and diesel 22.7 US cents/litre, and kerosene 24.5 US cents/litre. It is unclear whether the Government prices contain an indirect subsidy. In the past when the Dong was overvalued, a considerable indirect subsidy was contained in the Government fixed retail prices.

Coal

Taxes

10. Various taxes are applied; they differ between open and underground mines:

	Open	Underground
Tax on gross revenue	2%	1%
Resource Tax (as % of output value)	2%	1%
Export Tax	2%	2%

Subsidies

11. Overall the coal industry is reported to balance financially, no subsidies are given to the production enterprises. However, a subsidy is provided to compensate for the high cost of transporting coal to the mountain regions. The objective is that consumers in mountain regions shall be able to buy coal at the same price as households close to the mines. About 200,000 tons are distributed to the mountain regions annually with a total transport subsidy of Dong 10 billion. The 1993 budget contains a subsidy of Dong 13 billion. Thirteen provinces receive subsidised coal deliveries directly from state trading companies while remaining mountain provinces go and collect the coal themselves and then have their transport costs reimbursed from the Central Government.

12. Revenues from coal exports are said to balance the costs of providing this subsidy to households in mountainous provinces. If this is the case, the government take from coal exports is entirely distributed to households in mountainous provinces.

Fuelwood

13. A tax of 15-20 percent is levied on use of forests. The revenue is allocated to the Ministry of Forest for reforestation work.

Annex III. Previous Household Energy Studies: the Basis for Current Policy

Report on Daily Life Fuel, 1987

1. The most recent primary data on residential energy use patterns in all regions of Vietnam was collected by the Ministry of Energy in 1987.[1] Fifty to 100 households in each of Hanoi, Ho Chi Minh City, Danang, 80 provincial towns, and villages in the Red River Delta, the Mekong Delta and in coastal and mountainous zones were surveyed. These spot surveys collected data on appliance holdings, stove types, fuel prices, and the quantities of each fuel used for cooking, boiling pig food, lighting, and other uses. In addition, measurements were taken of actual cooking fuel use. The only available results of these surveys were estimates of average fuel use for cooking by rural households in each region and by urban households nationwide. These reported average fuel use figures have been used in Annex V to estimate urban and rural household cooking fuel use in each region.

Report on Sectoral Energy Demand, 1992

2. The first attempt to include traditional fuels in constructing a consistent and comprehensive picture of energy supply and demand in Vietnam was initiated by the Ministry of Energy in 1989.[2] In this study, the Institute of Energy working group recognized that of all economic sectors, energy use is most complicated in the household sector. The working group found broad gaps in data on non-commercial fuels and distribution figures from the national, regional and provincial offices of coal and oil distribution companies were often incomplete and inconsistent. One outcome of the study is that the Minstry of Energy is committed to addressing the gaps in the existing sectoral energy demand database by undertaking extended surveys of energy use in the household/service sectors in rural and urban areas.

3. The energy usage patterns of households in Hanoi city and in all major urban areas of Hanoi Province were surveyed for this study. The key results, presented in Table 2.2, show that electricity and kerosene were much cheaper than wood as cooking fuels in Hanoi city and these two fuels met almost 90 percent of cooking energy needs. In contrast, almost 90 percent of the cooking energy needs of households in other urban areas of Hanoi Provincewere met by coal and crop residues.

4. Fuel use patterns like those reported in Table 2.2 for Hanoi are not available for households in other areas of Vietnam. The spot surveys of villages in other ecological zones, mentioned above, continued during 1985-1990. The Institute of Energy has reportedly constructed a "non-commercial" energy database on the basis of these spot surveys, disaggregated at the regional level, used for planning in the sector. However, neither data nor summaries of the data from the spot surveys were available.

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1 Report on Daily Life Fuel at the National Level, Ministry of Energy, Institute of Energy, April 1989.

2 Sectoral Energy Demand in Vietnam, Ministry of Energy, June, 1992. Sponsored by the Regional Energy Development Program of the United Nations Economic and Social Commission for Asia and the Pacific.

5. Using regional electricity supply company estimates of rural electrification, the working group reported that the share of the rural poulation connected to electricity service grew steadily from 4 percent in 1976 to 14 percent in 1990 which constitutes a 7 percent growth rate in percent of rural housheolds electrified over the period. To date, these are the official estimates that have been used in most reports on rural electrification in Vietnam. Nonetheless, the power supply companies apparently define "rural" in a manner different from the official demographic definition employed by the General Statistical Office. New evidence, reported in Chapter 2, based on partial returns from a random sample of households throughout Vietnam and employing the official demographic urban/rural classification of communes, indicates that 35 percent of rural households nationwide had electricity service by early 1993.

6. Following its review of energy usage in the sector, the working group identified the widespread use of wood and agricultural residues for cooking as a priority issue to be solved in 1990-2000 to reduce deforestation and protect the environment. Noting that:

i) current technologies for utilizing biomass fuels are inefficient -- rural stoves burn wood and agricultural residues at 8 to 19 percent efficiency for cooking and traditional small-scale brick kilns in rural areas achieve very low efficiencies of around 10-15 percent; and
ii) massive use of woodfuels and crop residues may be causing deforestation, depleting the nutrients in the soil, and destroying local ecosystems,

a rural energy supply policy for 1990-2000 was recommended. The components of this policy include:

i) a program to improve the efficiency of rural cookstoves and widely disseminate stove designs for biomass fuels reaching 20 percent efficiencies;
ii) supply of coal as a substitute for biomass fuels;
iii) two programs to install mini/micro hydro power stations in mountainous areas and biogas digestors in rural plains areas; and
iv) encouragement of fuelwood plantations on private farms as part of the reformed rural economic system.

Along with the priority commitment to improve the household/service sector database through extended survey efforts, this rural energy supply policy outlines the current approach to rural and household energy planning in Vietnam.

Annex IV. 1992 SURVEY OF HOUSEHOLDS IN THE RED RIVER DELTA

Table 1. Red River Delta 1992: Income and Expenditure Data
Units: 000 Dong

	Villages	*Small Town*
Household Income per month	381.3	679.7
Household Expenditure per month	330.8	505.1
Per capita Income per month	75.2	138.7
Per capita Expenditure per month	64.3	102.0

Table 2: Red River Delta 1992: Fuel Expenditure by Income Class

Units: Percentage except Household Size (Number)

	Village Income Class						Small Towns Income Class					
	Low	low Middle	Middle	High Middle	High	Mean	Low	Low Middle	Middle	High Middle	High	Mean
Household Size	5.91	5.51	5.54	5.24	4.22	5.33	5.85	5.61	5.15	4.87	4.33	5.16
Firewood	1.2	1.3	1.1	0.9	1.1	1.1	4.1	2.4	2.2	1.9	1.7	2.5
Crop Residues	0.1	0.0	0.0	0.0	0.1	0.0	1.1	0.1	0.1	0.1	0.0	0.2
Coal	1.1	1.3	1.4	1.7	1.1	1.3	1.6	1.7	1.4	0.9	0.8	1.3
Kerosene	1.3	1.1	0.9	0.9	0.6	1.0	0.7	0.7	0.6	0.8	0.7	0.7
Electricity	2.8	3.3	3.8	2.4	2.9	3.0	5.0	5.1	5.0	4.8	4.4	4.8
Total	6.5	6.9	7.4	5.9	5.8	6.5	12.5	10.0	9.3	8.6	7.6	9.6

Village Income Categories: (Dong/Month)

for Other Provinces:		Hanoi Province :
Low	0 - 46000	0 - 86000
Low-Mid	46000 - 53350	86000 - 96500
Middle	53550 - 62000	96500 - 11200
High-Mid	62000 - 84000	12000 - 130000
High	above 84000	above 130000

Small Towns Income Categories:

Low	0 - 85000
Low-Mid	85000 - 110000
Middle	110000 - 134000
High-Mid	134000 - 182000
High	above 182000

Source: 1992 Rural Energy Survey in Red River Delta

Annex IV

Table 3. Red River Delta 1992: Energy Choice and End Use by Fuel Type

Units: Percentage[a]

	Village					Small Town				
	Fuel Wood	Crop Residue	Coal	Kerosene	Electricity	Fuelwood	Crop Residue	Coal	Kerosene	Electricity
Lighting	0.0	0.0	0.0	97.7	90.6	0.0	0.0	0.0	75.2	99.5
Cooking	46.7	88.8	46.2	0.5	0.5	59.8	17.5	56.7	7.8	17.8
Boiling Drinking Water	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	2.2	35.5
Heating Water	0.3	0.0	0.3	0.3	0.0	5.1	1.8	3.2	0.5	1.0
Boiling Pig Feed	38.8	76.1	44.9	0.0	0.0	16.2	11.3	22.6	0.0	0.0
Business Use	0.2	0.0	1.5	0.0	1.3	2.5	0.9	9.6	0.9	19.4
Starting Fire	29.4	0.0	0.0	5.1	0.0	42.5	0.0	0.0	20.6	0.0
Other Uses	1.0	40.0	0.5	1.5	78.9	43.3	4.1	6.1	3.5	97.9

[a] Note: Because of multiple fuel choices, figures do not add up to 100%.

Table 4. Red River Delta 1992: Energy Use by Fuel and End Use

Units: Per Capita Kg. Oil Equivalent

	Village						*Small Town*					
	Fuel Wood	Crop Residue	Coal	Kerosene	Electricity	Total	Fuel Wood	Crop Residue	Coal	Kerosene	Electricity	Total
Lighting	0.0	0.0	0.0	0.2	0.1	0.3	0.0	0.0	0.0	0.2	0.2	0.4
Cooking	1.6	4.4	2.1	0.0	0.0	8.1	2.9	0.8	3.7	0.1	0.1	7.6
Boil Drinking Water	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.2
Heating Water	1.0	2.7	1.9	0.0	0.0	5.6	0.5	0.3	1.1	0.0	0.0	1.9
Boiling Pig Feed	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.1	4.2	0.0	0.0	4.5
Business Use	0.3	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.0	0.0	0.0	0.7
Other Uses	0.0	0.9	0.0	0.0	0.2	1.1	0.5	0.1	19.6	0.0	0.7	20.9
Total	2.9	8.0	4.1	0.2	0.3	15.5	4.9	1.3	28.7	0.3	1.0	36.2

Table 5. Red River Delta 1992: Energy Used for Cooking by Income Class

Units: Per Capita KG Oil Equivalent per Month

	Village: Income Class						*Small Town, Income Class*					
	Low	Low Middle	Middle	High Middle	High	Mean	Low	Low Middle	Middle	High Middle	High	Mean
Firewood	1.6	1.6	1.6	1.3	2.1	1.6	2.7	2.4	2.8	3.3	3.7	3.0
Crop Residue	4.3	4.9	4.3	4.2	4.7	4.4	2.0	0.7	0.6	0.6	0.1	0.8
Coal	1.2	1.7	2.1	2.9	2.5	2.1	2.5	3.8	4.0	3.8	4.2	3.7
Kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.1
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1
Total	7.1	8.2	8.0	8.4	9.3	8.2	7.2	7.0	7.5	8.0	8.4	7.6

Source: 1992 Rural Energy Survey in the Red River Delta

Table 6. RED RIVER DELTA 1992: FUELWOOD USE BY SOURCE

	Village	*Small Town*
Quantity Kgoe/m/p		
a) Purchased	2.86	6.29
b) Collected	2.87	1.14
Distance to Collect (km)	8.71	3.11
Source of Fuelwood (%)		
Don't Use	31.2	14.8
Purchase only	34.3	80.8
Collect only	27.4	2.5
Both	5.6	1.3
Other	1.5	0.6
Total	100.0	100.0
Source of collected wood (%)		
Own land	33.7	32.1
Other Private land	3.1	0.0
State/Forest Land	37.8	5.4
Sawmill Residue	4.0	17.9
Village or common land	21.4	44.6
Total	100.0	100.0

Table 7: Red River Delta 1992 Type of Coal Used

Units: Percentage

	Village	*Small Town*
Briquettes	12.3	44.8
Coal Dust	33.2	12.1
Briquettes plus Dust	0.0	0.8
Lump Coal	2.0	3.3
Dont Use	52.5	39.0

Source: Rural Energy Survey in Red River Delta

Table 8 :Red River Delta 1992: Consumption of Coal

Units: Per Capita Kg. Oil Equivalent per month

	Village	*Small Town*
Briquette	0.78	7.69
Coal Dust	3.13	19.92
Lump Coal	0.23	1.00
Total	4.14	28.61

Source: Rural Energy Survey in Red River Delta

[a] Note: Because of multiple fuel choices, figures do not add up to 100%.

Annex V. 1993 Living Standards Survey: Fuel Choice and Expenditures

Table 1. Fuel Choice and Expenditures by Urban/Rural

	urban	rural	All
Primary Cooking Fuel			
leaves, straw, sawdust	5.5%	55.6%	40.8%
wood	48.0%	39.8%	42.2%
coal or charcoal	33.2%	4.4%	12.9%
kerosene	11.0%	.1%	3.3%
electricity	2.3%	.1%	.8%
Total	100.0%	100.0%	100.0%
Valid N	N=346	N=825	N=1171
Main Lighting Fuel			
electricity	91.3%	48.7%	61.3%
kerosene, oil, or gas	8.7%	50.6%	38.2%
battery		.7%	.5%
Total	100.0%	100.0%	100.0%
Valid N	N=346	N=826	N=1172
Source of Fuelwood			
not used	41.6%	52.2%	49.1%
collected	17.1%	36.6%	30.9%
purchased	41.3%	11.1%	20.0%
Total	100.0%	100.0%	100.0%
Valid N	N=346	N=827	N=1173
Total expenditures			
('000 Dong/mo)	748	422	518
Std Deviation	663	675	687
Valid N	346	827	1173
Energy share of household budget			
(non-transport)	9.17%	3.36%	5.08%
Std Deviation	6.45	3.70	5.39
Valid N	346	820	1166
Electricity			
('000 Dong/mo)	34.03	4.54	13.29
Std Deviation	39.12	7.75	26.02
Valid N	346	820	1166
Coal, wood, sawdust or husk ('000 Dong/mo)	17.07	2.50	6.80
Std Deviation	19.41	8.94	14.54
Valid N	346	827	1173
Cooking & lighting fuels			
('000 Dong/mo)	5.48	3.49	4.08
Std Deviation	11.52	3.90	7.12
Valid N	346	827	1173
Labor for collecting Wood (hours/year)	4.05	42.16	30.27
Std Deviation	22.88	219.13	183.02
Valid N	312	688	1000

Source: 1993 Living Standards Survey
(preliminary results - only 20% of sample clusters)

Table 2. Fuel Choice by Location

	Rural North	Rural Red River Delta	Rural Hanoi	Rural Central	Rural Mekong Delta	Urban Red River Delta	Urban Hanoi	Urban Central	Urban Mekong Delta	HCMC
Primary Cooking Fuel										
leaves, straw, sawdust	49.1%	98.5%	70.0%	60.2%	7.8%	3.3%		17.7%		
wood	49.7%	1.0%	8.7%	39.8%	90.7%	38.3%	12.5%	51.0%	98.4%	30.2%
coal or charcoal	1.2%	.5%	20.7%		1.0%	55.0%	53.1%	27.1%		40.6%
kerosene					.5%	3.3%	15.6%	4.2%		28.1%
electricity			.7%				18.8%		1.6%	1.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Valid N	173	194	150	103	205	60	32	96	62	96
Main Lighting Fuel										
electricity	36.4%	72.2%	95.3%	21.4%	16.6%	100.0%	100.0%	89.6%	67.7%	100.0%
kerosene, oil, or gas	63.6%	27.8%	4.7%	78.6%	80.5%			10.4%	32.3%	
battery					2.9%					
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Valid N	173	194	150	103	205	60	32	96	62	96
Electrified HH with Shared Electric Meter										
Total	32.0%	31.0%	24.0%	50.0%	12.0%	15.0%	31.0%	55.0%	38.0%	25.0%
Valid N	63	140	143	22	34	60	32	86	42	96
Source of Fuelwood										
not used	33.9%	97.9%	75.5%	54.4%	6.3%	26.7%	75.0%	39.6%	1.6%	67.7%
collected	60.9%	1.0%	1.3%	34.0%	77.1%	1.7%	6.3%	12.5%	62.9%	5.2%
purchased	5.2%	1.0%	23.2%	11.7%	16.6%	71.7%	18.8%	47.9%	35.5%	27.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Valid N	N=174	N=194	N=151	N=103	N=205	N=60	N=32	N=96	N=62	N=96

Source: 1993 Living Standards Survey (preliminary results - only 20% of sample clusters).
Communes are classified as urban or rural according to the administrative definition (see Annex 1).
North includes communes in the Northern Highlands and North Midlands Regions.
Red River Delta includes communes in Ha Tay, Hai Hung, Hai Phong, Thai Binh, Nam Ha, and Ninh Binh Provinces.
Hanoi includes communes in Hanoi Province and immediately adjacent areas.
Central included communes in North Central, South Central, and the Southern Highlands Regions.
Mekong Delta includes communes in Northeast of the Mekong Delta and the Mekong Delta Regions.
HCMC: Ho Chi Minh City.

Table 3. Fuel Expenditures by Location

	Rural North	Rural Red River Delta	Rural Hanoi	Rural Central	Rural Mekong Delta	Urban Red River Delta	Urban Hanoi	Urban Central	Urban Mekong Delta	HCMC
Total expenditures										
('000 Dong/mo)	317	294	421	418	636	437	917	596	722	1,054
Std Deviation	191	171	303	374	1,256	400	960	439	631	749
Valid N	174	194	151	103	205	60	32	96	62	96
Energy share of household budget										
(non-transport)	2.23%	3.46%	5.62%	3.11%	2.67%	11.15%	6.94%	9.95%	4.44%	10.97%
Std Deviation	1.43	4.17	5.14	2.84	2.91	5.55	3.70	6.85	3.76	6.98
Valid N	174	194	150	103	199	60	32	96	62	96
Electricity										
('000 Dong/mo)	2.14	5.21	11.73	1.90	1.94	21.38	31.25	26.16	15.87	62.45
Std Deviation	3.62	5.04	12.40	4.02	5.76	13.01	20.13	34.19	17.63	52.48
Valid N	174	194	150	103	199	60	32	96	62	96
Coal, wood, sawdust or										
husk ('000 Dong/mo)	.21	1.09	6.48	3.20	2.50	16.98	8.59	20. 1	6.37	23.72
Std Deviation	1.42	7.74	14.68	9.82	6.36	12.65	9.22	16.67	14.59	25.93
Valid N	174	194	151	103	205	60	32	96	62	96
Cooking & lighting fuels										
('000 Dong/mo)	3.56	2.11	1.20	5.50	5.43	.78	7.47	4.10	3.02	10.73
Std Deviation	3.40	2.03	1.67	5.42	4.45	2.61	17.41	7.90	4.47	15.96
Valid N	174	194	151	103	205	60	32	96	62	96
Gasoline and motor oil										
('000 Dong/mo)	.44	.00	.40	1.48	1.70	3.18	7.31	4.75	6.44	19.44
Std Deviation	3.72	.00	2.51	10.16	11.29	9.73	14.49	12.90	17.44	23.26
Valid N	174	194	151	103	205	60	32	96	62	96
Matches, candles & flint										
('000 Dong/mo)	.28	.29	.65	.52	.83	.85	.50	.17	1.00	2.28
Std Deviation	.57	.88	1.54	1.17	1.13	2.70	.51	.43	1.28	4.72
Valid N	174	194	151	103	205	60	32	96	62	96
Labor for collecting										
wood (hours/year)	155.97	.13	.00	37.67	17.88	.00	.42	.00	26.60	.00
Std Deviation	436.59	1.87	.00	124.18	27.40	.00	2.33	.00	54.08	.00
Valid N	153	193	149	84	109	59	31	84	47	91

Source: 1993 Living Standards Survey (Preliminary Results)

Annex VI. Estimates of Residential Fuel Consumption

Table 1. Vietnam 1992 Population and Estimated Cooking Energy Requirements by Agro-ecological Zone

Region (1)	*Area ('000 ha)*	*Population ('000 people)* Rural	Urban	Total	*Cooking Energy (2) (kg wood equivalent /cap/day)* Rural	Urban
Northern Highlands	9,361	6,127	1,320	7,447	2.5	1.35
North Midlands	919	4,020	366	4,386	1.1	1.35
Red River Delta	1,262	11,171	2,347	13,518	1.1	1.35
North Central	5,123	8,282	1,005	9,287	1.5	1.35
Southern Highlands	5,557	2,149	656	2,805	2.5	1.35
South Central	4,517	5,450	1,742	7,192	1.5	1.35
N.E. of Mekong Delta	2,349	4,339	4,067	8,406	1.5	1.35
Mekong Delta	3,956	12,694	2,527	15,221	1.5	1.35
Vietnam	33,044	54,232	14,030	68,262		

(1) See Map 1 for boundaries of each agro-ecological zone.
(2) These cooking energy requirements are from the "Report on Daily Life Fuel at the National Level", 1987, Ministry of Energy - Institute of Energy (reported in FAO, 1992). The Institute of Energy derived these estimates from the results of quick sample surveys of households in Hanoi, Ho Chi Minh City, Danang, 80 provincial towns, and villages in the Red River Delta, the Mekong Delta and in coastal and mountainous zones. These surveys collected data on appliance holdings, stove types, fuel prices, and the quantities of each fuel used for cooking, boiling pig food, lighting, and other uses. In addition, actual cooking fuel use was measured over a period of time. Cooking energy requirements for households in the Red River Delta and North Midlands are based on results from the 1992 Survey of Households in the Red River Delta undertaken for this study.

Table 2. Vietnam 1992 Estimated Share of Cooking Services (including boiling pig food) Provided by Each Fuel

Region	*Crop residues*	*Fuelwood*	*Charcoal*	*Coal*	*Kerosene*	*Electricity*
Rural						
Northern Highlands	48.5%	49.1%	0.0%	2.4%	0.0%	0.0%
North Midlands	48.5%	49.1%	0.0%	2.4%	0.0%	0.0%
Red River Delta	42.0%	20.0%	0.0%	37.0%	0.0%	1.0%
North Central	60.2%	39.8%	0.0%	0.0%	0.0%	0.0%
Southern Highlands	60.2%	39.8%	0.0%	0.0%	0.0%	0.0%
South Central	60.2%	39.8%	0.0%	0.0%	0.0%	0.0%
N.E. of Mekong Delta	22.8%	72.7%	3.5%	0.0%	0.0%	1.0%
Mekong Delta	22.8%	72.7%	3.5%	0.0%	0.0%	1.0%
Urban						
Northern Highlands*	17.7%	51.0%	2.1%	25.0%	4.2%	0.0%
North Midlands*	17.7%	51.0%	2.1%	25.0%	4.2%	0.0%
Red River Delta	1.9%	27.1%	0.0%	54.1%	8.7%	8.2%
North Central	17.7%	51.0%	13.5%	13.6%	4.2%	0.0%
Southern Highlands	17.7%	51.0%	13.5%	13.6%	4.2%	0.0%
South Central	17.7%	51.0%	13.5%	13.6%	4.2%	0.0%
N.E. of Mekong Delta	0.0%	57.0%	24.7%	0.0%	17.1%	1.2%
Mekong Delta	0.0%	57.0%	24.7%	0.0%	17.1%	1.2%

Estimated shares are based on the share of households using each fuel as a primary cooking fuel in each region from 1993 Living Standards Survey, modified to allow for multiple fuel usage (common throughout Vietnam). Rural Red River Delta shares use 1992 Rural Energy Survey Data and assume 20% of the rural population live in small towns and 80% in villages.

* Based on urban Central region patterns, but adjusted for more coal and less charcoal than in Central provinces.

Table 3. Vietnam 1992 Estimated Residential Fuel Consumption for Cooking and Boiling Pig Food

Region	*Crop residues ('000 tons)*	*Fuelwood ('000 tons)*	*Charcoal ('000 tons)*	*Coal ('000 tons)*	*Kerosene ('000 m3)*	*Electricity GWh*
RURAL						
Northern Highlands	6,829	4,118	0	108	0	0
North Midlands	1,972	1,189	0	31	0	0
Red River Delta	2,522	1,140	0	730	0	48
North Central	6,875	2,707	0	0	0	0
Southern Highlands	2,973	1,171	0	0	0	0
South Central	4,524	1,781	0	0	0	0
N.E. of Mekong Delta	1,364	2,591	45	0	0	26
Mekong Delta	3,991	7,579	132	0	0	75
Rural Total	31,050	22,276	177	869	0	149
Northern Highlands	193	332	5	87	5	0
North Midlands	54	92	1	24	1	0
Red River Delta	37	313	0	336	17	102
North Central	147	253	24	36	4	0
Southern Highlands	96	165	16	24	2	0
South Central	255	438	42	63	6	0
N.E. of Mekong Delta	0	1,142	180	0	59	26
Mekong Delta	0	710	112	0	37	16
Urban Total	782	3,445	380	571	132	144
Vietnam	31,832	25,721	557	1,440	132	294
Vietnam (kTOE)[1]	9,952	9,531	387	767	107	25
Assumptions:						
Stove Efficiency	12.0%	17.0%	35.0%	22.0%	45.0%	70.0%
Unit	kg	kg	kg	kg	liter	kWh
Heat Value (MJ/unit)	13.5	16	30	23	35	3.6

Estimates are based on i) the estimated share of cooking energy services from Table 2 above, ii) the population estimates and end-use cooking energy requirements displayed in Table 1, and iii) heating values and average stove efficiencies shown here. There are many types of coal traded in Vietnam, but the grade most commonly used by households has a lower heat content than the industrial hard coals (the average heating value of coal used across all sectors is roughly 28.8 MJ/kg). An additional 50% was added to rural consumption of residues, wood, charcol, and coal for the preparation of pig food (based on fuel use patterns in villages and small towns in the Red River Delta). Rural fuel consumption estimates for the Red River Delta use mean figures from the 1992 Rural Energy Survey of the Red River Delta presented in Annex IV and weight results according to the assumption that 20% of the rural population live in small towns and 80% live in villages.

[1]Note: 1 TOE= 43.18 GJ

Annex VII. Estimates of Land Use and Biomass Supply

Assessing the Woody Biomass Resource Base

1. The only information that is available on the growing stock (and annual yield) of woody biomass in Vietnam is from periodic inventories that the Forest Service undertakes in natural forests. However, these inventories are confined to the stem wood of trees above a minimum diameter. Branch wood, small wood, scrub and bamboos, etc. are excluded from the equation as are all trees outside the natural forests. Official figures are also reported for plantations, but appear to be based on estimates, not measurements.

2. The latest published figures indicate a 1989 total stem volume of 586 million cubic meters, including 6 million m^3 for forest plantations.[3] This total volume has been used as a basis for assessing total above ground woody biomass in the natural forests. To account for branches, bamboo's, scrub, etc., an additional 12 percent has been added to this total, bringing the average above ground volume in forest land to 75 m3 per hectare (53.6 air dry tons per ha, 15% moisture content -wet basis-).

3. Official estimates of average standing stem volume for plantations of 10 m^3 per ha. appear to be low. The Tropical Forestry Action Plan for Vietnam (TFAP) assumed that the average annual sustainable off-take from plantations is 10 m^3 per year. This would be impossible if the growing stock were only 10 m^3/ha. Based on the average age of the plantations, a figure of 30 m^3 per ha. or 20 t./ha. has been used to estimate the standing stock in these plantations.

4. Annual yield figures are not reported by the General Statistical Office. What is given is the production of sawlogs (cutting wood), stated to be 3.5 mill m^3 for 1991 or 2.5 percent of the commercially valuable species, - a production that should be sustainable. The same book gives the production (estimated consumption) of firewood from all sources, estimated to be 32 million stacked m^3 (steres) or about 19 million m^3 (13 mill. t.) for 1991. This represents about 3 percent of above ground woody biomass in natural forests, again a figure that should be sustainable. However, the estimated demand for wood energy in 1992 is approximately 27 million tons, more than double the above figure: if this latter figure is correct then the additional supply may come from a reduction of the growing stock and/or trees from outside the forest.

5. No measurements have been made for trees on the 23.6 million ha. of farm, miscellaneous, urban and degraded forest land. The TFAP, estimates the sustainable yield from these areas as 12 million tons, but no estimate is given of standing stock. The same paper also estimates the sustainable yield from natural forests for fuelwood to be 2.1 million tons per year which is only 0.5 percent of the standing stock. This is a very low figure and significantly below the sustainable supply.

6. There is an urgent need to undertake inventories of biomass on these non-forested areas, both for woody and non-woody growth and yield in order to obtain a more accurate picture of the dynamics of supply and demand. Most of the people live on or near these areas that are and will be the

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3 Statistical Data of Vietnam's Agriculture, Forestry and Fishery (1976-1991), Statistical Publishing House, Hanoi, 1992.

primary supply sources. At the same time, an inventory of plantations should be undertaken together with estimates of total above ground growing stock and annual yield in natural forests.

Table 1. Vietnam 1992 Land Area by End Use ('000 hectares)

Region	Agriculture					Forest			Misc.	Urban	Total
	Rice	*Other foods*	*Sugar, pine-apple, etc.*	*Tea, rubber, etc.*	*Irrigation canals*	*Closed forest*	*Plantation*	*Degraded*			
Northern Highlands	396	328	18	33	1	1527	175	5111	1616	156	9361
North Midlands	185	111	7	9	10	115	30	186	223	43	919
Red River Delta	528	151	15	3	29	32	16	69	181	238	1262
North Central	381	262	17	28	21	1495	161	1621	1018	119	5123
Southern Highlands	160	94	11	128	0	3290	40	707	1049	78	5557
South Central	227	131	33	20	12	1546	80	1524	735	206	4514
N.E. of Mekong Delta	265	163	40	240	14	499	76	278	587	187	2349
Mekong Delta	1615	33	95	115	87	183	50	254	1225	299	3956
Vietnam	3757	1273	236	576	174	8687	628	9750	6634	1326	33041

Sources: Statistical Data of Vietnam's Agriculture, Forestry and Fishery (1976-1991); The Pivotal Areas of Commodity Production; Hanoi; 1992. Economy and Trade of Vietnam 1986-1991; Hanoi; 1992. Various other Government and Consultancy Reports.

Table 2. Vietnam 1992 Estimated Growing Stock of Woody Biomass ('000 tons air dry 15% moisture content, dry basis)

Region	Agriculture					Forest			Misc.	Urban	Total
	Rice	*Other foods*	*Sugar, pine-apple, etc.*	*Tea, rubber, etc.*	*Irrigation canals*	*Closed forest*	*Plantation*	*Degraded*			
Northern Highlands	119	197	5	550	0	81,805	3,750	14,603	4,617	223	105,869
North Midlands	56	67	2	150	0	6,161	643	531	637	61	8,308
Red River Delta	158	91	5	50	0	1,714	343	197	517	340	3,415
North Central	114	157	5	467	0	80,091	3,450	4,632	2,909	170	91,994
Southern Highlands	48	56	3	2,133	0	176,254	857	2,020	2,997	111	184,480
South Central	68	79	9	333	0	82,823	1,714	4,354	2,100	294	91,776
N.E. of Mekong Delta	80	98	12	4,000	0	26,733	3,257	794	3,677	267	38,917
Mekong Delta	485	20	29	1,917	0	9,804	2,143	726	10,500	427	26,050
Vietnam	1,128	765	70	9,600	0	465,385	16,157	27,857	27,954	1,893	550,809
Assumptions:											
(cubic meters/ha)	0.5	1	0.5	25	0	75	30[a]	4	4	2	
(tons/cubic meter)	0.6	0.6	0.6	0.6667	0.6	0.7143	0.7143	0.7143	0.7143	0.7143	
(tons/ha)	0.3	0.6	0.3	16.6675	0	53.5725	21.429	2.8572	2.8572	1.4286	

[a] Except for plantations in NE Mekong Delta and Mekong Delta where growing stock assumed to be 60 cu.m. per ha. Also in NEMD and Mekong Delta, 15,000 ha. of miscellaneous land assumed to be plantation land.

Table 3. Vietnam 1992 Production of Woody Biomass (Sustainable Supply) ('000 tons air dry 15% moisture content, dry basis)

Region	*Agriculture*					*Forest*			*Misc.*	*Urban*	*Total*
	Rice	*Other foods*	*Sugar, pine-apple, etc.*	*Tea, rubber, etc.*	*Irrigation canals*	*Closed forest*	*Plantation*	*Degraded*			
Northern Highlands	24	39	1	66	0	3,272	937	3,651	1,154	22	9,166
North Midlands	11	13	0	18	0	246	161	133	159	6	747
Red River Delta	32	18	1	6	0	69	86	49	129	34	424
North Central	23	31	1	56	0	3,204	862	1,158	727	17	6,079
Southern Highlands	9	12	1	256	0	7,050	214	505	749	11	8,807
South Central	13	16	2	40	0	3,314	429	1,089	525	29	5,457
N.E. of Mekong Delta	16	20	2	480	0	1,069	814	199	919	27	3,546
Mekong Delta	97	4	6	230	0	392	536	181	2,625	43	4,114
Vietnam	225	153	14	1,152	0	18,616	4,039	6,965	6,987	189	38,340
Assumptions: (tons/ha)	0.06	0.12	0.06	2	0	2.143	5.357	0.7143	0.7143	0.143	

Assumptions: Average growing stock of woody biomass on rice land and sugar land: $0.5m^3$/ha, rotation 10 years, annual offtake $0.1m^3$ or 0.06t; average growing stock of woody biomass on other food land: $1.0m^3$/ha, rotation 10 years, annual offtake $0.2m^3$ or 0.12t; average growing stock of woody biomass on tea, coffee, rubber, mulberry, coconut, pepper and orange land: $25m^3$/ha, annual offtake $3m^3$ or 2.0t, rotation 17 years; average growing stock of woody biomass of natural forest: $75m^3$/ha, annual offtake $3m^3$ or 2.14t, nominal rotation 50 years; average growing stock of woody biomass on plantations: $30m^3$/ha, annual offtake $7.5m^3$ or 5.6t, rotation 8 years, except in NE of Mekong Delta and Mekong Delta where the growing stock and yield are assumed to be double these figures, namely, GS 60 cu.m. per ha, annual offtake 15 cu.m. per ha or 11.2t, rotation 8 years; average growing stock of woody biomass on degraded and miscellaneous lands: $4m^3$/ha, annual offtake $1m^3$ or 0.71t, nominal rotation 8 years; average growing stock of woody biomass on urban land/roads: $2.0m^3$/ha, annual takeoff $2m^3$ or 0.14t, nominal rotation 20 years. From various surveys, there is evidence that there is more wood outside the closed forests and plantations in NE of Mekong Delta and in the Mekong Delta. Therefore, it has been assumed that 50,000 ha. of miscellaneous land in NEMD and 175,000 ha. of the same land in the Mekong Delta have been converted to plantations with an annual yield of 15 cu.m. per ha and a growing stock of 60 cu.m. per ha. General formula used: Yield (offtake) = (Average Growing Stock X 2) ÷ Rotation (assuming average growing stock per hectare is half the final felling growing stock). This is total above ground woody biomass. Stem volume is 83% of above figures. Ref. Openshaw, K., 1986.

Table 4: Vietnam 1992 Production of Agricultural Residues ('000 tons air dry 15% moisture content, dry basis)

Region	*Rice Straw*	*Rice husk bran*	*Maize Straw*	*Maize cob bran*	*Sweet Potato*	*Cassava*	*Pulses (Beans)*	*Sugar Bagasse*
N.H.	1469	386	330	88	32	132	70	15
N.M.	888	237	63	17	56	39	48	14
R.R.D.	4386	1170	167	45	98	7	72	33
N.C.	2522	673	96	26	115	58	125	80
ST.N.	9245	2466	656	176	301	236	315	142
S.H.	633	168	129	34	0	40	62	46
S.C.	2571	686	45	12	40	107	122	194
NE.M.D.	1251	334	110	29	8	58	200	222
M.D.	15450	4120	39	10	71	37	78	584
ST.S.	19905	5308	323	85	119	242	462	1046
VIETNAM	29150	7,774	979	261	420	478	777	1188
C.F.	1.5	0.4	1.5	0.4	0.2	0.2	2.5	0.2

Region	*Sugar Tops*	*Cotton*	*Coffee Husk*	*Cocoshell/ husk*	*Tobacco*	*Total*
N.H.	7	8	0	0	3	2520
N.M.	7	0	0	0	3	1372
R.R.D.	17	0	0	0	1	5996
N.C.	40	1	4	53	1	3794
ST.N.	71	9	4	53	8	13682
S.H.	23	6	208	0	0	1349
S.C.	97	2	2	303	7	4188
NE.M.D.	111	2	139	245	7	2716
M.D.	292	0	0	1726	6	22413
ST.S.	523	10	349	2274	20	30666
VIETNAM	594	19	353	2327	28	44348
C.F.	0.1	4.0	1.0	2.25	1.0	

C.F. = Conversion Factor Food to Residue (residues as a multiple of food production).

Table 5. Vietnam 1992 Production of Grass, Tree Leaves, Weeds, etc. ('000 tons air dry 15% moisture content dry basis)

Region	*Agriculture* Rice	Other foods	Sugar, pine-apple, etc.	Tea, rubber, etc.	Irrigation canals	*Forest* Closed forest	Plantation	Degraded	*Misc.*	*Urban*	*Total*
Northern Highlands	24	820	3	66	5	8,399	963	20,444	6,464	78	37,266
North Midlands	11	278	1	18	50	633	165	744	892	22	2,814
Red River Delta	32	378	3	6	145	176	88	276	724	119	1,947
North Central	23	655	3	56	105	8,223	886	6,484	4,072	60	20,567
Southern Highlands	9	235	2	256	0	18,095	220	2,828	4,196	39	25,880
South Central	13	328	6	40	60	8,503	440	6,096	2,940	103	18,529
N.E. of Mekong Delta	[illegible]	408	7	480	70	2,745	418	1,112	2,348	94	7,698
Mekong Delta	9[illegible]	83	16	230	435	1,007	275	1,016	4,900	150	8,209
Vietnam	225	3,185	41	1,152	870	47,781	3,455	39,000	26,536	665	122,910
Assumptions: (tons/ha)	0.06	2.5	0.17	2	5	5.5	5.5	4	4	0.5	

Source: These assumptions are derived from a review of Net Primary Production (NPP) for countries within 10 degrees of the equator found in Openshaw (1986). NPP principally depends on rainfall, although the quality of the soil is important. Bearing this in mind, the NPP for Vietnam should range from 5 tons to 10 tons per hectare, except under intense agriculture such as sugar production and double/triple rice cultivation, where NPP will be higher. The estimated total production of leaves and grass - 123 million tons (100 million tons of wood equivalent) - is more than the combined total production of woody biomass and crop residues. This is not surprising when considering that the annual production of tree leaves is approximately equal to the production of wood and that grass and weeds are ubiquitous and grow throughout the entire year. Nonetheless, these are very low quality fuels and are only used as a last resort. They also provide feed for many animals of all kinds. For example, the cattle and buffaloes in Vietnam require about 23 million air dry tons of grass and crop residues for feed each year.

Annex VIII. Energy Issues in Rural Industry

1. Non-household energy accounts for twenty percent of energy used in Vietnam, with industry making up two-thirds of this total. Table 2.1 gives a breakdown of the 1990 estimated final consumption of energy by sector and by fuel. Industry accounts for the bulk of non-household energy use a substantial share of this is used in small scale, mainly informal, industries. Biomass supplies almost one-third of all energy requirements to the industrial sector, principally to rural enterprises which require a cheap and reliable supply of fuel for process heat. Therefore, it is important to survey these industries to discover if they have energy supply problems, and if so determine what could be done to alleviate this problem. For example, as wood has become scarce in the Red River delta region, coal has taken its place, particularly in brick kilns and it is now an important small scale industrial fuel in this region. Table 1 gives an estimate of the 1990 consumption of biomass energy and coal for small scale industries in Vietnam.

Table 1. Vietnam 1990: Estimated Small Scale Industrial Use of Biomass and Coal ('000 toe)

Industry	*Coal*	*Fuelwood*	*Residues*	*Total*
Mineral based (1)	400	463		863
Agricultural processing (2)	26	117	357	500
Food processing (3)	7	20		27
Wood industries (4)	0	28		28
Alcoholic beverages (5)	3	65		68
Miscellaneous (6)	7	24 (7)		31
Total	**443 (8)**	**717**	**357**	**1517**

Notes: (1) These include brick and tile making, lime burning, principally for mortar manufacture, and ceramic manufacture.

(2) These include processing the following products:- coconut and other vegetable oils, coffee, rubber, sugar, gur (jaggery) and molasses, tea and tobacco.

(3) Food processing includes animal fat rendering, bread and cake making etc., cassava drying, bean curd (tofu) manufacture, fruit and other food preparation for canning, mollusk preparation, noodle production, nut roasting, sweets manufacture etc. It excludes, food preparation in restaurants, canteens, cafes and mobile hot food vendors and process heat for laundries. These are included under the service sector and use an estimated 43,000 toe of coal, 14,000 toe of charcoal and 46,000 toe of wood. (Table 2.1)

(4) Wood industries use waste wood to provide energy for motive power and in the manufacturing process. These industries include sawmilling, veneer, plywood and other board manufacture, pulp and paper production and wood processing.

(5) These include local production of alcoholic beverages and spirits.

(6) Miscellaneous industries cover:- essential oil extraction, metal working, salt production, soap making, tannin extraction for leather tanning, road tarring and road maintenance.

(7) This includes ?,000 toe of charcoal used by blacksmiths and small metal manufacturers etc..

(8) This figure, plus some of the household total for coal, includes an estimated 43,000 toe of power station ash which is recycled and made into briquettes or patties.

Source: Koopmans. A.1991, (TFAP) adapted and Mission estimates.

2. Brick, tile and lime burning are the largest group of industries that use fuelwood and coal. In rural areas near cities and towns there are a large number of kilns producing building materials. Indeed on one of the roads out of Hanoi, small brick factories were counted at about one kilometer intervals for over 40 km. There has been a tremendous upsurge in building activities over the last two to three years and this is likely to continue for some time to come, thus an increasing amount

of energy may be required for these industries. Such industries are labor intensive and should be encouraged as a means of creating rural employment. If the fuel source is wood, this will bring rural employment in its growing, production, transport and marketing. According to estimates presented in Chapter 3, more than 100,000 full time people obtain employment in the production, transport and marketing of fuelwood and charcoal across the nation. In addition, more than 10,000 people may be employed in growing and tending trees, especially if the bulk of the woodfuel supply in Vietnam is coming from planted forests as in Danang (see above).

3. Agricultural processing covers a large number of rural industries that are almost entirely dependent on biomass for their process heat requirements. If wood is being over cut to meet the demands of these industries then they could be in jeopardy. A survey of all these industries should be undertaken to ascertain how much energy they use and if it is biomass, their supply sources If these and other rural industries, which depend on a supply of energy close to where the raw material is grown, cannot rely on a sustainable supply source, then steps should be taken to ensure its sustainability.

4. Such rural industries may need assistance to improve their energy efficiency in the production process. This could be included in the work of an expanded "Improved Stove Unit" under the Energy Institute or coordinated by them, (see para. 83. Chapter 3.). There is already a considerable body of knowledge about improved kilns and improved agricultural processing devices and assistance could be given to the Energy Institute to make this knowledge available.

5. Because these industries are mainly run by the informal sector, they do not have the capacity, money or capability to undertake energy audits or efficiency improvements. Yet these industries as a group use more energy and most likely employ more people than the formal industrial sector. These industries also bring income to rural people and supply the means to pay for electrical connections and other improvements to living standards. Therefore, it should be in the interest of the government to support these rural industries, by ensuring they are using their energy efficiently and if they are using biomass, it is coming from a renewable supply source. Unless they are near to another fuel such as coal, they have little opportunity to switch to other energy forms. From an environmental viewpoint, they should be encouraged to use an indigenous renewable fuel that can be grown near to the demand.

6. Biomass is also used by the service sector in restaurants, cafes, mobile hot food shops, canteens in schools, colleges, army camps and hospitals etc. and by laundries. Such establishments would benefit from energy efficiency improvements and an expanded stove unit could cater to their needs.

7. For these reasons, government should survey all the users of non-household biomass energy to determine with more accuracy the size, location and kind of industry or service that uses biomass fuels and find out the quantity and source of biomass consumed. With this information as a basis, a strategy can be formulated to assist these sectors improve their operations and end-use efficiency and ensure that their will be a sustainable supply of renewable energy.

Da River Water Catchment Area Project

Introduction.

1. This project is envisioned to be part of a much larger watershed management project identified in the Tropical Forestry Action Programme Project Profile for Vietnam. (Ministry of Forest, Hanoi, December 1991.). The TFAP project covers six watershed areas of 4.7 million hectares and has three components namely:

a) identification of environmentally threatened areas;
b) watershed management pilot projects; and
c) watershed management projects.

2. The estimated cost for the whole project is between US$ 275 and 300 million with a lifetime of at least 10 years. Out of this total, the Da river component is estimated to cost about US$ 110 million, or over one-third of this total.

3. The particular project being proposed in this report would be a small portion of TFAP's Da river project component and could be implemented as a "fast track" project. It will focus on the low lying areas near the population concentrations of the North Midlands and Red River Delta Regions plus densely populated areas of Hoa Binh province. It will cover areas totaling 575,000 hectares in the provinces of Hoa Binh, Yen Bai and Son La.

4. Practically all hilly and mountainous parts in these areas are affected by serious erosion. The worst cases are encountered on low hills adjacent to densely populated agricultural areas. These hills have been cut-over many times to supply wood products, principally fuelwood, to nearby urban and lowland rural households and industry. Also, because of population pressure, due in part to over 100,000 people being displaced by the flooding caused by the building of the storage reservoir, many of these areas have been cultivated with agricultural crops and/or over grazed beyond their sustainable capacity.

5. The Da river feeds the 2 GigaWatt Hoa Binh hydro-electric power station which was commissioned in 1988. Due to serious erosion problems, the storage capacity reservoir is anticipated to have no more than one-fifth of its planned lifetime of 250 years, unless steps are taken to slow down the erosion rate significantly.

This project is intended to:

a) slow down the rate of erosion, thus protecting the huge investment of US$ 3000 million in the dam and power plant;
b) provide fuelwood and other tree products to the urban and rural communities in and around the Red River delta;

c) introduce sustainable silvicultural and agricultural practices to the water catchment areas, especially agro-forestry and multipurpose tree planting;
d) provide employment and sustainable economic development to the people; and
e) help with the resettlement of the displaced people.

Project Description.

6. As part of the project, informtation will be gathered about the supply, demand and trade in wood and tree products, particularly fuelwood in the water catchment areas that serve the lowland agricultural and urban areas. The study would highlight the present demand for and trade in wood energy and other tree products. Forecasts will be made of potential future demand, taking into consideration supply constraints at present.

7. Parallel to the woodfuel demand and marketing study, the project area will be identified and delineated. A land use map will be produced and land ownership/land occupancy register will be compiled. This should be done in cooperation with the Red River Delta Master Plan Project.

8. Once this information has been compiled, a land planning exercise will be undertaken to classify land according to its most sustainable use from the points of view of land reclamation, erosion control and sustainable economic development. Specific interventions to be considered are terracing, check dams, river bank protection, and general watershed management activities. This initiative will take place in consultation with and with the agreement of the population already living in the area or the displaced people about to be moved there.

9. After identifying appropriate technical and institutional approaches such as community forestry, agro-forestry, woodlots, tree fodder production, terracing etc. for the bare and degraded land and improved management interventions for the existing forest and plantation areas, pilot projects will be initiated in representative areas which will cover the various communities. Successful planting and management initiatives such as those undertaken by the World Food Programme and CARE International will be used as models.

10. A preparation and implementation plan will be prepared to cover the whole area. This will include technical assistance and investment costs and benefits for the project's lifetime.

Tentative Costs and Area Covered.

11. It is envisaged that there will be interventions in five areas, three of which are concerned with tree planting activities, namely:

a) establishing about 50,000 hectares of woodlots, plantations and riverside plantings at an estimated cost of US$ 10 million;

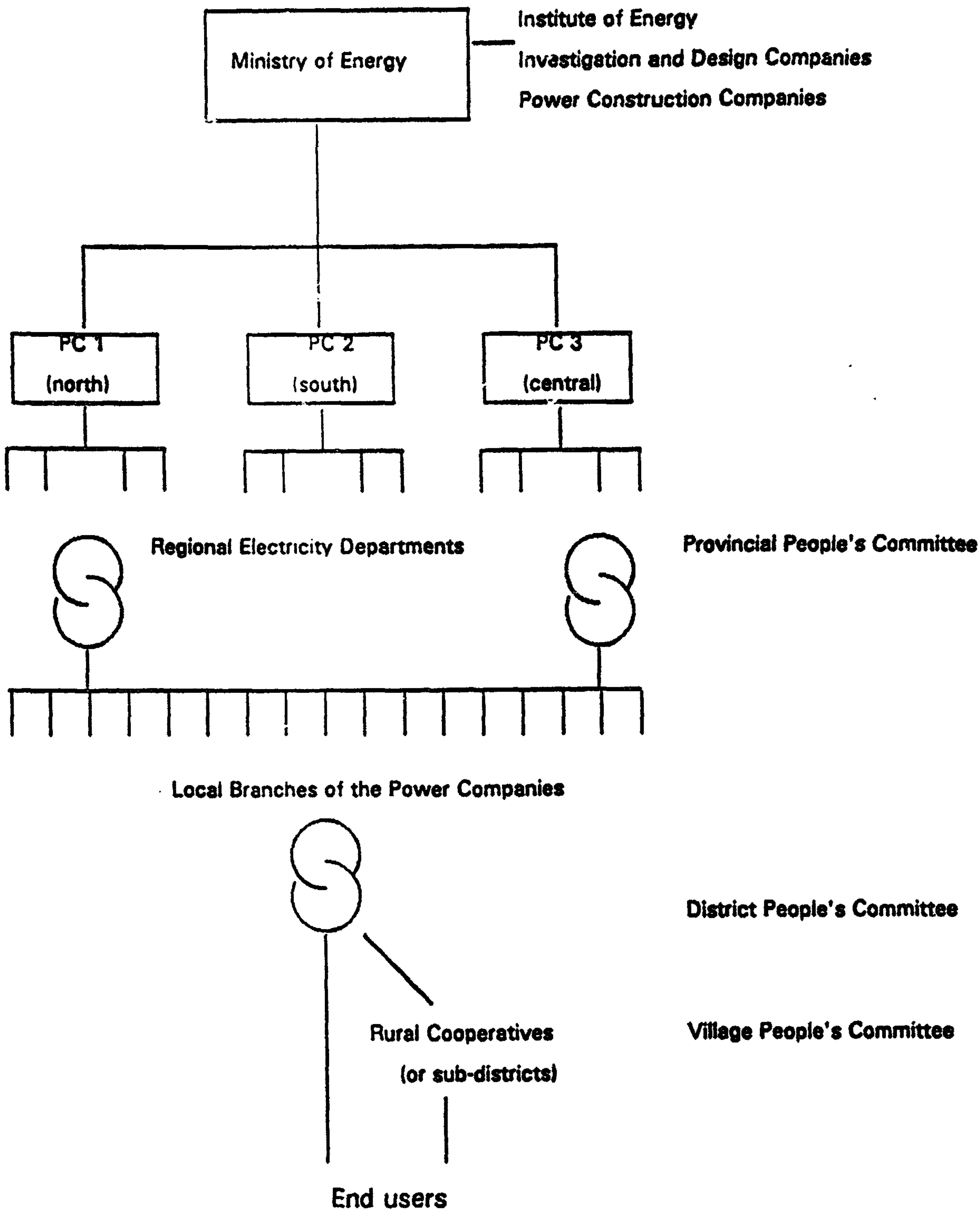
b) converting about 125,000 hectares of degraded agricultural or pasture land to land with sustainable soil conservation interventions such as agro-forestry, terracing, fodder production in which trees will cover an estimated 20 % of the area. This will cost approximately US$ 5 million;

c) reclaiming 400,000 hectares of degraded forest land through various management techniques such as encouraging natural regeneration from superior trees, under planting and enrichment planting, and management for multipurpose use. The cost of this intervention will be about US$ 10 million.

In addition there will be the demand and market survey and an initiative to increase the end use efficiency of fuelwood.

12. The total cost, including the preparation and supervision work, is estimated to be about US$ 30 million in 1993 dollars and the project's lifetime will be an initial 10 years. The above costs exclude many inputs by the people themselves who will be providing land and labor freely or in exchange for food and other inputs. The overall benefits include reduced erosion, prolonged reservoir life, sustainable agricultural and silvicultural development and enhanced provision of fuelwood and other tree products.

Annex X
Participants in Rural Electrification Process



Annex XI. Comparative efficiencies of Vietnamese and currently installed Chinese transformers.

Size kVA	Vietnamese		Chinese (S7) (*)	
	No load losses (kW)	Load losses (kW)	No load losses (kW)	Load losses (kW)
50	300	1400	190	1150
100	550	2400	320	2000
160	700	3500	460	2850
250	900	3800	640	3000
320	1500	7500	920	5[illegible]00
630	2000	9000	1300	8100
1000	3400	15000	1800	11600
1600	5200	23000	2650	19500
2500	7000	32000	3650	23000

Source: Dong Anh factory information and mission data.

(*) The Chinese models referenced as "S7" serie are those currently installed on the Chinese power systems. Their cost is similar to the cost of Vietnamese transformers ($ 1850 for a 15 kV/0.4 kV 100 kVA transformer), which makes them a good reference for Vietnam. The Chinese factories are now proposing a new range of models ("S9" serie) whose efficiencies are similar to state-of-the-art silicon-steel core distribution transformers, but at a much higher cost (25% more than S7 transformers).

Annex XII. Electricity Tariff

Industry

(Dong/kWh)

	Supply : 6kV and above	Low Voltage supply
Normal tariff	450	480
Peak time (6 to 10 p.m.)	750	800
Valley time (10 p.m. to 4 a.m.)	300	320
Irrigation pumps	180	190

Households

(Dong/kWh)

Private meters	450
Main meters at village medium voltage/low voltage transformer	360
Main meter at Residential Estate medium voltage/low voltage transformer	400
Commercial services	750
Foreigners	variable

Penalties for excess consumption:

Less than 50 % above quota	+150 % on the applicable tariff
Between 50 % and 200% above quota	+200 % on the applicable tariff
Above 200 % above quota	+250 % on the applicable tariff

N.B. The quota depends on the size and the income of the family

Source : Power Company # 2

Annex XIII. Regional Considerations for Rural Electrification Projects

Zones	% rural people	Rural population (million)	Area (million ha)	Density in rural areas (inh/km^2)	Main crops, activities	Potential sources for E.R	Income (US $ / household)
North Mountains and midlands	86%	8.6	9.8	88	forest, nomadic breeding	Mini and micro hydro (44%)	above $ 600
Red River Delta	81%	11.3	1.0	1130	Rice paddy, poultry breeding	National / regional grids	from $400 to $ 600
North-Central	89%	7.7	5.2	148	Paddy, corn, cattle breeding	National grid / diesels Minihydro (6%)	from $ 250 to $ 400
Center-south coastal areas	76%	5.1	4.4	116	Paddy, cotton, cattle breeding	Minihydro (14%), diesels	from $ 250 to $ 400
Highlands	78%	1.8	5.5	33	Coffee, rubber, nomadic breeding	Minihydro (34%), diesels	from $ 150 to $ 250
East south	54 %	4.1	2.4	171	Coffee, rubber, cattle breeding	National / regional grids, minihydro (2%)	< $150
Mekong Delta	86%	12.4	4	310	Rice paddy, fruits, seafood, poultry breeding	National and regional grids	above $ 600

Source: Energy Institute, 1991

Joint UNDP/World Bank
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English - Out of Print)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English - Out of Print)	03/90	--
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English - Out of Print)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (Out of Print)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91

Region/Country	*Activity/Report Title*	*Date*	*Number*
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
Gabon	Energy Assessment (English)	07/88	6915-GA
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (Out of Print)	11/86	6137-GUI
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English - Out of Print)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English - Out of Print)	11/87	--
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90

Region/Country	*Activity/Report Title*	*Date*	*Number*
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English - Out of Print)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English - Out of Print)	08/90	122/90
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86

Region/Country	*Activity/Report Title*	*Date*	*Number*
Uganda	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English - Out of Print)	03/89	UNDP Terminal Report
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Petroleum Management Assistance (English)	12/89	109/89
	Power Sector Management Institution Building (English - Out of Print)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM

EAST ASIA AND PACIFIC (EAP)

Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English - Out of Print)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84

Region/Country	*Activity/Report Title*	*Date*	*Number*
Vietnam	Rural and Household Energy - Issues and Options (English)	01/94	161/94
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979/SOL
South Pacific	Petroleum Transport in the South Pacific (English-Out of Print)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English - Out of Print)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English - Out of Print)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English - (Out of Print)	12/88	--
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	05/91	120/91
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English - Out of Print)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86

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	EUROPE AND CENTRAL ASIA (ECA)		
Eastern Europe	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
Portugal	Energy Assessment (English)	04/84	4824-PO
Turkey	Energy Assessment (English)	03/83	3877-TU
	MIDDLE EAST AND NORTH AFRICA (MNA)		
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector(English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English - Out of Print)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	National Energy Plan (Spanish)	08/91	131/91
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
Chile	Energy Sector Review (English - Out of Print)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--

Region/Country	*Activity/Report Title*	*Date*	*Number*
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English-Out of Print)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English - Out of Print)	03/88	--
	Management Information System Phase I (English - Out of Print)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
Panama	Power System Efficiency Study (English - Out of Print)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English- (Out of Print)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English - Out of Print)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English - Out of Print)	12/85	5930-TR

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	Energy End Use Efficiency: Research and Strategy (English - Out of Print)	11/89	--
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	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
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Cao Bang
Lao Cai
Lai Chau
Tuyen Quang
Bac Thai
Lang Son
Yen Bai
Quang Ninh
Ha Bac
Vinh Phu
Son La
Ha Tay
HANOI
Hai Hung
NORTH MIDLAND
Hoa Binh
Thai Binh
Nam Ha
Hai Phong
Ninh Binh
NORTHERN MOUNTAIN HIGHLANDS
Thanh Hoa
RED RIVER DELTA
Ma
MYANMAR
LAO PEOP. DEM. REP.
THAILAND
CAMBODIA
VIET NAM
MALAYSIA
VIET NAM
ADMINISTRATIVE MAP OF VIET NAM
LAO PEOPLE'S DEMOCRATIC REPUBLIC
Nghe An
Ca
NORTH CENTRAL
VIENTIANE
Ha Tinh
Mekong
NATIONAL CAPITAL
RIVERS
PROVINCE BOUNDARIES
INTERNATIONAL BOUNDARIES
Quang Binh
Quang Tri
Thua Thien Hue
THAILAND
SOUTH CENTRAL
Quang Nam-Da Nang
Quang Ngai
Kon Tum
Gia Lai
Binh Dinh
CAMBODIA
Phu Yen
SOUTHEN HIGHLANDS
Tonle Sap
Dac Lac
NORTH-EAST OF MEKONG DELTA
Mekong
Khanh Hoa
Song Be
Lam Dong
Ninh Thuan
PHNOM PENH
Tay Ninh
Dong Nai
Binh Thuan
Ba Ria
Ho Chi Minh City
Long An
An Giang
Dong Thap
Tien Giang
Vung Tau-Con Dao Special Zone
Vinh Long
Ben Tre
Ho Chi Minh
Can Tho
Kien Giang
Soc Trang
Tra Vinh
Minh Hai
MEKONG DELTA
0 50 100 150 200 250
KILOMETERS
105°
110°
20°
15°
10°
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AUGUST 1993