ESM 178

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Joint UNDP / World Bank **Energy Sector Management Assistance Programme**
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VIETNAM HOUSEHOLD ENERGY TECHNICAL ASSISTANCE: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves

Activity Completion Report
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Power Development, Efficiency &
Household Fuels Division
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JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

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ESMAP
c/o Industry and Energy Department
The World Bank
1818 H Street N.W.
Washington, D.C. 20433
U.S.A.

Preface

This report is the principal output of a technical assistance project in Vietnam executed by the World Bank's Energy Sector Management Assistance Program (ESMAP) and financed by the Swedish International Development Authority (SIDA). The activity pursued recommendations of a previous ESMAP household energy strategy study which are to determine: (i) how the exisiting coal briquette industry can be improved, and (ii) how the current government program for the dissemination of higher efficiency cookstoves can be commercialized. After examining these subjects in detail, the report recommends a five-year pilot program to effectively push the market in this direction.

The technical assistance activity benefited immensely from the support of the Energy Institute of Vietnam, particularly Dr. Tan Quoc Cuong, Director, Dr. Pham Kanh Toan, Head of International Cooperation and Mr. Nguyen Duy Thong, household energy specialist. Support was also provided by other agencies including the Ministry of Mines, Hanoi Architectural Institute, Vietnam Coal Trading Company, Domestic Coal Company and others.

The World Bank/ESMAP team consisted of Ernesto Terrado (task manager), Wolfgang Mostert (economist), Roland Siemons (coal briquette specialist), Keith Openshaw (household energy specialist) and Xiao Ming Song (stoves technologist). The final report was written by Ernesto Terrado from contributions of the team members.

TABLE OF CONTENTS

PREFACE

I. INTRODUCTION

Background

In the beginning of the 1990's Vietnam ranked as one of the poorest countries in the world with a per capita GDP of US$ 200. But industry and ownership restructuring as well as rapid increases in national income are now making profound changes in the national economy. Since the adoption of the policy of "renovation" (doi moi) in 1986, Vietnam's centrally planned economy has undergone a gradual transformation to a more decentralized market-oriented structure. Structural reforms that were pursued vigorously since that time have produced impressive results. Real GDP growth accelerated from 6% in 1990/91 to 8% in 1992/93. With the recent lifting of the US embargo, it is expected that foreign investments, already flowing in at a rapid pace, will further expand.

In the energy sector, modern fuels are beginning to make deep inroads into domestic consumption patterns. Illustrative of this is Ho Chi Minh City where consumption of LPG, a relatively expensive cooking fuel, has jumped from zero in 1991 to about 15% of the household market today. The recently completed 500 kV interconnection project is providing increased electricity supplies to the previously shortage-constrained regions of the Center and South.

Yet, it is generally recognized that despite the pace of modernization, the overwhelming majority of Vietnamese will continue to rely on traditional fuels, such as coal briquettes in the North and fuelwood in the South, for the foreseeable future. This is because the country is starting from a very poor economic base where traditional fuels still account for about 80 percent of final energy consumption.The consumption of traditional fuels has some negative environmental effects. In the case of biomass fuels, the major concern relates to to the risk of degradation of the resource base. Coal use in households meanwhile is a major source of airborn dust and other air pollutants; in addition, it leads to high carbon dioxide emissions due to the low efficiency of the stoves and the high carbon content of coal. The transition to modern fuels that have less negative environmental impacts cannot be achieved quickly. The strategy in the short to medium terms should emphasize improving the *efficiency* of production and utilization of traditional fuels, particularly coal briquettes and fuelwood. Determining the optimal way of achieving these is the broad objective of the present study.

Past Government Activities

In Vietnam, the primary role of coal as a household fuel is to meet fuel demand of low income consumers in areas that (i) are affected by fuelwood shortages, (ii) are poor and (iii) are located in the northern parts of Vietnam, that is, relatively near to the coal mines. Coal is the major cooking fuel for low-income consumers in the major urban centers in the Hanoi province and Danang and the major purchased cooking fuel for rural households in the poor Northern provinces. The Vietnamese Government, therefore, closely monitors the household coal sector for social reasons (coal consuming households belong primarily to the low-to middle income groups), for regional development reasons (the coal consuming regions are the poorest provinces of Vietnam) and for environmental reasons (the promotion of coal as a means to reduce deforestation).

During the past ten years, the main concern of the Vietnamese Government and the relevant sector institutions was to promote household coal demand as a means to combat deforestation and to ensure that the supply chain could provide coal at affordable prices to the target households. With the Vietnamese Coal Trading Company being the prime motor in coal development, the policy of promotion achieved a major expansion of household coal demand in the northern and central areas of Vietnam. From the beginning of the 1990's, the successful stimulation of a household demand for coal attracted a large number of private entrepreneurs and public coal companies to take up coal briquetting, production of coal stoves, transport of briquettes or retailing.

The experience that has been acquired has implications for policy. As will be discussed later, household coal supply in Vietnam develops flexibly in response to demand, suggesting there is less reason to be concerned about the quantity of coal production than on the improvement of product quality and cost, and the reduction of adverse environmental impacts. The promotion of fuelwood savings to protect watershed areas continues to be a major policy objective of the government. But the Government is becoming equally concerned with increasing emissions of CO_2 and CO, SO_2 and particulates due to household coal consumption.

Any program to improve efficiency of coal briquette production must be integrally linked with a program to improve the efficiency of end-use, i.e., combustion in household cookstoves. This approach maximizes the social, economic and environmental impacts of the actions to be taken. Although the government has been conducting an improved cookstoves program since the 80s, the efforts have been very limited, particularly on commercial dissemination. Only through a program of commercialization of higher efficiency coal and biomass cookstoves can their widespread use occur. Such a program could save money for the users, especially the urban poor, and save energy for the country. This in turn would improve the local environment through less emissions of smoke, other particulates and poisonous carbon monoxide. It will benefit the global environment through a reduction of carbon dioxide and other greenhouse gas emissions.

Previous Studies

In 1993 the World Bank conducted an Energy Sector Investment and Policy Review[1] to assist Vietnam in identifying investment priorities and needed policy reforms in the petroleum, coal, and power sectors. Complementing that report was an ESMAP study[2] focused on rural energy issues and options, including traditional fuel production and use. The ESMAP report concluded *inter alia* that household consumption of coal, particularly in the north, will continue to grow in the future. One important reason is that coal is likely to be the primary fuel of choice to substitute rice straw consumption in areas affected by biomass scarcities. The report also identified critical areas

[1]World Bank, "Vietnam: Energy Sector Policy and Investment Review" (1993)
[2]World Bank/ESMAP, "Vietnam: Rural and Household Energy Issues and Options", Report No. 161/94 (1994)

of the country where fuelwood resources are probably being mined already, with demand well in excess of sustainable supply. A variety of actions, on both supply and demand sides, were recommended, among them : (1) the provision of assistance to both large-scale and informal sector makers of coal briquettes to improve their production methods, and (2) the expansion and re-direction along commercial lines of the Government's improved cookstoves program. These are the specific areas that the present report has addressed.

In preparation for the present study the Energy Institute of Vietnam (EIV) conducted two limited surveys of coal briquette and cookstoves producers in the major regions, including capacities, methods of manufacture and market prices of products[3]. The findings were used extensively in the present study. Finally, a study was financed by UNIDO in 1993 to determine how to increase supply of household coal through the establishment of a series of large-scale mechanized coal briquetting plants[4]. The present study used some findings of the UNIDO report to evaluate production costs but has taken a different approach to the objective of meeting future incremental demand.

Structure of the Report

On the production side, the present study has concerned itself only with coal. On the end use side, i.e., on improving efficiency of use in cooking, both coal and woodfuels are treated. The reason is that much is already known in Vietnam on addressing fuelwood supply issues. Several international agencies are assisting in replanting programs, most notably the World Food Programme (WFP). The FAO, through its Tropical Forestry Action Plan (TFAP), has conducted extensive studies on deforestation in Vietnam. More recently, the World Bank has proposed a comprehensive environmental action plan[5] that has, as one of its main priorities, the improved management of the country's agricultural and natural resources. Thus, the present study's concern with fuelwood has been limited to determining how the Government's high-efficiency cookstoves program can be commercialized, so that a significant dent is made on overall fuelwood consumption.

In contrast, much less have been done to investigate issues related to the supply of domestic coal fuel, particularly problems on the production of coal briquettes. Only one recent study was made of this subject, a UNIDO pre-feasibility study published in 1993 that recommended the establishment of modern, large-scale coal briquetting factories. This recommendation was based on a very high estimate of demand growth for coal briquettes. Chapter 2 discusses a more likely demand trend that would result in a significantly lower estimate. Chapter 3 then examines the profile of the industry and finds that there is sufficient unutilized capacity in the state-owned plants alone that can be activated to meet most of the projected demand. The evaluation also finds significant scope for improvements in existing product quality that has the potential not only to

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[3]Energy Institute of Vietnam " Current Status of Coal Briquettes and Commercialization of Improved Stoves (2 reports)" Jan 1995 and March 1995.

[4]UNIDO, "Prefeasibility Study for Bee-Nest Coal Briquettes Production as Energy Alternative for Domestic Use in Vietnam", TF/VIE/90/A90 (1993)

[5]World Bank, " Vietnam: Environmental Program and Policy Priorities for a Socialist Economy in Transition" (1995)

attract more consumers but also to reduce environmental impacts. The possible technical actions to address this issue are outlined in Chapter 4.

Chapter 5 analyzes the present and future market for coal and biomass cookstoves and estimates potential benefits to households, stoves producers, the nation and the environment of a comprehensive program for commercializing the dissemination of higher efficiency models.

Chapter 6 discusses the implications of the above findings to existing policy and institutional arrangements and recommends a pilot program to test the feasibility of the indicated long term approaches. The policy discussions re brief and limited to issues directly related to the coal briquette and stoves manufacturing industries. Policy recommendations dealing with broader issues of household and rural energy supply and demand in Vietnam have been treated in the previous ESMAP study. Chapter 7 outlines the details of this program, a five-year phased investment program for coal briquetting and for the commercialization of high-efficiency fuelwood and coal briquette stoves. The pilot project will require some $2 million and consists of technical and credit assistance to manufacturers, establishment of testing centers, training and promotional activities. The economic feasibility and environmental benefits of the project are estimated.

II. DOMESTIC COAL DEMAND AND SUPPLY PATTERNS

Sectoral Breakdown of Demand

The 1994 consumption of coal in Vietnam was about 4 million tonnes of which half was consumed in the major urban industries (power cement and other industries), the other half by rural enterprises (mainly bricks, tiles, ceramics) and by households.

Table 1. Sectoral Distribution of Coal Demand in 1994

Direct sales by mines to state owned industries	
power plants	900,000 tonnes
cement:	600,000 tonnes
other industries:	500,000 tonnes
Sales to customers through VCTC, transporters/traders and interior mines:	
sales to informal industries (30%):	600,000 tonnes
sales to households including pig food prep. (70%):	1,400,000 tonnes
Total national supply	4,000,000 tonnes

Note (1). *Source*: Figures for direct sales provided by VCTC, and the breakdown of remaining coal demand between informal sector/household demand are based on ESMAP survey data and information received through interviews of coal managers

Geographically, household demand for coal is regionally concentrated in the Northern parts of Vietnam and to a lesser extent in the Central coastal area. The majority of household coal consumption takes place in the rural areas of the Red River Delta where fuelwood supplies are scarce and there is insufficient rice straw to use as fuel [1] .While the major towns in Hanoi Province represent an important center of coal demand, demand in Hanoi proper itself is rather small [2].

Forms of Household Coal Demand

About half of household coal demand in non-urban areas is used for cooking and water heating; the other half is used for productive purposes in household enterprises including the preparation of pig feed. In rural coal consuming areas, rural households using coal for cooking benefit from the demand for coal for productive purposes. It is the latter demand which creates the primary demand for the transport and the distribution of coal to rural areas.

Three different coal-stove combinations are used by households: (i) commercially produced briquettes, mainly of the bee-nest type, are used in stoves that are dimensioned for a

[1] Three fourths of national household coal demand takes place in the Red River Delta. Two thirds of this demand is in the rural Red River Delta (11 million residents); one third in the urban Red River Delta (2.5 million residents), mainly in Hanoi Province.

[2] According to table 2.3 in the ESMAP rural energy study (based on the 1989 household expenditure survey) cooking fuel use of coal amounted to 200,000 tonnes in the major towns of Hanoi Province (used by 55% of households) and to 16,000 tonnes in Hanoi City (11% cooking share).

particular size of briquette (typically 1 kg or 1.3 kg); (ii) households who turn coal fines, mixed with clay, into coal patties (or into crude forms of briquettes) for use in different stoves (iii) coal fines, only mixed with water, used directly in small specialized stoves with an electric blower. Therefore, household demand for coal expresses itself on the market both in the form of a demand for coal briquettes and in the form of a demand for coal fines/dust.

Table 1: 1995 Estimated Consumption of Briquettes and Fines by Sector. Units 000 tonnes (energy value 20/MJ/kg.)

Briquette Type	Bee-nest	Patties & Fines	Ovoid	Total	Household Number,'000
Urban H/h.	520	60	0	580	460
Rural H/h.	60	1400	0	1460	940
Service sector	20	20	20	60	-
Rural Industry	0	900	0	900	-
Total	600	2380	20	3000	1400
Standard Coal (1).	417	1653	14	2084	

Note. (1) The weight of coal has been converted into standard coal weights with an energy value of 28.8 MJ/kg.
Source: Mission Estimates

Coal patties are the typical entry form for coal use, and the dominant type of coal used in the villages (less than 600 inhabitants) in the Red River Delta. They are seldom used by households in the small towns of the Red River Delta and still less in the larger urban centres. Compared to the use of coal briquettes it is time consuming and dirty. In general, the efficiency of stoves for burning coal patties is lower than briquette stoves, but the fuel amounts can be better adjusted to individual cooking needs.

Almost all urban coal-using households use briquettes for cooking. In the small towns (more than 600 inhabitants) of the Red River Delta, three-quarters of coal consumers consume coal primarily in the form of briquettes. In the villages briquettes are used by one fourth of coal consumers. The bee-nest briquette is designed for "continuous space heating cum cooking" with the latter being a more of a side benefit. It was and partly still is used in this way in China, Korea and Japan. The briquettes are difficult to ignite and give much smoke (from fuelwood) during ignition. They take long time before temperature and heating power is sufficient to enable cooking. The briquette cannot be quenched with water in a convenient manner; once burning, a bee-nest briquette must be left for complete burn out. This affects fuel consumption and thus the cost of fuel negatively.

For rural household consumers, coal dust or fines has the advantage of being more readily available due to the wide use of coal by industrial and rural enterprises. Where clay and lime are abundant, coal dust are transformed locally into patties. The direct use of fines (or patties) in special electrically fanned stoves is relatively recent and are mainly used by households having access to mains electricity, although the fans can also be used with a battery. Compared to the briquette (bee-nest) stove, the coal fines stove has the advantage of rapid ignition and fuel economy (the quantity of fuel can be adapted). Its disadvantages include relatively high cost of the stoves, the need to have access to electricity and lack of control for sulfur emissions.

All of the three stove-coal combinations cause smoke damage in kitchens and living rooms. None is particularly convenient for the consumers. Fuel consumption during the cooking cycle cannot be regulated as well and as quickly as in the case of kerosene or LPG stoves. From a food taste viewpoint, consumers generally prefer charcoal over kerosene and fuelwood over coal. However, coal is a relatively more affordable fuel, as shown in the Table below:

Table 2. Price Competitiveness of Coal for Cooking Purposes in Hanoi, 1995.
Units: Dong, (US cents).

FUEL	UNIT	PRICE	MJ	STOVE EFFICIENCY	PRICE /USEFUL MJ
Coal	kg	320	20	15% (1)	107 (1.0)
Kerosene	liter	3500	35	45%	222 (2.0)
Electricity	kWh	600	3.6	70%	238 (2.2)
LPG	kg	7000	45	60%	259 (2.4)

Note. (1) This efficiency of 15% assumes continuous burning of the briquettes. For normal cooking purposes, two 1 kg. briquettes are used, with an efficiency of about 22%, (price per useful MJ, dong 73). For continuous burning, 3 briquettes are use.

Source. Mission estimates.

Its cost advantage make coal a transitional and marginal fuel for household fuel consumption. For many consumers in coal-rich regions, coal will be the affordable entry level "non-biomass" fuel. Once their income rises sufficiently, these consumers will switch to the more convenient fuels, principally LPG, but also electricity and kerosene.

Demand Trends

Household demand for coal in Vietnam is influenced by the following five main factors:

(i) the market for products produced by household enterprises in the Red River Valley (mainly influences the demand of households for coal dust);

(ii) demographic factors, including overall growth rate of the population, specific rate of population growth in the most important areas of coal consumption, and rate of urbanisation, specially in the larger Hanoi region;

(iii) growth in household income and distribution among regions and socio-economic groups;

(iv) the relative price of coal compared principally to coal and, to a lesser extent, to LPG, electricity and charcoal; and

(v) the increasing marketing of LPG.

Population growth of 2% per year, and an annual growth rate in per capita income of 5% will be the two most important factors to influence the future market for household coal. As a transitional fuel, the income elasticity of demand for coal is positive in the slow growing rural areas where coal replaces consumption of rice straw and fuelwood; and negative in the faster growing urban areas where coal (and fuelwood) demand is replaced by LPG, kerosene and electricity. Therefore, the regional and urban-rural differences in the development of household coal consumption that were witnessed during the early 1990's will continue in the coming years.

In the slow growing Northern and Central provinces of Vietnam, the reduction in absolute poverty levels will continue to widen the rural household market for coal. In the fast growing south, where fuelwood is the dominant urban fuel of the poor, and charcoal is a middle and upper income fuel, the increase in income has already largely by-passed coal as a household fuel. Kerosene and LPG have become affordable substitutes, especially for charcoal, for a wide range of the population, particularly in Ho Chi Minh city and the surrounding area.

Given these factors, the likely scenario is as follows[3]:

- Most of the growth in demand for coal will occur in the rural areas, particularly near coal mines in the north.. For the state-owned briquette producers, companies, this development is unwelcome as their competitive situation vis-a-vis the small independent producers is particularly difficult.

- In the South, coal is likely to disappear almost completely as a household fuel for cooking. Whatever usage remains will be for household enterprise production. VCTC's production of briquettes will certainly stop; and private production of briquettes made by handpresses will be sporadic and disappear by the year 2000.

- In Hanoi, demand up to the year 2000 will most likely be stagnant, falling in the centre of Hanoi, but increasing in the river area of Hanoi, where low income migrants will settle. Coal will lose market share, but demand from poor rural migrants should provide a continued market for briquette production, presumably at the present level of production. After the year 2000, household coal demand in Hanoi should fall, and largely disappear within a five to ten years period.

3 A more detailed discussion of the factors leading to this forecast of household coal demand is provided in Annex I.

- In Danang proper, coal demand should continue to increase slightly - say by 5% per year over the next two to three years, after which a levelling of demand is likely. The rural areas outside Danang, however, should continue to grow for at least an additional five years before it levels off. Thus, overall, 5% growth rate seems to be attainable up to the year 2000.

- In the Red River delta, absolute demand will increase by 5-10% per year up to the year 2000 in response to the absolute growth in population and a narrowing of the coal consumption patterns between the smaller towns and the villages. By the year 2000, demand in the Red River delta should have reached its zenith and kerosene and LPG should be making inroads in the smaller towns. Until then a demand growth of 5% seems likely.

- In the Northern provinces, where wood and rice straw are scarce, there should be a strong demand in the 5-10% range over the next five year, before levelling off.

Altogether, it is likely that household consumption of coal will grow by 5% per year up to the year 2000 from the present (1995) 2.1 million tonnes to 2.6 million tonnes. The amount of coal used for briquettes in the above total is likely to grow from 580,000 tonnes in 1995 to about 740,000 tonnes by the year 2000 [4], after which stagnant demand for about 5 years and falling household demand after that period. can be expected.

Supply of Household Coal

Coal in Vietnam is produced from two sources of mines: (i) mines located in the Quang Ninh Province with short transport distances to the sea, and thus a good potential for exports and (ii) mines located in the interior provinces where transport costs are too high to make exports feasible. At the 1994 level of production 75 percent of the design capacity of the coal mines was exploited. Only one agency, COALIMEX, is licensed by the Ministry of Energy to do importing and exporting of coal.

The Vietnam National Coal Corporation, VINACOAL, is the leading coal company in Vietnam. It was established by Government decision in March 1994 as a holding company reporting to the Ministry of Energy (the owner) and uniting under its umbrella a number of companies formerly managed by different ministries. [5] The individual companies owned by Vinacoal have their own balance sheets and independent legal status. But, Vinacoal has a consolidated company account as well. The mines located in Quang Ninh are owned and operated by a subsidiary of Vinacoal.

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4 The figures given in this paragraph are in terms of an energy value of 20 MJ/kg. These numbers translate into the following numbers using the standard energy value for coal of 28.8 MJ/kg.:-

1995. Total household demand, 1.42 mill. t. of which briquette demand is 0.40 mill. t.

2000. Total household demand, 1.81 mill. t. of which briquette demand is 0.51 mill. t.

5 This chosen form of organisation is part of the Government's commercialization and corporatization strategy to modernise the economy.

The six "major" mines located outside Quang Ninh are owned and operated by the Domestic Coal Company, DCC (alternatively translated as Interior Coal Company, ICCO) also a Vinacoal subsidiary. The company has a staff of 6,000 and operates in 7 provinces. In addition to mining, the company through its 20 affiliates/divisions is involved in construction, beer and soft drink production, hotelling, building materials, coal briquetting and marketing as well as production of coal stoves - both bee-nest and coal patty/dust stoves. In 1994 ICCO mines produced 600,000 tonnes, expected to increase to 650,000 tonnes in 1995. About 40% of mine production is sold to producers of construction material, 30% to other industries and 30% to the household market.

Fifteen so-called "local mines" are owned by the provincial authorities. Their production is small and mainly destined for local energy intensive industries such as brick and lime production. Fly ash from coal power plants is also sold to briquette producers.

Domestic Coal Distribution and Marketing Issues

In 1994, supply to the domestic market (national demand for coal excluding stock changes) was somewhere between 3.7 and 4.1 million tonnes [6]. The major part of production is *sold directly by the mines to consumers* and to coal processing companies, including private producers of briquettes. Half of national production is consumed by the large energy intensive industries, power, cement and "other industries" which buy their coal directly from the mines in Quang Ninh.

The *Vietnam Coal Trading Company, VCTC* (owned by Vinacoal) was established with the specific mandate to develop the national market for coal. VCTC's function is:-

(i) to supply and trade coal nation-wide to consumers who do not purchase coal directly from the mines,
(ii) to carry out coal research, and
(iii) to process coal for minor industries and household customers.

About one fourth of domestic coal demand in 1994, or 1 million tonnes, was covered by supplies from VCTC. The enterprise has 1300 employees. In addition to company headquarters which are located in Hanoi, the company consists of one transport division and 14 provincial subsidiaries. The transport division of VCTC has coal barges for the inland transport of coal on the rivers, e.g. to Hanoi. Coal traded in Danang is brought by boat from Quang Ninh in the North and by truck from Non Son mine about 85 km from the city. For the transport of coal from Quang Ninh to Danang and to Ho Chi Minh City, VCTC charters boats from shipping companies. The marketing of coal in the Hanoi area is done by headquarters. The 14 provincial subsidiaries operate about 100 depots and shops located in cities and provincial towns.

[6] According to Vietnam Coal Trading Company, national coal production in 1994 amounted to 5.2 million tonnes of which 1.5 million tonnes were exported. This would provide a national demand of 3.7 million tonnes. According to an article on the national coal corporation, Vinacoal in Vietnam Economic News, January 28-February 17, 1995, national coal production in 1994 was 6.3 million tonnes of which 2.3 million tonnes were exported. This provides a national demand of 4 million tonnes. In the same Economic News issue, an article written by Minister of Energy, Mr. Thai Phung Ne gave a 1994 coal production figure of 5.1 million tonnes and no figures on exports. The 1995 production target was 6.3 million tonnes of which 1.86 million were to be exported. This gives a 1995 consumption of 4.4 million tonnes.

Private transporters purchase coal at the mines or at shipping outlets and depots of the VCTC and transport it to rural consumers in small 6-10 tonnes vans. Typically, a van load is split between three to five rural families (covering a year's demand); some is purchased by local retailers who resell the coal fines in quantities of 50-100 kilos to rural consumers who cannot afford to purchase coal in large quantities directly from the transporters.

Transportation cost (freight and unloading) increase nearly 400% for coal which is transported to the Southern Region, including HCMC, from 40 dong/kg in Hanoi to 199 dong/kg. Compared to the cost of a briquette ex-factory in Hanoi, the higher cost of transportation increases the cost of coal in the Southern Region by 56%.

VCTC continues to be the major operator in the marketing of coal. VCTC is the only producer with production and distribution outlets across provincial boundaries and the only operator who markets "all" household coal products. Briquettes produced at its plants make up 15% of VCTC's sales of coal; the other 85% of coal sales are in the form of coal fines, lump coal and "coal mixes" for production of briquettes. VCTC has some limited "artisanal type" production of coal stoves, which it sells through its depots. VCTC has proved to be an imaginative and very flexible operator:-

- its depots/sales outlets are opened and closed in line with regional demand (for example, responding to the development in local brick production);
- in the rural areas VCTC promotes demand by supplying coal mixes and molds for self-made production of improved coal stoves to households;
- from 1991 to 1993 VCTC was used as the Government's vehicle to supply coal fines at subsidized costs (coverage of cost of transport) to the Northwestern mountainous regions to counter perceived threats of deforestation due to fuelwood demand.

Yet inspite of its flexibility, The state companies mainly concentrate on supplying briquettes to the urban centres of briquette demand. The plant in Danang for example, stated that 80% of its production of briquettes are sold in Danang, 8% in the other provincial cities in its area of supply and the remaining 12% in the rural areas. The briquettes are not suitable for transport over longer distances - they break too easily. The primary means to expand sales of briquettes to rural areas is by setting up a small production line for briquetting at one of the depots. The VCTC subsidiary, , which owns the Danang plant has a total of 16 provincial depots. In seven of its depots it has installed a production line for briquetting. In addition, the Danang plant experiments with developing a package of 12 briquettes to reduce breakage risk during transport.

The Danang plant sells its 1.4 kg briquettes ex-plant at a price of 500 dong. Private transporters carry the briquettes at a fee of 50 dong/briquette to retailers. There are five private retailers in Danang. They resell the briquettes at a price of 600-630 dong/briquette.

The private producers do not seem to sell their briquettes at cheaper prices than VCTC or DCC. Their success is based on other advantages. First of all, they are located closer to the consumers - the depots of the state companies are clearly outnumbered by the production (and sales) sites of the private producers of briquettes. Secondly, they are more agressive in their marketing and are willing to delive at any time of the day directly to households by bicycle transport; whereas the state companies only sell within normal working hours and only from their depots (15). In the future, the state companies are likily to lose further market share in the urban areas, particularly in Hanoi. The consumption of coal will move out of the inner city and to the new suburbs where the majority of poor rural migrants will settle.

III. STATUS OF THE DOMESTIC COAL BRIQUETTING INDUSTRY

Industry Output

Bees-nest briquettes in Vietnam are manufactured by both government and private companies, the latter being mainly in the informal sector. There are 31 govenment factories in all, owned by two holding companies, namely the Vietnam Coal Trading Company (VCTC) with 27 factories throughout the country, but mainly in the north, and the Domestic Coal Company (DCC) with 4 factories in Hanoi. The total capacity of the government-owned companies is about 154,000 t/yr. The breakdown between the two companies is as follows:

Table 3.1. Production capacities and capacity utilization of DCC and VCTC briquetting factories.

DCC:

Type of briquetting machines	No. of installed briquette machines	Production capacity for each briquetting machine (briqu's/minute)	Weight of dried briquette (kg/briquette)	Capacity (t/yr)
Vietnamese	4	18	1.20	11,068
	1	38	1.20	5,841
Chinese	4	38	0.89	17,308
	1	15	0.89	1,708
Total capacity (t/yr)	10			35,925
Actual production (t/yr)				11,000
Percent Utilization				31%

VCTC:

Type of briquetting machines	No. of installed briquette machines	Production capacity for each briquetting machine (briqu's/minute)	Weight of dried briquette (kg/briquette)	Capacity (t/yr)
Vietnamese	1	50	1.20	7,686
	1	38	1.20	5,841
	1	20	1.20	3,074
	33	18	1.20	91,310
Chinese	4	8	0.89	3,644
	1	54	0.89	6,1649
Total capacity (t/yr)	10			117,704
Actual production (t/yr)				60,000
Percent Utilization				51%

Note: The above figures assume one shift per day, 7 hours per shift and 305 days per year operation. To standardize weight data, a reference moisture content of 10% is assumed throughout, which is not necessarily the actual moisture content of the briquette products. The energy is assumed to be 20 MJ/kg.

Although individual plant capacities are much smaller, private bees-nest production overall is nearly *seven times larger* than state enterprise production or about 500,000 tons in 1994. Production takes place by means of hand presses - the US$ 4500 cost of a mechanised briquette press made in Haiphong is too large a financial outlay for the typical private entrepreneur in the informal sector. The disadvantage of lower labour productivity due to lower levels of mechanisation is more than compensated for by other competitive advantages [1]:

- The workshops in the informal sector can often get coal fines at lower prices than the formal production plants due to illegal sales by coal mine staff and managers, or from sales from "private "mines and power station ash.
- The producers often do not comply with the state norms on the maximum 1% sulphur content in the briquettes, andcan thus buy lower priced coal [2].
- Many avoid paying some of the taxes which the formal sector companies have to pay
- Many do not comply with labour laws and regulations on mimimum wages and benefits such as maternity leave, paid sick, paid annual leave, etc. [3].

Table 3.2. Annual Production of Briquettes by State and Private Producers in Tonnes.

	1991	1992	1993	1994
VCTC				
- Total:	4,923	32,148	46,756	60,000
- Danang:		(8,200)	(14,300)	(17,700)
DCC	0	3,700	13,200	10,100
Private sector				500,000
TOTAL				570,000

Source: Mission Estimates

[1] Although the state owned briquetting plants are mechanised, coal briquetting is not a capital intensive industry, see table from Vietnamese report providing the cost structure of briquettes. The cost of capital is only a fraction of the total cost of a briquette. The major item, obviously is the raw material. The land used by the briquetting plants is leased at US$12-16/$m^2$ (according to existing Vietnamese law only the Government may own land). The SPC plant at Danang used a total of 1400 m^2 which included storage space for coal fines that are sold to other customers as well.

[2] In 1994/95, coal with a sulphur content higher than 2.5% cost 195.000 Dong/ton, coal with a sulphur content less than 0.6% 240,000 Dong/ton.

[3] This does not mean that the private enterprises pay lower wages than state companies. The ILO report "Small Enterprises in Vietnam" showed that wage levels in the urban non-state companies are quite similar to wages levels in the small state enterprises. In the urban areas half of the household enterprises produce, on average, a total value added below US$ 1610 and less than US$ 380 per worker. Broadly speaking the first three to four workers are unpaid members of the owner household and all additional labor is wage labour.

Basic Production Techniques

The technologies employed in the government and informal sector factories are essentially the same (the briquettes are made in moulds, while the compression is effected by a ram), however the extent of mechanization differ. The resulting products are very similar in shape and quality..

Government Factories. The raw coal is received and stored in piles. Coal of the correct particle size distribution is *either* obtained by selecting (sieving) the coal in different fractions (the larger sizes distributed to specific end-users) *or* by milling the coal in a roller crusher. The coal fines are mixed with clay and water to obtain a mixture which can be moulded. In some cases lime is added to reduce sulphur emissions (during combustion the lime binds the sulphur as sulphate in the ash). Today all Government briquette manufacturers employ Vietnamese made rotary-table presses, based on a Chinese design, in which the coal mixture is moulded under low pressure. The green briquettes are sold "as is" to retailers.[4] If there is any atmospherical drying, this is accidentally, i.e. if production cannot be sold immediately. The production capacity of the various Government owned plants is of the order of 1-15,000 t/yr. Labour productivity and capital involvement (machinery, buildings, land) is higher than in the private sector.

Informal Sector Process. The raw coal is received and stored in piles. The size distribution of the delivered coal is such that sieving or milling is not necessary. The coal is then mixed with clay and water to obtain a mixture which can be moulded. No operations were observed in which lime is added to reduce sulphur emissions. Two types of moulding were found by the Mission: (1) moulds which were filled manually and where the required pressure was achieved by hammering the filled mould onto a stone, and (2) moulds, filled manually, in which the required pressure was created by a lever. Particularly the first of these methods requires a lot of water to make the coal mixture sufficiently plastic. Operations which use this method were found to employ one more production step, i.e. drying. For drying, the briquettes were first left to dry for one day in the open air and then stacked in hollow pilesover a maintained coal fines fire. The production capacity of the single producers may range from 300 to 2500 t/yr. Labour productivity and the capital involvement (machinery, buildings, land) is much smaller than in the Government briquette industries.

[4]Green, in briquetting, means: as coming from the press, without any post-moulding treatment like thermal drying.

Comparison with Western Technology

The techniques employed by both state owned and private factories are very simple compared with state-of-the-art briquetting technology used until recently in industrialized countries[5]. In those high-technology operations much attention was paid to briquette strength, both under handling and combustion conditions. This is reflected in moisture control, particle size distribution control, the use of strong binders which are difficult to process, process temperature control and the use of high pressure. Binders used for anthracite are coke-oven tar pitch, bitumen and sulphite liquor, but also coking bituminous coal. These binders require high precision dosage systems and complicated processing steps (grinding of the binder, high temperature mixing of the coal and binder, cooling of the binder/coal mixture before pressing, high pressure or high-temperature pressing). In highly industrial briquetting operations the moisture content is usually decreased to 4% or less. The particle size distribution, especially with anthracite, is carefully addressed in high-technology processes. In highly industrialized coal briquetting plants clay was never used as a binder.

Problems

In the Vietnamese context, the present coal briquette production system based on a simple moulding process with a clay binder appears to be adequate as it already produces a useful, low cost product. The industry as a whole, however, has a number of problems. The state-owned producers operate well below rated capacity as the small informal sector producers have multiplied and increased their market share, particularly in rural areas. This in itself is not undesirable and is an indication of the economy's increasing market orientation. Nevertheless, there are strong arguments against permitting the present situation to continue. Although the quality of briquettes produced by state-owned factories needs to be significantly improved, the briquettes produced in the informal sector are generally far worse. Lack of enforcement of regulations enable these producers to buy lower quality raw coal, disregarding the 1 % maximum sulphur content limitation. The potential long-term environmental impacts of this practice is an issue that cannot be ignored by the government. Secondarily, the small informal producers often do not bother to comply with labor laws or pay taxes and duties that the formal sector companies have to pay, resulting at the least in losses to the government's coffers.

Strategy

In the medium term, as demand for coal briquettes requires new production output, it is clear that a mere expansion of the present inefficient situation is not a desirable course. A UNIDO pre-feasibility study published in 1993 recommended to increase the supply of household coal through the gradual establishment between 1995 and 2015 of 180 mechanized plants (50,000 tons/year capacity) for the production of bees-nest

[5] Coal briquetting used to be an important industry in the USA, Western Europe, Eastern Europe and the Soviet Union. Today, since the 1970-80s, the market for coal briquettes has decreased considerably. Hence many of those briquetting plants were closed down

2015 of 180 mechanized plants (50,000 tons/year capacity) for the production of bees-nest coal briquettes. The modem plants, while clearly efficient and therefore environmentally cleaner, require high capital investments. For example, the first plant proposed to be built costs over 7,000 million Dongs (US636,000). Given other investment priorities in Vietnam, it is not surprising that so far there has been no action taken on the proposal.

The UNIDO proposal was based on a very high growth in demand for coal briquettes. It estimated, based on fuelwood substitution arguments, that demand will reach 8.5 million tons by 2000. If this is indeed the case, the addition of new large-scale mechanized plants to the industry would be a reasonable course. The present study, as discussed in the preceding chapter, estimates a growth to only 2.8 million tons by the year 2000. Given this significantly lower figure, the question is whether there is still need to establish large-scale, mechanized plants to meet demand growth. It is this study's contention that this will not be necessary, and that a better, more affordable strategy is to activate idle capacity in the state-owned plants. As seen in Table 3.1, unused capacity in these plants amounted to 80,000 tonnes in 1994 out of a total capacity of 154,000 tonnes on a one-shift basis. If operated on a two-shift basis, available capacity would be at least 300, 000 tons and, for three shifts, 450,000 tons. This means that existing capacity in the state-owned factories could satisfy a demand increase of up to 380,000 without need for need for short term investments, provided that sufficient storage/drying capacity exists.

As a short- to medium term strategy, the activation of idle capacity must be combined with an industry-wide technical assistance program to improve product quality, including the establishment of testing laboratories that serve both the public and private producers. It must also be linked to a program for the improvement and commercial dissemination of high-efficieny coal briquette stoves.

IV. IMPROVING BRIQUETTE QUALITY

Characteristics of Bees-nest Briquettes

Until recently, two types of coal briquettes were produced on an industrial or semi-industrial scale in Vietnam, ovoid briquettes and bees-nest briquettes. *Ovoid briquettes*, produced in roller presses, have virtually disappeared from the market now. The concept of using bees-nest coal briquettes as a household fuel was imported from China. In the bees-nest coal briquette, the space between the inner stove wall and the briquette, together with the axial holes in the briquette provide both the draft and the size of the burning surface area (see Figure 1). Draft and surface area are the main parameters for the stove's heating power. Even more particularly than other fuels, this type of fuel is closely linked with the stove in which it is utilized. Bees-nest coal briquettes can only function properly if the height and diameter of the stove correspond with size of the briquette. Therefore, when discussing the quality of, and the market for the briquettes, the stoves in which they are used are an integral part of the considerations.

In Vietnam, anthracite and semi-anthracite are the two coal types of which bees-nest briquettes are made. Clay is added as a binder and a burn-rate controller. If only few clay is added, the briquettes burn too quickly, hence at a power which is too high. This would result in a large waste of energy and in inconvenient cooking.[1]

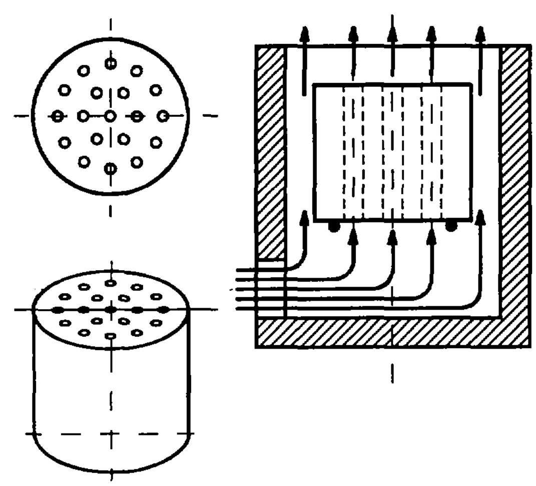

Figure 1, Bees-nest coal briquette (left) and combustion air flow around and through a burning briquette loaded into a stove (right).

A specific characteristic of bees-nest coal briquettes is that they cannot be quenched in a convenient manner (with water). The heat content of the burning briquettes makes this just too dangerous. Additionally, the binders utilized do not permit such quenching (the briquettes disintegrate). Once burning, therefore, a bees-nest coal briquette must be left for complete burn-out. It does not surprise therefore that bees-nest coal briquettes are used in situations where they serve also the purpose of space heating in multi-purpose stoves (e.g. in China and South Korea). Yet, although only they are only used for cooking and hot water provision, bees-nest coal briquettes have found a market in Vietnam.

[1]A good coal briquette contains a balanced amount of inert material. Although it might appear that consumers obtain less energy per briquette, they actually get a product suited to releasing energy gradually. Instead of clay other incombustible additives could be used (ash, sand). Since inert additives (including clay) are cheaper than coal, production cost can be kept lower than when such materials are not used.

Production Cost

It was found difficult to obtain reliable information on current production costs of bees nest briquettes in both state-owned and informal private sector factories. Based on certain assumptions of capital and labor in an "average" briquetting plant (base case), and characteristics of typical brquettes sold in the market, it was estimated that the production cost of a typical briquette (1 kg, 20% moisture content) is in the neighborhood of 300 Dong/kg. These assumptions are shown in Tables 1 and 2, Annex II.

The base case was defined according to the general operation of visited briquetting plants, characterized by a single shift operation and underutilized. It assumes annual production of about 8,300 tonnes, 305 working days per year and a single shift of 4.5 hours per day. Table 4.1 shows the estimated costs of production inputs.

Table 4.1 Production cost items of the base case

Cost Item	Total (million Dong)
Annualized capital	664
Labour	89
Raw material	1,505
Consumables	2
Energy	126
Maintenance and repair	194
Total (Production cost)	2,579

Assumptions: 8,316 t/y production, 305 days/y, 4.5 hrs/shift

Result :

Specific production cost (Dong/t) approx 310,000

At the current selling price of around 300 Dong per 1 kg briquette, it is evident that some of the above cost items are probably lower in an actual plant. Nevertheless, it is clear that current profit margins are extremely low. This suggests that establishing similar briquetting plants—operated under the same conditions—is not a course to be recommended to meet growth in demand.

Briquette Quality Problems

Sulphur content, clay content and moisture content are the decisive parameters for briquette quality. Observations indicate that raw coal with sulphur content in excess of the 1% maximum officially allowed is sometimes used by Vietnamese manufacturers. The amount of clay added tends to be non-uniform and moisture content over 20% have been measured in commercially available briquettes. If quality standards are not satisfied, the image of a bad product results. The consumer's perception of a "bad" briquette may be due to:

- difficulty of ignition (needs over 20-25 minutes).
- too much smoke during ignition (i.e. smoke of the **wood** used for ignition; the briquettes themselves are smokeless), especially if ignition takes such a long time.
- long wait before temperature and heating power is sufficient to enable cooking,
- expensive (mainly due to excessive deformation and breakage loss during transport)
- bad odour when burning (sulphur emission).

Bees-nest coal briquettes can provide a suitable type of heat (i.e. of the desired temperature and heating power) if a number of conditions are satisfied. Some of these are controlled by the consumer, such as using a stove with a suitable internal diameter and height and selecting the correct briquette height. Other necessary conditions can only be provided during briquette manufacture.

Specific Technical Improvements

A list of potential measures to improve the quality of the existing bees-nest coal briquettes produced in the existing manufacturing facilities is given in Table 4.1 below.

Table 4.1. Potential actions to improve bees-nest coal briquettes in Viet Nam.

No.	Measure	Result	Means
1	Use coal types of which the sulphur content is known, in proportions which allows to comply with sulphur emission standards.	- Sulphur emissions controlled. - Bad odour controlled.	To be combined with 2. Check sulphur content of raw coal in the laboratory of the briquetting plant. Control the sulphur content of the raw coal input by managing a distinct storage of raw coal deliveries and by controlling which batch of raw coal is being processed. Check sulphur content of the resulting briquettes in the laboratory of the briquetting plant.
2	Add the right proportion of lime.	- Sulphur emissions decreased and controlled. - Bad odour controlled.	To be combined with 1. Employ a fixed lime/sulphur ratio.
3	Add the right quantity of water.	- Strength improved and controlled. - Ignition time improved and controlled. - Heating temperature and power controlled.	Teach labourers to develop a feeling for the correct moisture content. Supervise the labour such that water content remains correct (application of bonuses and penalties).
4	Dry the briquettes before selling.	- Strength improved and controlled (easier distribution). - Ignition time improved and controlled. - No drying required by the end-user (higher value product). - Heating temperature and power controlled.	Atmospheric drying and/or thermal drying (Thermal drying gives the best results). For thermal drying use coal fines as fuel.
4	Add the right quantity of clay (dependent on ash content of the raw coal).	- Heating temperature and power controlled. - Production cost will decrease in a number of cases. For those who put too much clay now, production cost will increase.	Check ash content of raw coal in the laboratory of the briquetting plant. Control the ash content of the raw coal input by managing the separate storage of raw coal deliveries and by controlling which batch of raw coal is being processed. Check ash content of the resulting briquettes in the laboratory of the briquetting plant (for feed-back to labourers).
5	Add an ignition agent (e.g. KNO_3, (pure, or combined with charcoal)).	- No smoke during ignition. - Ignition time becomes longer (**this measure is therefore not recommended**).	- Either the total raw material is mixed with 1% nitrate, - **or** an ignition layer is applied to only one side of the briquette.
6	Use organic binders instead of or in combination with clay.	- Strength improved.	
7	Give the briquettes a heat treatment.	- Strength improved (dependent on binder type). - The briquettes become resistant to humidity (both rain and humid air). - Ignition improved with certain organic binders.	Combined with measure 6. Whether a heat treatment is effective with only a clay binder is not known.
8	Mix briquettes with biomass (e.g. saw dust, rice husk).	- Ignition improved (although the effect is not precisely known).	

Sulphur emission management. The varying sulphur content in the raw coals results in a large variation of briquette quality in terms of sulphur emissions to the ambient air. One obvious means to control these emissions is to set a standard to the maximum allowable level of sulphur in the raw coal. Actually this has been effected by the government (a 1% upper limit for the sulphur content in the raw coal is imposed). In addition to limiting the sulphur content in the raw coal, lime can be added to reduce sulphur emissions. The addition of slaked lime ($Ca(OH)_2$) may prevent 70-80% of sulphur emissions (the sulphur is bound as $CaSO_4$). A briquette made from slaked lime and coal which contains 3.3% sulphur would thus produce the same quantities of sulphur emissions as a briquette made without lime and from coal containing 1% sulphur. The result is substantial and would enable utilization of almost all Vietnamese coal types. The quantity of lime required is determined by the sulphur content of the coal. A molar Ca/S ratio of 3 is recommended. This is equivalent to a weight Ca/S ratio of 3.75:1. For a briquette made from coal containing 1% sulphur an addition of 0.069 kg $Ca(OH)_2$/kg coal would be needed. (Account has been taken of molar weights. Uncontaminated pure slaked lime is assumed.) This quantity is directly proportional to the sulphur content of the coal.

Table 4.2. Dependence of sulphur emission on addition of lime.

Sulphur content (%)	Lime additive?	Sulphur capture (kg S/kg coal)	Sulphur emission (kg S/kg coal)
1.0%	No	0	0.01
3.3%	Yes	70% x 3.3% = 0.0231	0.033 - 0.0231 = 0.01

Source: Mission Estimates

Currently Government owned briquetting factories claim that they comply with Government standards as to the sulphur content of the raw coal. Private briquette producers do not pay any attention to this matter and the Government is not presently exercising any control. It is questionable however whether regulating the *raw coal quality* is at all desirable. Assuming that the briquetting industry is to be expanded, it can be argued that coals which are rich in sulphur need to be allowed, especially since such coal types are considerably cheaper. Given the results of a lime based additive, it can be concluded that there is no real need to impose an upper limit to the sulphur content in the raw coal, *provided that lime is added in a controlled manner*. The issue of sulphur emissions is manageable. It concerns both the management of coal types used and the addition of lime. To this end briquetting factories need appropriate management systems and testing facilities.

Control of water content in the manufacturing process. Water is added to produce a granulate of coal and binder with plastic properties that allows proper briquetting. In the Vietnamese briquetting process the water ratio is not well-monitored and there is a tendency to use more water than needed. The main reasons to limit the water content at a low level are:

- Strength is improved and controlled (easier in-factory handling and distribution).
- Ignition time is improved and controlled.
- Less drying is required by the end-user (higher value product).

Quality improvements in this respect would make the bees-nest briquettes a much more attractive/acceptable product. It is total water content of the briquette which counts. Therefore, since the water present in the raw coal and clay may vary from batch to batch, the amount of water which needs to be added also differs. The water content of the unbriquetted mixtures can be controlled through acquired experience of the laborers. This feeling needs to be developed and guided by regular check-ups on the green briquettes. To this end briquetting factories need appropriate testing facilities and management systems (testing, feed-back to operators). During implementation of such systems, a first priority is to reduce moisture contents in green briquettes to the lowest possible level.

Control of water content before marketing. The quality of briquettes can be improved by drying them prior to distribution. The same reasons as mentioned above apply. Drying of the green briquettes can be achieved by placing them in well vented store rooms. Direct sun radiation would be advantageous, but the required surface area would be very large and therefore costly. The cost involved is the unsold stock and cost of the drying rooms. Test data on the required time to achieve specified moisture contents are not available.

Control of clay content. To produce a constant quality product in terms of burn-rate and energy content, it is necessary to control the clay content as a function of the varying ash content in the raw coal. Given the quality of the raw coal obtained by briquette producers from various mines in the north, clay/coal ratios would normally vary from 16% to 27% (dry clay/ dry coal). The way in which clay and coal are measured today is by volume (buckets or baskets are counted). This is an acceptable manner if densities do not vary substantially (this condition is probably met). However this method should be supported by weighing when new clay and coal types are utilized. Rather than on a volume basis, the choice can be made to always weigh the clay and coal prior to blending. A distorting factor is the water content of the clay and the coal. An iterative method (trial and error) must be followed to establish the instructions for the plant operators. The same simple laboratory facilities recommended to support moisture control of the green briquettes is needed here. One priority is to increase the clay content to the largest acceptable level for a good quality briquette. Since clay is cheap this reduces production cost. For marketing reasons, this activity needs coordination with major manufacturers. The Energy Institute of Vietnam may play a role here.

Alternative Binders. Alternative binders evaluated for use in Vietnam are clay, coke oven tar pitch, petroleum residues (bitumen), sulphite liquor, molasses and starch (See Table 4.3 below).Of these binders, molasses would give the best results in terms of strength (given the low-pressure and low-temperature briquetting technology). A cost analysis, however, shows that although technically a preferred binder, molasses can not compete with clay.

Table 4.3. Review of potential binders (Source: EIV).

Binder	Available in Vietnam (I/LP/NA)	Price (1994) (Dong/t)	Reference location for this price	Quantity produced locally (t/yr)	Current utilization (purpose)
Coke-oven tar pitch (from coke production)	NA				
Petroleum residues (bitumen) (from refinery or imported for road construction	I	2,000,000	Hanoi		Road construction
Sulfite liquor (from paper production)	NA				
Molasses (from sugar production)	LP	800,000	Hanoi	450,000	Alcohol production, Cattle feed
Clay	LP	125,000			
Starch	NA				

I = Imported
LP = Locally produced
NA = Not currently available

Source: EIV

Adding an ignition agent. A disadvantage of the briquettes, in comparison with other fuels, is that ignition is difficult. The implication is threefold:

- Ignition is expensive. It costs either a lot of wood to ignite a briquette or an extra briquette (in a continuous burning stove: one briquette is kept burning overnight).
- Ignition produces a lot of smoke if wood is used for starting the fire.
- It takes considerable time before cooking can begin.

To overcome the problem of difficult ignition the use of ignition agents has been considered in Vietnam. The solution proposed by a number of Vietnamese institutes is the application of a reactive ignition layer on one side of the briquette (Institute of Mining and Geology, and the two State coal corporations). This ignition layer would act as follows: The briquette is placed into the stove with the layer at the top. The layer is lit with a match or a piece of burning paper. A perforated lid is placed on top of the stove to keep the heat inside and transfer it as much as possible to the briquette. Ignition of the briquette will proceed and when the briquette is sufficiently hot the lid can be removed and the cooking pot placed on top of the stove. In this manner the production of smoke is avoided. However, before cooking can start it takes considerably (2-3 times) longer than when wood is used for ignition of an ordinary briquette. If ignition agents would be mixed with the entire briquette the problem of increased ignition duration would remain. Due to the added expense and the marginal improvement in product quality, the addition of ignition agents is not recommended in the present study.

Adding biomas. Ignitability of the bees-nest briquettes can sometimes be enhanced by adding biomass (sawdust, rice husk) to the briquettes. Little work has been done on this possibility and supporting research at the EIV might include an investigation of this option.

Product Quality Management System

For control of clay, ash, sulphur and moisture contents in the briquettes, an investment by the factory in a small laboratory, including skilled staff is needed. The typical equipment required are listed in Table 3, Annex II and costs about US$ 9,000. It can be shown that with a production increase achievable under an improved base case operation (single shift, 7 hr/day, added unskilled labour), this investment, as well as the additional working capital of about 114 million Dong needed for the increased production, can be recouped in less than a year (See Table 4.4 below). As seen in the Table, the selling price in the improved base case remains unchanged. However, there are significant savings in the unit production cost due to economies of scale and better utilization of capital with multiple work shifts. Although briquette production is not capital-intensive, the change to two or three shifts has the effect of spreading the cost of land and buildings over a higher level of annual production. In addition, there are savings in the cost of capital due to the higher utilization rate of the briquetting machines.

Table 4.4. Additional costs and returns of an improved briquette quality *management system.*

Cost item	Annual cost (million Dong/yr)	
	Base case	Managed briquette quality (with increased annual production)
Production, tonnes/yr	8,316	13,230
Annualized capital	664	664
Labour	89	122
Raw material	1,505	2,394
Consumables	1.8	2.9
Energy	126	126
Maintenance and repair	194	194
Total (Production cost)	2,579	3,504
Specific production cost (Dong/t)		266,426
Selling price (Dong/t)		300,000
Total investment (Dong)		4,369
Incremental investment:		
- Laboratory		97.9
- Working capital		114
Results of Analysis:		
IRR of total investment (%/yr).		25%
IRR of incremental investment (%/yr)		257%
NPV of total investment (million Dong)		1,919
NPV of incremental investment (Dong)		235,394
Simple pay-back period of total investment (yr)		3.9
Simple pay-back period of incremental investment (yr)		0.4

Source: Mission Estimates

Conclusions

In conclusion, the major quality parameters which can be addressed by state-of-the-art technology are reduced sulphur emissions and constant burn rate. The ease of ignition can be improved by minimizing water content and drying, but the ignition smoke cannot be completely avoided.

No specific technical measures were identified to lower current briquette *production cost*. Neither were alternative binders identified which are cheaper and better than the clay currently used. The use of cheaper coals (high-sulphur) combined with a lime additive was also investigated and it was concluded that production cost are hardly affected.

The establishment of a quality control laboratory in the factory is a sound investment, if accompanied by fuller utilization of capacity and improved management of the process. Fine-tuning of the briquette dimensions with an appropriately designed stove is also a sensible approach. These measures will require some investments that are affordable to the mechanized producers but may be a major cost to the small, artisanal producers.

V. SUSTAINABLE DISSEMINATION OF IMPROVED BIOMASS AND COAL COOKSTOVES

Introduction

To a large extent, the existing commercial producers of fuelwood, charcoal and coal stoves in Vietnam are private, small scale, labor intensive enterprises. The stoves they produce include metal tripod rings with or without a metal shield, unburnt clay, concrete, metal casings filled with earth and ceramic stoves. Some of the ceramic and concrete coal or biomass stoves have a sheet metal cover but *few, if any, have an insulation layer,* indicating less than optimal thermal efficiencies[1].

The design of many of these stoves seems to have evolved by trial and error. Some initiatives for "improved" stove designs have been introduced by the Energy Institute, the Hanoi Architectural Institute and the Forest Science Institute. Competitions have been held to promote such improved stoves but follow up actions have been meager. Little or no testing has been done on these stoves to determine their efficiency and no advice has been given to private producers about materials, production systems, methods to improve stove efficiency and marketing techniques.

There are several reasons why the commercial dissemination of improved (higher efficiency) stoves should be pursued in Vietnam. These include:

- reducing the relative cost of these fuels to the poorest strata of the urban and peri-urban communities;
- decreasing smoke, sulfur and other pollutants, especially within the house and urban areas;
- slowing down the demand for fossil fuels and curtailing the emissions of greenhouse gases, particularly methane, carbon monoxide and oxides of nitrogen;
- encouraging and sustaining an indigenous informal stove industry;
- reducing the demand for wood from areas which are being over-harvested and encouraging tree planting and management and its sustainable supply;
- improving the habitat and environment of rural areas;
- providing gainful employment, especially for rural people, in the production, transformation, distribution and marketing of coal and biomass fuels; and
- diverting foreign exchange spending to more appropriate needs by ensuring that indigenous labor intensive fuels are competitive with imported or capital intensive form of energy.

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[1] As mentioned earlier, coal fired stoves with a small electric fan, powered by a battery or the mains have recently appeared in Hanoi markets. These stoves have sheet metal casings with earth as a filler which also acts as a poor insulator. It may have one or two pot openings; the more expensive models have cast iron grates.

The present improved stoves programs of the Government are not geared to commercialization. There is need to realign current efforts so that they lead to the early identification of suitably efficient and marketable models, the shift of some of current production of private manufacturers to the improved models and the education of households to the benefits of using efficient stoves.

Potential Market

There is a large commercial market for biomass and coal stoves, primarily in urban and peri-urban areas. This is because fuelwood, coal and charcoal remain dominant household fuels in these areas. It is only in Ho Chi Minh city (HCMC) where the demand for a modern household fuel, liquid petroleum gas (LPG), has been rising steeply, currently occupying 15% of the household market. It is anticipated to eventually become the fuel of choice for middle and upper income people in HCMC and later in other urban areas, displacing kerosene and charcoal.

Nevertheless, because of the relatively high price of the LPG containers and stoves, fuelwood will remain an important fuel for the urban poor in the south and central parts of the country. Charcoal will continue to be used by the middle and upper income people in these areas. Coal and to a lesser extent wood or crop residues will still be significant in urban and peri-urban parts of the North. Coal and biomass fuels will continue to be used extensively by householders to prepare pig feed, by mobile hot food traders and by small hot food shops in urban and peri-urban areas.

Some *rural* households purchase fuelwood and residue stoves as well, although most are self-made. Practically all charcoal and coal stoves are purchased. There is very little use of kerosene, LPG and electricity in rural areas; only about 0.5% of the rural population use these fuels for cooking. Table 5.1 summarizes the number of households in rural and urban areas, by principal cooking fuels, who purchase their stoves, indicating a market of over 4 million stoves.

Table 5.1. Vietnam 1995: Estimate of Households That Purchase Biomass and Coal Stoves. Units: '000 Households.

	Crop Residues	Fuelwood	Charcoal	Mineral Coal	Total
Urban	215	1585	400	460	2660
Rural	210	320	120	940	1590
Total	425	1905	520	1400	4250

Note. It is assumed that 5% of the rural households cooking with crop residues or fuelwood purchase their stoves. Further, it is assumed that all households cooking with charcoal and coal purchase their stoves and all urban households using residues and wood purchase their stoves.

Source. Calculated from Tables in Annex III

The above figures are clearly an underestimate as there are households who use more than one type of fuel and other households (and establishments) who use more than one stove. If it is considered further that, on average, each stove lasts two years, then the annual demand for purchased biomass and coal stoves could very well exceed four million.

Cooking Cost Comparisons with Different Fuels

To see if an improved stove program is justified in economic terms, the cost of cooking with different fuels has first to be determined. Using an average of 4.85 people per household and wood energy consumption for urban areas of 1.35 kg/capita/day, the consumption of other fuels can be estimated[2]. Specific (unimproved) stove efficiencies have been assumed, based on experience in Vietnam and neighboring countries. Existing stoves in the market range in efficiencies from 10% to 25% and their price varies from Dong 4,000 to about Dong 46,000.

Table 5.2 summarizes the annual consumption of "cooking energy" for an average household in Vietnam based on this method.

Table 5.2. Estimated Average Household Consumption of Cooking Energy with Alternative Fuels.

Fuel	Unit	Energy value, MJ/Unit	Stove efficiency, %	Annual consumption, Original Unit	Average price, Dong/Unit	Annual cost, '000 Dong
Residues	kg.	13.5	12	4,012	200	802
Fuelwood	kg.	16	17	2,390	350	836
Coal	kg.	20	15	2,167	350	758
Charcoal	kg.	30	25	867	1,700	1,474
Kerosene	lt.	35	45	413	3,500	1,446
LPG	kg.	46	60	236	5,500	1,298
Electricity	kWh.	3.6	70	2,579	600	1,547

Notes:

- MJ. - MegaJoule (10^6 Joules); Average energy value of crop residues - 13.5 MJ/kg., with a moisture content of 15% (dry basis)/ 13% (wet basis) and an ash content of 10%; average energy value of wood - 16 MJ/kg. mc 15% (db), ash content 1%; average energy value of fully carbonized charcoal - 30 MJ/kg., with a moisture content of 7.5% (db), ash content 4%;
- coal powder, fines eggs and briquettes - 20 MJ/kg., mc 15% (db), ash (and clay) content 23%. U. - unit.
- The stated price per unit for the different fuels are average prices in the principal (urban) centers where they are sold, except for crop residues where a shadow price of dong 200 per kg. is used. Some residues are traded, but even in small towns the residues are collected from the farm. the price of dong 200 represents the cost of collecting the residues. For fuelwood, charcoal and coal, the price varies according to distance from the production site to the market and the means of transport - water, road, rail, foot, bicycle, mechanized transport. On the other hand the price of kerosene and electricity varies very little from town to town. For LPG the price in HCMC has been taken as the average price.

Vietnamese Dong - Feb. 1995 exchange rate, US$ 1 = D. 11,000.
Source. ESMAP - WB/UNDP 1994, Mission estimates.

[2] See ESMAP " Rural and Household Energy Issues and Options", Annex VI, page 68 (1994)

Irrespective of fuel type, some 6.5 GigaJoules (GJ) of energy needs to be delivered to the pot each year per household to cook the food, boil water, etc . Considering differing stove efficiencies and fuel energy values, it is seen from the Table that the average household will, for example, use approximately 2400 kg. of wood or 400 liters of kerosene or 2600 kWh. of electricity *if* they are using only one type of fuel..

The results also show that while four tons of air-dry crop residues are required to cook the meals for an average family each year, only 236 kg of LPG would be needed. This is because the estimated efficiency of crop residue stoves is only one-fifth that of the LPG stove, and oxygenated fuels such as crop residues, fuelwood and dung have an inherently lower energy value per unit weight when compared to the hydrocarbon (and carbon) fuels.

Table 5.2 explains why LPG is making significant inroads into the household sector of HCMC. It is cheaper than charcoal and kerosene, is more convenient to use and easier to control. Its greatest drawback is the initial price of the container, (dong 350,000 for a 12 kg. bottle) and the cost of the stove, (D. 400,000 for a 1 burner and D. 1,000,000 for a 2 burner), although many households in the former Saigon already have stoves and bottles.

LPG in Hanoi is about 30% more expensive than in HCMC and charcoal is about 50% dearer. Hence these fuels are not very common in the capital. But in the small towns along the coast of the central and southern areas and near production centers, charcoal is still used by some middle and upper income households. This is because of its relative high energy value and convenience, and because of the flavor it imparts to some foods.

Current Situation in Coal Stoves Production and Marketing

The business prospects provided by the growth in household demand for coal briquette (bees-nest type) stoves encouraged the state-owned briquette producers and the private sector to engage in the production of stoves. The entry of the private sector is logical as the stove production business seems ideal for entrepreneurial initiative. The key to success in the business would appear to be the development of the right stove, efficient organization of production, distribution and marketing, and possession of adequate working capital. The number of existing coal stoves producers, however, is much smaller than in the case of briquetting. Most are located near Hanoi from where the stoves are transported to retailers as far south as HCMC. The production technique employed by VCTC, DCC and private producers today is, for the most part, artisanal — tools rather than equipment are used.

DCC's efforts in the coal stoves business appear to be more ambitious than the others. DCC started stove production in 1992 and markets several models— bees-nest stoves in different sizes as well as coal fine stoves. The stoves are of good quality with estimated lifetimes longer than two years and the prices are competitive— the normal bees-nest stove model is sold for 20,000 dong ex-plant. DCC advertises its stoves through brochures, TV commercials and at fairs. But inspite of its development and marketing efforts, DCC has not been successful in significantly penetrating the market. In 1994, DCC sold a mere 27,000 stoves.

Private producers have captured the larger part of the market. DCC's *annual* sales of coal bees-nest stoves, for example, correspond to just the individual *monthly* sales of two private workshops producing similar stoves, both located within two kilometers of each other in a locality outside Hanoi. The two private workshops appear to be well managed and have their own marketing strategies. One of the companies, owned and managed by a former staff from the Technical Committee of the Province, produces three bees-nest stove models, sold ex-plant with iron insert for 12,000 dong, with ceramic insert for 10,000 dong and without insert for 8,000 dong. The manager believes that consumers are very price conscious and unwilling to pay more for better quality. He therefore provides consumers with a range of price-quality combinations. Another bees-nest stove producer produces a relatively large model which was designed by an engineer from the provincial Institute of Technology. In collaboration with the Energy Institute, the engineer had persuaded the manufacturer to take up the production of that particular model. The stove is sold for 20,000 dong ex-plant and for 25,000 dong by retailers in Hanoi. All of the regular coal stoves being marketed (unimproved models) by both state and private owned producers have efficiencies of about 20-23%.

Efficiency Improvements for Coal and Biomass Stoves

Many of the technical measures that can significantly improve thermal efficiency of existing stove models require modest additional cost. These include:

- adding an insulation layer of a material like rice husk ash, diatomite or vermiculite;
- improving the dimensions where required, with appropriate molds and tools;
- increasing the primary (and secondary) air inlets and grate air space;
- controlling the heat output (with a door);
- increasing durability, and
- adding an outer sheet metal cover for holding the insulator

These measures and others have been applied at the laboratory level by past and ongoing stoves research work at the Energy Institute, the Forest Science Institute and the Hanoi Architectural Institute. Tests carried out by the mission in the Energy Institutes' laboratory in February 1995 on improved wood and coal stoves recorded efficiencies ranging from 20% to 24% for improved wood stoves and from 23% to 35% for improved coal stoves (see Annex IV).

It would seem, therefore, that the program is ready to move from the R & D and demonstration stage to the commercialization phase, using selected improved stoves models.

The improvements would increase production cost but would not require complicated retooling or significant new capital investments. The additional cost to purchasers is estimated to range from about dong 15,000 to dong 25,000 per stove. Adding a pan recess or a jacket may add another dong 10,000 per stove and increase the efficiency by another 5% to 10%. The recent introduction of the coal stove with a fan in the market is evidence that people are willing to pay for improvements in their cookstoves. Aside from potential fuel savings, the fan stoves enable savings in cooking time and provide users some control over the heat output. The fan stove costs about *four times* more than an ordinary coal stove that can accommodate two coal briquettes for continuous burning. Currently, over 100,000 of these fan stoves are being produced each year and their sales reportedly have tripled over two years.

Potential Financial and Energy Savings to Households

Table 5 below estimates the gross savings a household will make by purchasing an improved stove. It is assumed that improved stoves will improve end use efficiency by between 20% and 30%, resulting in a saving of energy of between 17% and 23%.

Table 5.3. Estimated Annual Gross Savings Per Family with Improved Biomass and Coal Stoves.

Fuel	Fuel use with existing stoves	Annual savings with 20% increase in stove efficiency		Annual savings with 30% increase in stove efficiency	
	kg/yr.	kg.	000 dong	kg.	000 dong
Crop Residues	4012	669	134	926	185
Fuelwood	2390	398	139	552	193
Charcoal	867	145	246	200	340
Coal	2167	361	126	500	175

Note: The energy value of charcoal has been calculated by assessing the amount of wood used to make the charcoal. It was assumed that 5 tons of air dry wood (1.54 TOE) are required to make 1 ton of charcoal.

Source : Mission estimates.

With a 20% increase in efficiency in an improved biomass or coal stove, the estimated financial savings range from dong 126,000 with an improved coal stove to dong 246,000 for an improved charcoal stove. Similarly if the average efficiency improvement is 30%, then the respective savings are dong 175,000 (coal) and dong 340,000 (charcoal). Of course, the savings using a coal stove could be substantially more, if the improved stove was not a continuously burning one. Rather, if it is similar to the stoves that are just being introduced with a fan, then the savings could be increased by up to 50%. This is because coal would be used only when needed. In this case the savings using an improved coal stove may range from about dong 190,000 (20% efficiency improvement) to dong 260,000 (30% improvement).

For the average family of about five people, existing stoves vary in price from dong 4,000 to dong 46,000 and their efficiencies range from 10% to 25%. The additional cost to a household of purchasing an improved vs. an ordinary cookstove would range from about dong 15,000 to dong 25,000 per stove. A pan recess or a jacket may add another dong 10,000 per stove and increase the efficiency by another 5% to 10%. Disregarding the pan recess improvement, but assuming each household has two improved stoves with an overall efficiency increase of 20%, the total net savings over the two year lifetime of the improved stove should range from dong 200,000 for coal, through dong 250,000 for wood or residues to dong 450,000 for charcoal. If the average efficiency increase is 30%, then the net savings should range from D 300,000 for coal stoves to D 650,000 for charcoal stoves over two years. The payback period is thus seen to be only between 2 to 4 months.

National Benefits of A Long Term Program

Achieving widespread usage of high efficiency stoves in Vietnam will take time and, based on experience elsewhere in the world, is not an easy task. The potential economic, social and environmental benefits, however, far outweigh the typical investment requirements of stoves dissemination programs. The potential benefits to the nation can be illustrated by considering a ten year program with a modest goal of a million stoves per year sold in year ten.

In ten year's time the total population of the country will be about 91 million, an increase of over 20%. However, the urban population may increase by about 80%. This is the important statistic from the viewpoint of promoting an improved stove program. After making allowances for households switching to LPG, kerosene and electricity, but also considering rural people who will buy their stoves instead of making them, the number of people buying their biomass or coal stove should increase by at least 50%. So the potential annual market for improved stoves in ten years time may be over six million.

To illustrate the magnitude of benefits of long term program to promote higher efficiency stoves, very modest market penetration rates can be assumed such that the build up would commence with only 25,000 per year production achieved in two years time until 1 million per year production is reached in year 10 (Table 5.4). The calculations assume an average of 20% increase in stove efficiency, stove lifetime of two years, average gross fuel savings of 150,000 dong per year and average 20,000 dong incremental outlay for the improved stove. It is also assumed that the types of stoves sold are in proportion to current sales in the market (see Table 5.1).

As shown in Table 5.4, , the cumulative energy savings over the ten year period could be nearly 650,000 TOE or 3% of present energy consumption. In money terms, the estimated savings rise from about dong 1,600 million, (US$ 150,000) in year 2 to about 118,000 million, (US$11 million) in year ten. There is no reason why a higher market penetration rate cannot be achieved by a systematic program such that much higher national benefits are obtained.

Table 5.4. Estimated Financial and Energy Savings over Ten Years of a Modest Program

Year	Units Sold	No. of Households	Energy Savings '000 TOE /yr	Financial Savings, Billion Dong/yr	Financial Savings, million US$
1	0	0	0.0	0.0	0.0
2	25,000	12,500	2.2	1.6	0.15
3	50,000	37,500	6.8	4.9	0.44
4	150,000	100,000	18.0	13.0	1.2
5	250,000	200,000	36.0	26.0	2.4
6	400,000	350,000	58.5	42.3	3.8
7	600,000	500,000	90.0	65.0	5.9
8	700,000	650,000	117.0	84.5	7.7
9	800,000	750,000	135.0	97.5	8.9
10	100,000	900,000	162.0	117.5	10.7

Assumptions:

1) each household owns two stoves, each with a lifetime of 2 years. The replacement process results in one new stove being purchased per household per year.

2) The type of stoves sold are in proportion to current sales in the market (see Table 5.1)

3) the average energy saving per household is 180 kg. oil equivalent or 7.56 gigajoules valued at 150,000 dong.

4) net financial savings per stove per year is 150,000 less 20,000 dong incremental cost of the improved stove, or 130,000 dong.

5) TOE - Tons of oil equivalent; 1 TOE = 42 GigaJoule

6) Feb. 1995 exchange rate : US$ 1 = 11,000 Vietnamese Dong

Source: Mission Estimates.

VI. POLICY AND INSTITUTIONAL IMPLICATIONS

Market Imperfections

This chapter summarizes the policy and institutional implications of the situations described in the preceding chapters. Concerning demand growth, the coal briquetting industry will face no difficulty in meeting the projected growth in demand in the next five years. Supply is very elastic in the coal briquetting and stove production industries and the environment is fiercely competitive. Barriers to entry are low in both industries.

The household coal fuel industry, however, will face increasing problems. On the supply side, there is pressure from modern fuels such as kerosene, electricity and LPG. Continued rural electrification efforts and the fortchcoming local production of LPG and kerosene will intensify this pressure. Furthermore, as per capita incomes rise nationallly, the affordability of these modern fuels will be enhanced. Finally, there will be increasing pressure from the coal industry for briquette producers to pay higher prices for coal supply: export prices are now about 50% higher than ex-mines prices charged to local consumers.

Due to the highly competitive nature of the industry, profit margins will be low. Nevertheless, financing of capacity expansion is not likely to be a major problem. If the "capital intensive" state companies VCTC and DCC are unable to finance new investments, the informal sector with its lower investment intensity of production will very likely fill the gap. But whereas the elasticity of supply is adequate, the Government is concerned about the social and environmental implications of the current situation and trend. The low efficiency of coal and biomass stoves hurts the already poor financial situation of the lower income groups. For biomass stoves, the key environmental concern is the contribution of inefficient stoves to the degradation of an already fragile resource base. On the other hand, inefficient coal stoves and sub-optimal briquettes compound the already serious environmental problems associated with the use of coal, through increased emissions of particulates, sulfur dioxide and nitrogen oxides. At the local and household levels, the cost is in worsened air pollution and increased incidence of respiratory problems. Globally, the cost is in the form of increased greenhouse gas emissions into the atmosphere.

It is not likely that these quality problems can be addressed by market forces alone. Consumer perception and appreciation of stove efficency is close to zero. It is perhaps better for coal briquettes: consumers are able to percieve differences in moisture content and in stability. During usage they are able to perceive differences in sulphur content (by odor). The supposedly higher quality of products produced by the state-owned factories, however, has not prevented a continuing loss of market share to informal producers.

It is clearly to the interest of the industry to promote more efficient stoves as it expands the overall market by improving the price competitiveness of coal. But the difficulty and cost of expanding consumer awareness leaves the individual producer little incentive to improve his stove product. Even if he desires to do so, the technique of producing higher efficiency stoves that are not significantly more expensive than existing ones is currently limited in the industry.

Framework for Public Intervention

The three most important public institutions concerned with the household coal consumption are: (i) the coal briquette production and marketing companies VCTC and DCC, (ii) the Ministry of Energy, that affects the subsector through its formulation and implementation of energy policies, and (iii) the technological service institutes, the Energy Institute and the Institute of Mining, which provide R&D, testing facilities and advisory support services to independent producers.

The existing public structure for household coal development is probably adequate for the early stage of the economic transition in Vietnam. There move away from central planning, however, is gaining momentum and many state enterprises are now quickly being corporatized and commercialized. It is important that, parallel to this process, the framework for policy formulation and implementation and for the provision of support to national industries be adjusted in order to correspond to the requirements of the new market situation. The different actors have to adjust their attitudes, skills and actions to the new roles they are being asked to play.

In the household coal area, the public sector structure is, in many ways, already adapting to meet the new challenges although some weak points remain. The technological institutes appear to have the basic requirements for the provision of technical and other advisory support to private industry in briquetting and stove production. It already has significant experience in stove design, in data colllection and in assisting producers. What it needs are better laboratory facilities and testing equipment, and more up-to-date international technical literature. There is scope for continued technical assistance programs with bilateral aid agencies.

The attitude of management at VCTC and DCC towards the household coal industry presently fluctuates between that of "public utility service" and "commercial business opportunity". Management is willing to make efforts to cover the social needs of the population, but wants to have governnment protection against "unfair competition". The performance of VCTC and DCC in household coal development during the 1985-94 period has been good; its present weaknesses are likelt to be temporary. Based on their track record, it is expected that VCTC and DCC will show the needed flexibility to meet inexorable future changes in the industry.

The major weakness appears to be in the area of policy making. Household energy—the subsector where domestic coal and improved stoves lie— is not a subject that attracts much attention, As it also straddles social and environmental issues, it makes it complex to incorporate in overall energy sector planning. There is, furthermore, a serious dearth of data on supply and demand of household fuels—data needed badly for sound planning and policy making. An important step was made in this direction during the 1993 joint ESMAP/EIV study on rural and household energy issues and options. The present study is also envisioned to make an important contribution towards clarifying complex issues in the subsector. The policy makers at the Ministry of Energy—not just staff at the Energy Institute—must begin to devote more attention to household energy issues that, after all, affects the majority of the population.

Options for public intervention

Public ownership allows the state to use VCTC and DCC as direct agents of change by influencing their decisions about investments in new capacity, the development and marketing of new products and the establishment of new distribution channels in the household coal industry. But it is more in line with the Government's economic reform programme to regard VCTC and DCC as purely commercial companies engaged in the competitive activities of coal stove production and briquetting. Decisions on issues of investment and development in this area best made independently by management on the basis of purely commercial criteria. These criteria, of course, can be influenced by Government subsidies. The energy policy makers thus must jointly develop with management of VCTC and DCC the framework for providing consumers with better quality products on a purely commercial basis.

In light of the highly competitive industry situation, management of DCC and VCTC hvae to rethink their competititve strategy: both companies are losing market shares and are seeing their profits squeezed. There are three potentially useful generic strategic approaches to outperforming other firms in an industry: (i) overall cost leadership, (ii) product or service differentiation, (iii) focus on a particular buyer group segment of the product line, or geographic market. DCC and VCTC have no chance of competing on costs; and market pressure has led already to a certain market focus - serving urban rather than rural consumers. Neither DCC nor VCTC have attmpted to differentiate themselves from their competitors eiither by improving the quality of their briquettes or the services they offer to consumers. What they could do is to commbine their urban focus with attempts to offer better and slightly higher-priced briquettes. Such a strategy, if it succeeds, will *shift the total demand for briquettes* upward by widening the product choices of consumers. The strategy could improve *profit margins* bu not necessarily not market share (as some previous customers are lost to producers of lower quality but also cheaper briquettes) Due to better image and higher consumer loyalty, the companies will be less dependent on reducing profit margins to maintain their competitiveness on the market.

Before DCC and VCTC pursue such a strategy, assumptions concerning consumer reactions willl first have to be tested in a pilot project. While important environmental and health benefits of improved briquette production are important, these benefits are reaped by society, not by the briquetting producers. It is unlikely that the profits of producers could be increased by a quality strategy (the concumers are too poor to afford to pay more for better quality); at best their market position will be strengthened. Although the "public service" mentality of the state owned briquetting firms is still strong, competition forces them to evaluate such initiatives on a commercial basis. Thus, without donor assistance, the quality of briquette production is not likely to be improved.

The other policy option of the Government is to impose norms and standards on briquettes and stoves , combined with licensing for briquette productions. The issues to be considered are:

(i) Whether the norms are enforceable, particularly outside the major cities of Hanoi and Danang. Enforcing the norms on rural briquette production may be unmanageable and costly. On the other hand, it is in the urban areas that the environmental problems associated with coal demand are most severe.

(ii) Whether the norms can be combined with appropriate technical and other support to producers

Another option is to establish quality norms for various briquette types but to leave it to producers to decide which type they want to produce. Briquette quality would be clearly indicated for consumers when they buy the product. This approach has to be combined with the conduct of an extensive consumer information campaign and the establishment of a workable monitoring system .

VII. A FIVE-YEAR PILOT PROJECT

To translate the preceding findings into action, a five-year pilot project is recommended, consisting of a subproject to revitalize the coal briquetting industry and a subproject to achieve the accelerated commercialization of improved biomass and coal stoves. The conduct of the two subprojects is simultaneous and, in a number of ways, are interdependent. The specific goals of the program are to achieve production increase of 60,000 tonnes per year of higher quality bees-nest briquettes and to market a total of close to half a million improved cookstoves by the end of year five. The total cost is estimated to be about $2.7 million and is proposed to be financed from bilateral arrangements. The expected benefits are, as discussed in the preceding chapter, financial gains for briquette producers and stoves manufacturers, reduced fuel expenditures and improved kitchen conditions for households, and significantly reduced emissions of SOx, CO and particulates. Global benefits accrue as well from reduction of carbon dioxide emissions from these household fuels. This Chapter briefly describes the preparatory work required, the specific components of each subproject, the implementation plan and the estimated budget.

Preparatory Activities

Surveys

There is presently very limited information about the traders of coal fines, informal sector briquette producers, and the consumers of these briquettes and fines. A first priority should be to make a list of all transporters (road, river, rail and sea) and traders of fines and briquettes. The major government mines should be able to assist in this, but small private mines and power plants who sell fly ash for briquetting are also important sources of information. The transporters and traders should be questioned about their customers and the amount of fines and briquettes they sell.

From the transport/trader survey, a list of private briquette manufacturers should emerge. This may be incomplete, for some manufacturers may buy directly from the mines, especially small private mines. This is why it is important to survey the mines as well. The survey should also provide information about the number and type of informal industries using fines and the amount of fines that is used by this sector (and the service sector). Some of these fines are made into patties by hand before use, so there may be a potential market for manufactured egg/ovoid briquettes. A survey of coal fines-using industries, should indicate if such a market exists.

Although a preliminary survey of stoves producers was conducted by EIV in March 1995, the information is incomplete and there is need for additional efforts to find the location of major stoves manufacturers in the various regions, record their capacities and production methods, and determine their suitability for participation in the project.

Stoves Tests

Efficiency tests should be conducted by the EIV on major models of existing commercial coal and biomass cookstoves that are marketed in the various regions. The purpose is to obtain a benchmark against which the efficiency of improved models could be compared. With the assistance of local and external experts, designs of improved coal and biomass stoves suitable for dissemination in Vietnam should be selected. For each model, the changes necessary in current production processes will be determined, including additional equipment, materials and labor, and the incremental production costs.

Final Implementation Plan and Budget

The broad implementation plan and indicative budget for the components of the pilot project are described below. Based on the results of the surveys and stoves tests recommended above, some revisions may need to be made. In particular, the appropriate budget allocations for the stoves/briquette centers will depend on which government agencies are finally selected as sites, and which staff will be involved. It is suggested that, as soon as financing for the pilot project is firmed up, an external consultant be recruited to finalize details of the implementation plan and budgets, and to help start up the project.

Subproject I: Coal Briquetting

This subproject assumes that the market for coal briquettes will grow as projected in Chapter I, and that consumers will prefer higher quality products than is currently available. Although the coverage for technical assistance includes informal producers, the focus of the subprogram will be factories of VCTC and DCC for two principal reasons: (1) the factories have much larger capacities than any private producer, and (2) there is substantial unutilized capacity. As actual market growth is difficult to accurately predict, the plan is to start with two selected factories, improving product quality and activating unused capacity. Additional factories will be similarly assisted to expand at a pace dictated by the market, until the largest government factories are covered. It must be emphasized that the subproject will also identify and target the most important informal sector producers for technical and credit assistance, at the same time that more focussed efforts are directed at the state factories.

Improved Utilization of Installed Capacity

As discussed earlier, the effective daily operating hours of the briquetting lines in the VCTC and DCC plants were typically only 4.5 hr/day. It is useful to evaluate the following production options:

- an improved base case (effective operation 7 hr/day),
- 2 Shift system,
- 3 Shift system

In Table 7.2 below analyses are made of multiple-shift operation, as well as an improved base case (single-shift) operation that make better use of installed equipment by employing more unskilled labour, using the briquetting machines for 7 hrs/day instead of only 4.5 hrs. It is shown that the improved base case reduces production cost substantially (compare with Table 4.1, Chapter 4). The 2-shift system (two 8 hr shifts with an effective operating time of 14 hr/day) yields a substantial improvement of the production cost, IRR, NPV and pay-back period. The 3-shift system (three 8 hr shifts, effective operating time 22 hr/day) performs even much better. It is concluded that any new investment in briquetting capacity can only be justified if accompanied by improvement of the existing single shift system.

Table 7.2. Cost analysis of the improved base case, the 2-shift and the 3-shift system.

Cost item	Annual cost (million Dong/yr)		
	Improved base case	2 Shift system	3 Shift system
Annual production, tonnes (1)	13,230	26,460	41,580
Annualized capital	664	1,233	1,233
Labour	115	140	190
Raw material	2,394	4,789	7,525
Consumables	2.9	5.9	9.2
Energy	126	252	378
Maintenance and repair	194	194	194
Total (Production cost)	3,496	6,043	8,960
Marketing cost	0	0	0
Specific production cost (Dong/t)	264,216	228,414	215,497
Selling price (Dong/t)	300,000	300,000	300,000
IRR (%/yr)	26%	56%	85%
NPV (million Dong)	2,069	9,036	16,973
Investment (Dong)	4,269	4,566	4,908
Simple pay-back period (yr)	3.8	1.8	1.2

Subproject Phases

Table 7.3 summarizes the components of a five-year pilot subproject to improve product quality and increase production output in the industry. The subproject considers a base case of about 8,000 tonnes/yr production at 4.5 hrs/day operation—the current capacity of the largest state-owned plants. To begin with, the subproject would select two plants, one from DCC and another from VCC, and would culminate at the end of year five with completion of production improvements in the largest plants of the remaining government factories. The merging of smaller plants to achieve economies of scale at the same time as operational improvements are made would be sought as a "rationalization" strategy.

The budget shown in the table includes the assignment of an external technical expert and the training abroad of key local staff. The detailed budget breakdown for each of the phases are shown in Annex VI. The budget includes financing the establishment of a small test laboratory in each of the two plants, and strengthening of the cookstoves and fuels testing capabilities of the Institute of Energy. Not included is the working capital needed to expand production volume that must be borne by the plants themselves. Although this could be recouped in a short time, financially healthy briquette producers should be selected as additional capital of about Dong 210 million or about $19,000 is required. This is estimate is based on the analysis of the base case (Chapter 4) and should be redetermined, depending on actual plant-specific data.

The factories selected should possess the proper physical requirements for increased production. They should be located near Hanoi, in order to be close to the Institute of Energy that is expected to play a key administrative and technical role in the project. Given specific project requirements, both the VCTC and the DCC will be invited to propose candidate plants.

Table 7.3. Bees-nest briquette subproject: review of proposed investment phases.

Year	Phase	Activity	Result at End of Phase	Production increase (t/yr), relative to existing production of 70,000 t/yr	Cost (US$), foreign component only.	Remark
1	1: Test phase	Test phase of briquette quality management & demand promotion	2 existing briquetting plants operating at full single-shift capacity	10,000	430,000	5,000 t/yr production increase for each pilot plant (1 shift)
2-3	2: Dissemination phase	a) Dissemination of briquette quality management & to remaining mechanized briquetting facilities; demand promotion campaign	Largest of existing gov't facilities plus selected large private factories operating at full single-shift capacity (about ten total)	84,000	200,000	Existing capacity at 110,000 t/yr (1 shift). Current prod'n 70,000 t/y.
		b) Re-investment in & improved maintenance of existing briquetting facilities	Rationalization (merging of smaller plants) and optimized management			
4-5	3: Consolidation phase	a) Extension of briquetting capacity in existing briquetting facilities	Rationalization (merging of smaller plants) and optimized management	237,000	89,000	Target capacity of 307,000 t/yr with currently installed equipment and double-shift operation.
		b) Re-investment in & improved maintenance of existing briquetting facilities	Rationalisation (merging of smaller plants) and optimized management			
		c) Introduction of 2-shift system				
Total Phase 1-3					US$ 719,000	

Total foreign investment per production increase, US$/(t/y) 3
Estimated specific investment cost for new factories, based on double shift operation, US$/(t/y) 13
Source: Mission Estimates

The total budget for the subproject is $719,000, disregarding certain local cost components. Budget details for each phase are shown in Annex VI. Expressed as a specific capacity investment, the cost of activating unused capacity would be about US$3/ton /yr as compared to about 13 US$/ton/yr for new installations. The economics of the investments to upgrade and increase production capacities have been shown in Table 7.2 above as favorable.

Improved Product Quality Management

It must be stressed that the subproject does not only involve the activation of idle capacity but also importantly the introduction of improved product quality management, as discussed in detail in Chapter IV. Moreover, the subproject will not limit the introduction of such practices to the selected state-owned plants but to also to the non-selected plants, and particularly to the small, informal sector producers. Although the additional costs involved are modest, these improvements may not be attractive to the artisanal producers because of the low level of capitalization in that sector. The most significant informal sector producers should be identified and targeted for technical and credit assistance. During the project, efforts must be made to set standards for product quality that can be reasonably achieved by most briquette producers.

Investigation of Alternative Coal Fuel

Within the subproject, an effort must be made to systematically investigate the market potential of specific low-sulfur fuels for a different type of coal stove which has emerged in the market. The stove is fueled with home-made "grains" made from coal fines mixed with water. The stove has a forced draft supplied by an electric fan, run from a battery or the mains. Both private and government-owned enterprises are currently involved in the production and marketing of this type of stove. The advantage of this stove type, compared with the bees-nest stove, is the rapid ignition and the fuel economy (the quantity of fuel can be easily adjusted). A disadvantage is that sulfur emissions are not controlled and the coal may burn too fiercely, although many motors have variable fan speeds. Manufacturers of this new stove have reported a three to fivefold increase in demand over a three year period. The subproject should investigate options to develop a low-sulfur emission fuel for this stove type. A simple fuel improvement—based on mixtures of coal and lime—is foreseen (See Annex VII).

It is important that these alternatives to the bees-nest be investigated, as part of the overall objective to improve household coal products. As with the bees-nest, efforts should be made to:

- improve the quality and burning properties of the patties/eggs burnt in the stove.
- test, develop and facilitate the availability of low-sulphur fuel for this stove type; alternatively, add lime to fines at mine-head before sale
- regulate particulate and CO emissions, (health and environment considerations);

- promote higher efficiency stove models.
- support the dissemination of these more efficient complementary stoves;

Subproject II: Commercialization of Improved Cookstoves

Objective and Plan

The objective is to assist existing large stove producers convert part or all of their current production to improved stoves, based on designs to be provided by the Institute of Energy. The production techniques, stove designs and materials used in the selected factories will be critically examined. Aside from technical assistance to improve the production process, assistance will be provided to improve basic management and business practices, as well as marketing techniques.

During an initial 6-8 month trial phase, a limited amount of improved stoves will be produced and marketed. After demonstrating the viability of the operation, the participating factories will be encouraged to expand production of the improved stoves line, through provision of credits and continued promotions. The cost of the promotional efforts will continue to be borne by the project but the additional production costs will be borne by the factories. For this purpose, a revolving fund will be established to provide small loans for additional investments and working capital to the participating factories.

Improved Coal Stoves for the Northern Regions[1]

Possible candidate factories in the Northern regions include three private coal stove makers in Ha Bac province identified in the March 1995 mini-survey by the EIV. Each stove producer had been in business from four to six years; between them they produced 260,000 stoves in 1994. In the previous year, the output of these producers was about only 100,000 stoves, so demand seems to be growing rapidly. In Hanoi, candidate factories could be chosen from 4 state-owned bees-nest briquette producers that also manufacture coal stoves on the side. The 1994 stove output from these factories was 40,800 pieces, ranging from 2,000 stoves in the smallest factory to 30,000 units in the Dong An workshop of the DCC.

Improved Biomass Stoves for Southern Regions

Five major wood and/or charcoal stoves producers presently exist in District 8 of Ho Chi Minh city . Their combined 1994 annual production was estimated to be 114,000 stoves, ranging from 10,000 units in the smallest factory, to two factories with outputs of 36,000 units. All these producers have kilns and make burnt clay (ceramic) stoves of

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[1] A significant portion of households in the North uses biomass stoves. The subproject's plan to assist coal stoves producers only in this region is guided by the need to keep the pilot project small and simple. The focus on assistance to biomass stoves producers in the South will complete the knowledge gap. The results of the pilot activities in each region can then be applied nationally later.

various sizes with or without sheet metal covers or bands. The output from these factories is about one third of the demand in HCMC. Possible candidates for the subproject are the two largest producers, namely Ta Tam De and Le Thi Chau factories, that have both been in the business for 40 years or more.

Remaining Regions

The detailed actions for the remaining regions will be developed after completion of the recommended comprehensive survey.

Economic Justifications

Return on Investment by Participating Stoves Manufacturer

One can take as an example the following conservative situation that can apply equally well to a coal or biomass stove producer:

Loan for Capital Investment:	$30,000 330,000,000 Dong
Interest Rate:	25%
Terms, yrs:	5
Monthly Payments:	5,626,172 Dong
Add'l O &M:	5% of Investment
Promotions, etc	25% of incremental stove price
Incremental Price of New Stove*:	10,000 Dong
Incremental Production:	
Year 1	0 units
Year 2	10,000
Year 3	20,000
Year 4	30,000
Year 5	50,000

*Note: This is ex-factory. Incremental price at retail level is 20,000 dong.

The corresponding internal rate of return is 68%. A sensitivity analysis that reduces the stove incremental price and increases the production cost items show that extreme changes have to be made to reduce the IRR to less than 25%. This illustrates the general attractiveness of the business from the point of view of the producer.

Economics of the Subproject

It can be shown that the investment on the subproject is an attractive one, based on fuel savings benefits. The analysis below assumes that the there is an average 20% efficiency gain, the economic cost of the fuel is its market price (about 350 Dong/kg for either wood or coal) and that the total sales of improved stoves is 250,000 units per year by Year 5. It is further assumed that two stoves on the average are used per household, each with a lifetime of 2 years.

Table 7.4. ECONOMIC ANALYSIS OF STOVES SUBPROJECT, US$
Case: Fuelwood Stove

	Year 1	Year 2	Year 3	Year 4	Year 5
Subproject Costs(1):	257,500	195,000	177,500	172,500	165,000
Stoves Sales	0	25,000	50,000	150,000	250,000
Incremental Stove Costs	0	45,455	90,909	272,727	454,545
TOTAL COSTS	257,500	265,455	318,409	595,227	869,545
Wood Savings, tons (2)		4,979	14,936	39,831	79,661
Savings, US$	0	158,423	475,252	1,267,338	2,534,676
NET BENEFITS:	-257,500	-107,032	156,843	672,111	1,665,131

NPV@15% discount :: $1,168,380
IRR: 81%

Note: (1) Subproject cost is assumed to be half of the total common costs for the briquette and stoves components (See Table 7.5)
(2) Each household consumes about 398 kg wood per year, burned in two stoves. As a stove is replaced after its two year life, the savings from the other stove is added to the new savings.

The above calculations can be repeated for the case of other stove types: charcoal, coal and crop residues stoves. The IRR for these cases range from 16 to 25%. The average IRR for the 4 cases, weighted in proportion to current sales of these stoves in the market , is about 29%.

Organization

It is recommended that the lead agency for the pilot project be the Energy Institute. For the coal briquette subproject, the Ministry of Mines and Energy will be the principal cooperating agency. For the stoves commercialization subproject, EIV is expected to involve the Forest Science Institute and the Hanoi Architectural Institute in implementation.

The project will set up modestly equipped regional units or "centers" for conducting market surveys, tests on commercial stoves and briquettes, training courses for both public and informal sector producers and other activities. To minimize administrative costs, the centers will be established in existing agencies and will utilize managers already existing in the agencies. For the Northern regions, the center will be a combined stoves/briquette facility located either at the EIV or the Ministry of Mines. (Alternatively, the stoves function could be located at the EIV and the coal briquette function at the MOM). For the Southern regions, the center will be principally a stoves facility, possibly attached to the Energy Center of PC2 or the HCMC Polytechnic. The center for the Central region will also be a combined stoves/briquette facility, since both biomass and coal fuels are used in these regions. The centers, in effect, will be the regional implementation arms of the EIV project management. It will provide monitoring and evaluation of the progress of the project.

It is recommended that a $500,000 revolving fund be established, to provide loans to coal briquette and stoves producers, in accordance with the objectives of the pilot project. The loans will be provided on commercial or slightly more favorable than commercial terms. The administrator of the revolving fund need not be the EIV; this should be studied at the preparatory phase of the project.

Estimated Total Costs of the Pilot Project

Table 7.5 below provides an indicative budget estimate. It is estimated that the total pilot project will cost about $2.7 million, of which about $0.8 million are for direct investments in the coal briquette factories identified for upgrading. Not shown is the additional $500,000 that is recommended to be set up as a revolving loan fund. This amount is expected to be fully recovered at the end of the project. More details are provided in Annex VIII.

Table 7.5. Estimated Total Project Costs, $000

	Year 1	2	3	4	5	Total
Proj Management	50	50	50	50	50	250
Stove/Briquette Centers	120	45	45	45	45	300
Surveys, etc	120	60	55	55	50	340
Other Activities	75	105	105	105	105	495
Consultancies	100	80	50	40	30	300
SUB TOTAL*	465	340	305	295	280	1,685
Briquette Investments:						
Test Phase	300	130				430
Dissem. Phase		50	100	50		200
Consolidation Phase				49	40	89
SUBTOTAL	300	180	100	99	40	719
TOTAL	765	520	405	394	320	2,404
Contingencies, 10%	76	52	41	39	32	240
GRAND TOTAL	841	572	446	433	352	2,644

*These subtotals represent common costs to the two subprojects

Project Risks

For both the briquette improvement and stoves commercialization component, the major risk is that the envisioned sales volume of the improved products will not materialize, due to the higher costs and inadequate consumer awareness. For example, reducing the sales volume of improved stoves to half of the above scenario lead to a negative net income (loss). This risk can be mitigated by conducting continuous market surveys and by launching an extensive promotional campaign. The frequency of the surveys and the various approaches for promoting consumer awareness of improved stoves and briquettes should be determined during preparatory work for the project. The actual year to year investments should be adjusted in accordance with the findings of the market surveys.

ANNEX I : FORECASTING HOUSEHOLD DEMAND FOR COAL

Introduction

Demand forecasts for energy consumption are usually based on extrapolations of past demand and its correlation with a number of factors presumed to influence it. In the case of household coal demand in Vietnam, extrapolation from past experience is not a feasible option. First of all, the past and present consumption figures for household use of coal are too unreliable to permit formal quantitative modeling. Secondly, the structural shifts in the Vietnamese economy which result from the adoption of the policy of "renovation" (doi moi) imply a substantial break with past trends for several of the demand factors (see below) - and econometric/time series analysis loses its predictive powers in times of economic paradigm shifts.. Finally, coal as a fuel for cooking is a transitional fuel and experience in other household coal consuming countries has shown that consumption can fall drastically in a very short time - a fast shift which normally cannot be captured by econometric modeling[1].

Yet, forecasts are needed as a guide for policy making and have to be made. In view of the factors discussed above, a pragmatic, common sense forecast approach is used in this report. It involves three steps. First, an overview is provided of the basic data that are available on household coal demand and supply in Vietnam. Next, it is analyzed which factors influence demand and how. Where indications of their quantitative impact exist, those are given. Finally, based on qualitative assessments of how these factors will evolve in the future, a plausible scenario-type forecast of demand is given. This paper presents the results of the first two steps; the last step, the forecast is provided in the report text itself, in the subchapter called Demand Trends.

Estimate of Total Household Coal Demand

Coal consumption of households is not reliably recorded. Previous estimates of household coal demand range from 600,000 tons (Domestic Coal Company) to 1,400,000 tons (ESMAP Rural Energy study). In the table below, household coal demand is estimated as a residual of total coal supply on the market after deducting expert estimates on industrial coal demand. The resulting demand estimate of 1,400,000 tons is in line with estimates of the recently conducted ESMAP rural energy study.

[1] In South Korea, for example, consumption of coal briquettes has fallen 80% from 1990 to 1995, a drop of several million tons per year.

National supply 1994:	4,000,000 tonnes
Direct sales by mines to state owned industries:	
- power demand:	900,000 tonnes
- cement:	600,000 tonnes
- other industries (e.g. fertilizers):	500,000 tonnes
Supply provided by VCTC, transporters traders and interior mines:	
- sales to informal industries (30%):	600,000 tonnes
- sales to households, including pig feed prep (70%)	1,400,000 tonnes

Note (1). *Source*: Figures for direct sales provided by VCTC, and the breakdown of remaining coal demand between informal sector/household demand are based on ESMAP survey data and information received through interviews of coal managers

The estimate of sales to the state owned industries is based on recorded statistics provided by VCTC. The breakdown of the "rest demand" of 2 million tonnes between households and informal sector demand (rural industries comprise textile, paper, brick, tile, ceramics and food processing industries) is based on survey estimates [2].

Socio-economic characteristics of household coal use

Coal is used by rural households as a partial substitute for fuelwood and other biomass resources. It is the main or only cooking fuel of the urban consumers who use it. Unsurprisingly, the per capita consumption of urban coal users is higher than the consumption of rural coal consuming households. But since rural coal consumers are more numerous than urban coal consumers and coal is heavily used for preparing pig feed in rural areas, about 75 % of the coal demand for cooking and water heating is rural

In the Red River Delta, the rural households with the highest incidence of coal consumption in *villages* are found in the higher-middle income group, and in the small *towns* (600-1000 residents) among lower-middle income consumers. In *Hanoi*, coal is consumed by the poorer sections of the population

Household consumption of coal includes its use for productive purposes in household enterprises: over 689 of al] coal used in the surveyed households in Red Delta “small towns" was used in household enterprise; and in the villages, consumption of coal for cooking and for pig feed amounts to 45 % .

[2] One should note that the coal production figures do not include the production from the small mines located in the country, and that ashes from coal power plants are used to produce briquettes and coal patty.

Table: Structure of Rural and Urban Household Coal Demand

	Briquettes	Coal Dust	Lump Coal	Total
Red River Delta Villages				
- Users in % of popul .				
- Users in % of coal users	12 %	33 %	2%	47%
- Consumption kg oil equiv./	26%	70%	4%	100%
/per cap./month				
- Consumption in % of				
total	0.8 kg.	3.1 kg		
Red River Delta small towns				
- Users in % of popul	.45 %	13 %	3 %	61 %
- Users in % of coal users				
- Consumption kg oil equiv.				
/per cap./month	74%	20%	6%	100%
- Consumption in % of total				
	7.7 kg	199 kg	1 kg	28.6 kg
	27%	68%	4%	100%
Market shares:				
- Red River villages				
- Red River small towns	20%	80%		
- Hanoi	28%	72%		
- Total Vietnam:	55%	45%		
	33%	67%		

Source: ESMAP, 1993, Household and Rural Energy in Vietnam, Tables IV.7, IV.8,
Hanoi estimates from interviews with VCTC and ICC management.

The relative use of briquettes versus coal dust in households is strongly correlated with the degree of urbanisation. In Red River Delta villages, only 20% of household coal consumption is consumed in the form of briquettes, in the Red River Delta small towns this figure rises to 28 %, and in Hanoi and surrounding towns to 55%.

Based on the above statistics (which have to be used with care) and on an estimated 1994 total household coal consumption of 1,400,000 tons per year, the annual consumption of coal briquettes can be estimated at 400,000 tons, and of coal dust at 1,000,000 tons.

Household consumption of coal for cooking and for water heating is estimated at 740,00() tons (53%), and the use of coal in household production including the preparation of pig feed at 660,000 tons (47 %)[3]. Thus, the future demand for household coal will be strongly dependent on the market for household enterprise production in the Red River Delta.

If briquettes are used exclusively for cooking and other household purposes[4], then household cooking demand for coal dust (the primary market to be captured by briquettes) is about 400,000 tons. Thus, the future market for briquettes will be highly dependent on whether briquettes are an attractive option for households which presently use coal dust.

Factors which influence the Demand of Households for Coal

Growth of population

The relevant demographic factors which influence the demand for coal are (i) the overall growth in population, (ii) the specific rate of population growth in the most important areas of coal consumption and (iii) the rate of urbanization, in particular in the towns located in the Hanoi and, to a lesser extent, in the Danang areas.

Coal demand will be stimulated by an annual population growth rate of 2% over the next ten to twenty years. The estimated increase in population between 1995 and 2000 is 7 million, rising from from 72.5 million in 1995 to 79.9 million in the year 2000 (see table below). However, because of migration, the urban population will increase by 5%.

Population Forecast

(million inhabitants)	**Urban**	**Rural**	**Total**
1995:	61.1	56.4	72.5
2000:	19 8	60.2	79.9

Until the end of the 1980s, the central planners were able to control the movement of the population through administrative means. With the liberalization of the economy this will no longer be possible and the stronger economic growth in the urban areas combined with rural absolute poverty will provide a strong pull factor. Thus, the population of the larger cities such as Hanoi, Danang and HCMC is likely to grow at least 7 percent per year during the next two decades. This migration will positively affect the demand for coal, expecially briquettes, in Northern cities like Hanoi, inspite of a loss of market share to alternative fuels such as kerosene and in particular LPG.

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[3] Based on the following data: (i) according to the ESMAP 1993 survey, the productive use of household coal in either household enterprises or for the preparation of pig feed amounts to 59% of household coal consumption in the Red River Delta; (ii) assuming that 75% of the coal dust and 10% of briquettes used by households in Hanoi are used for productive purposes and that the Hanoi figures are representative for the "rest of the country" consumption.

[4] Management of the Danang coal briquetting plant estimates that 80% of its sales are to households, 15% to restaurants and 5% to industry. The plant was established in 1990.

Growth in Household Income

The income elasticity of the demand for coal - being a transitional fuel - is negative in the *long run*: as average income rises, more and more coal consuming households will be able to afford the more convient household fuels LPG and kerosene In the *short run*, the income elasticity of coal demand is less straightforward. *In urban areas*, where coal is consumed by the low income groups, the income elasticity will be negative. In the rural areas where coal is consumed by the middle income classes, the income elasticity of demand may be neutral or even positive; the well-to-do households will switch from coal to kerosene LPG or to electricity, the low income households from biomass residues to coal.

Due to the regional concentration of coal demand, the income elasticity of the demand for coal depends more on the evolution of household income in the major consuming regions than on the growth rate in average national income per capita. In addition, since coal is the "entry Ievel" non-biomass fuel for low-income households and the "exits" fuel for middle income households, the development in average income of the two categories of consumers in the coal consuming regions is of particular interest for coal demand.

The overall incidence of poverty is extremely high. The consumption level of 51% of the population is below a widely used international poverty line with significant regional disparities in living standards. Poverty incidence ranges from 35% in the southeast to 71% on the north central coast. There is a clear pattern in which relatively poor areas are growing slowly. The two poorest regions (which are important centres of coal demand), the north central coast and the north mountains, arc growing about 3% per year; whereas the prosperous southeast (where coal consumption is modest) is expanding at the annual rate of 15 % . The fast growth in income in the southeast is rapidly eliminating coal from the household market as witnessed by the decline in the demand for coal briquettes in HCMC. The growth rate in the two poorest regions, on the other hand, is too modest to push coal consumption out of middle income households; whereas it provides more low income households with the means to buy coal[5].

So far in the reform process, Vietnam has been successful in alleviating poverty, With 8()9G of households engaged in agricultural activities, decollectivisation and price liberalization resulted in higher incomes and improved living standards for most of the population. According to national statistics, the number of low living standard households decreased between 1989 and 1993 from SS % to 20% of households. a tendency which widened the market for coal briquettes. In the future as growth will be

[5] Obviously, this is based on the assumption that the growth in income is not heavily biased in favour of the middle income households.

driven mainly by development in the urban areas, progress in income distribution is likely to become more difficult.

The Relative Price of Coal

The Government's declared intention is to move away from administratively fixed prices in household energy to cost based Pries set by the companies. *Coal prices* were decontrolled in 1988, and have since then been cost based rising annually in line with inflation and real price increases at the coal mines. Some slight subsidisation still takes place, as prices charged to domestic consumers at the mine heads (in 1994 = US$16/tonne for quality no. 5) are below export prices (=US$ 22-23/tonne) *Kerosene and electricity* prices are fixed administratively and revised at infrequent intervals. During the first half of the 1990s, prices of kerosene and electricity were revised only once, in 1992, when prices doubled. This was followed by falling real prices as prices were kept constant in spite of high rates of inflation. The Minister of Energy has announced that electricity prices in 1995/96 will be increased by 10%, which is equivalent to the expected rate of inflation.

Evolution of Household Fuel Cost in Hanoi

	1990	1991	1992	1993	1994
Briquettes, Dong/kg	180	200	220	300	320
Electricity Dong/kWh	230	230	450	450	450
Kerosene Dong/litre	1200	1200	2300	2300	2500
Fuel Price Indexes	Br.: 100 El.: 100 kE.: 100	111 100 100	122 196 192	167 196 192	178 196 192
National Production f briquettes by VCTC and DCC	tonnes: ?	tonnes: 4,900	tonnes: 36,000	tonnes: 60,000	tonnes: 70,000

The difference in the price setting mechanism lead to substantial year-to-year changes in the relative price of coal compared to its substitutes and the demand for fuels proved to be very sensitive to these[6]. Demand for coal briquettes produced by the state companies VCTC and DCC (mainly consumed in the urban areas around Hanoi, Danang and HCMC) increased 14-fold from 5,000 to 70,000 tons between 1992 and 1994. If the

[6]The price of a briquette at the Danang plant increased from 420 dong in 1992 to 450 dong in 1993 and to 500 dong in 1994.

production of private briquette producers in those cities had been included, the growth in coal demand would have been even stronger. Total 1995 urban demnad is estimated to be 360,000 tonnes.

In the *rural areas*, household demand for coal continues to increase in regions affected by *rice straw and fuelwood shortages*. Fuelwood shortages express themselves on the market in terms of increased prices which change the relative price of coal vis-a-vis fuelwood. The high price elasticity of coal demand in rural villages was demonstrated by the Government programme to subsidise the transport of coal fines from mines to mountainous areas in 13 provinces. When the programme started in 1991, coal demand in these areas was 20,500 tonnes, raising to 1 15,000 tonnes in 1992 and to 195,000 tonnes in 1993 when the cost of the subsidy amounted to US$ 1 million or 50 dong/kg on average. After the abolition of subsidies in 1994, demand dropped to 80,000 tonnes. Since the price increase (coming on top of general increases in the price of coal fines) of 50-60% let to a demand decrease of 60%, the price elasticity of rural coal demand vis-a-vis fuelwood seems to be -1[7].

Availability of LPG

The future market for coal briquettes, in particular the urban market but also the rural market, will be negatively affected by large increases in the supply of LPG and a considerable drop in price. Until 1994, all LPG novas imported; and subject to a severe import licensing and pricing regime designed to discourage consumption Starting in 1995, national gas production and from the year 2000 the refining of crude oil will give rise to a large national production of LPG.

During the 1980s and 1990s, oil companies found relatively large oil and gas reserves offshore of Vietnam. Since 1988. Vietnam has signed 28 production sharing contracts (PSCs) with 15 international oil companies including some of the world's big names Royal Dutch Shell, Mobil Oil, Mitsubishi Oil, BHP, Total, PetroCanada, BP, British Gas and Petronas. Vietnam has now three producing fields, the VietSovPctro operated White Tiger (estimated reserves of 17S-300 million barrels) and Dragon Oilfields (t00-lS0 million barrels) and BHP's Big Bcar (300-600 million barrels)

Vietnam is expected to produce 7.7 million tonnes of crude in 1995. In the year 2000 *oil production* should reach a level of 15-20 million tons per year rising to 30-40 million tonnes in 2010. National consumption is expected to increase from the present 4 mtoe to 8-t0 mtoe in 2000 rising to 30-40 million tonnes by 2010.

Natural gas Production which in 1994 was a mere 200,000) cubic meters will become an important domestic fuel in the next few years. In 1994, the first stage was

[7] A price elasticity of demand of 1 implies that a 10% increase in price will lead to a 10% decrease in demand.

completed of a pipeline bringing gas ashore from the Big Bear field.. In 1995 this gas will be supplied to national consumers starting with the gas turbine power stations in Ba Ria and Vung Tau.

A national refinery will be operational from the year 2000. The government has approved the Instruction of a refinery plant in Dung Quat District., Quang Thai Province. TOTAL (leader) together with PETROVIETNAM, Chinese Petroluem Corp. and China Investment and Development co. are progressing oil detailed feasibility studies.

Already before the year 2000 annual LPG production will reach O.5 mtoe. Some of this production will be exported, some sold to industrial consumers, but in principle, there will be several hundreds of thousands of tons of LPG available for household consumers. In anticipation of this development, the Vietnamese Government now allows private oil and trading companies to import LPG and LPG appliances in order to build up gradually a market for LPG[8] , LPG for households was introduced in HCMC in 1992 and in Hanoi in 1994. The market expanded and the price of LPG in 12 kg bottles stropped in HCMC from US$2/kg in 1992 to US$0.50/kg (5,500 dong) in 1994/95. In Hanoi LPG was introduced in 1994 and the current price is $0.65/kg (7,000 dong). Thus the demand for LPG in Hanoi is relatively small at present, especially as potential customers have to buy stoves as well. Once national LPG production starts prices will go down due to the savings in freight costs, and as demand picks up, economies of scale in LPG storage and bottling facilities will provide further cost savings.

The promising market prospects for LPG are attracting very professional suppliers to the market, who are investing in LPG storage and bottling plant facilities. A liquefied petroleum gaz joint venture, VIETGAS has been formed between TOTAL, Petroleum Authority of Thailand (PTT) and PETROVIETNAM. Marketing will start in 1995 under the VTGAS brand name. In 1995 the Saigon Joint Ventura Gas Company is scheduled to import gas cookers including 150,000 small and 15,000 large cookers along with 15,000 tons of Butane gas targeted at household consumers in Hanoi and in HCMC.

LPG will be primarily bought by well-to-do households during the late 1990s. The price of 1-2 million dung for a gas cooker will limit the penetration of LPG in lower income households as much as the price of the fuel itself. But after the year 2000 LPG should be able to gain market shares also among middle-income families living in rural areas.

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[8] LPG was for the first time introduced to the household sector in North Vietnam in 1994. In South Vietnam, LPG had been a widely used fuel before 1975. Although LPG was not available between 1975 and 1992, households had kept their LPG appliances which permitted a rapid build up of a household demand for LPG.

ANNEX II. ESTIMATION OF BRIQUETTE PRODUCTION COSTS

Table 1. Definition of the model briquetting plant (base case).

Briquette definition:	
Size (kg) (wet)	
- as produced ($MC_w = 20\%$)	1.00
- as sold ($MC_w = 10\%$)	0.89
Quantities of raw material (coal/clay ratio as handled on wet basis)	
- Coal ($MC_w = 8\%$)	80%
- Clay ($MC_w = 8\%$)	20%
***Mass balance**: inputs to as sold composition (100% is air dried product (MCw = 10%))*	
- Wet Coal	78%
- Wet Clay	20%
- Added water	15%
Total wet components + added water	113%
Production capacity (briquettes/minute) (3 briquetting machines)	105
Specific investments	
- Equipment (Dong/(kg/hr)	198000
- Infrastructure (Dong/(kg/hr))	418000
Total specific investments (Dong/(kg/hr))	616000
Manpower requirements	
Fixed manpower	
- Plant manager	1
- Engineer	1
- Technician	1
- Foreman	1
- Accountant	1
Total fixed manpower	5
Hence for fixed manpower:	
Skilled	5
Semi-skilled	0
Unskilled	0
Variable manpower (man/shift)	
- Operator	5
- Unskilled labour	4
- Driver	1
Total variable manpower (man/shift)	10
Hence for variable manpower (man/shift):	
- Skilled	0
- Semi-skilled	6
- Unskilled	4
Working capital	
- Salaries (months)	2
- Inventories (days)	
- Coal	20
- Clay	20
- Slaked lime	20
- Accounts receivable	10
- Spare parts (% of investment)	2%

ANNEX I I (CONT'D):

Table 2. Production cost break-down in Dong/kg

Fixed cost	
Capital	80
Labour	5
Maintenance	23
Variable cost	
Labour	3
Coal	157
Clay	24
Lime	0
Energy, water	15
Total	**310**

Note: A 1 kg briquette is assumed. The mass balance was determined on the basis of assumed moisture contents in the raw materials coal and clay. For the production capacity 3 briquetting lines are taken. Specific investments were determined on the basis of investment reviews in UNIDO 1993. The UNIDO study assumes that all equipment is made in Vietnam. Price comparison with offers from Korean manufacturers showed that the equipment offered from Korea is approximately twice as expensive. Local manufacture is a reasonable assumption however. The comparison of the Korean and Vietnamese alternatives was not straightforward because the briquette dimensions are different in Korea (3.6 kg compared to about 1 kg in Vietnam).

Table 3. Laboratory equipment for briquette quality management.

Electronic balance, 0-200 g, ±0.0001 g	US$3,000
Fuel drying oven, 110 oC, ±5 oC	1,500
Fuel incineration furnace, 1350 oC, ±5 oC	1,000
Coal grinder	200
Mechanical balance (0-10 kg), ± 10 g (Vietnamese made)	200
Miscellaneous:	2,000
Alumina tube, Oxygen cylinder, Combustion boats, Heat resistant wire, Silica pusher, 2 Absorbers, Vacuum pump, Titration column	
Contingencies	1,000
Total	US$8,900
Local (Dong)	4,400,000
Foreign (US$)	8,500

Annex III. ESTIMATE OF STOVE-USING HOUSEHOLD, BY PRIMARY COOKING FUEL (1995)

Table 1. Number of Urban Households
Units: '000 Households.

Urban	Crop	Fuelwood	Charcoal	Coal	Kerosene	LPG	Electricity	TOTAL
NH	55	155	7	80	13	0	0	310
NM	15	40	2	20	3	0	0	80
RRD	5	93	0	184	30	0	28	340
HANOI	0	27	0	112	42	8	21	210
NC	41	120	32	32	10	0	0	235
SH	27	101	22	0	5	0	0	155
SC	72	210	93	20	15	0	0	410
NEMD	0	194	84	0	58	1	3	340
HCMC	0	155	150	12	197	100	6	620
MD	0	490	10	0	92	1	7	600
TOTAL	*215*	*1585*	*400*	*460*	*465*	*110*	*65*	*3300*
%	7	48	12	14	14	3	2	100

Table 2. Number of Rural Households
Units: '000 Households.

Rural	Crop	Fuelwood	Charcoal	Coal	Kerosene	LPG	Electricity	TOTAL
NH	440	850	0	30	0	0	0	1320
NM	420	430	0	20	0	0	0	870
RRD	1010	485	0	890	0	0	25	2410
NC	875	910	0	0	0	0	0	1785
SH	80	385	0	0	0	0	0	465
SC	510	670	0	0	0	0	0	1180
NEMD	210	680	30	0	0	0	10	930
MD	625	1995	90	0	0	0	30	2740
TOTAL	4170	6405	120	940	0	0	65	11700
%	35	55	1	8	0	0	1	100

Note for both Tables:

1. NH - Northern Highlands; NM - North Midlands; RRD - Red River Delta; NC - North central; SH - Southern Highlands; SC -South Central; NEMD - North East of Mekong Delta; MD - Mekong Delta.
2. The households using kerosene, LPG and electricity for cooking have been grouped together and are shown under the electricity column.
3. Total 1995 urban population estimated to be 16 million people.Total 1995 rural population estimated to be 58 million people. Total population 74 million.

Source:ESMAP 1994; GoVN 1991; GoVN 1993; Mission estimates.

Annex IV : TEST RESULTS OF FUELS AND HOUSEHOLD STOVES

Table 1. Coal and Firewood Heating Value Testing Result

	coal	firewood
gross calorific value (cal/g)	3606	4224
net calorific value (cal/g)	3362	3822
C(%)	36.11	45.79
H(%)	3.05	6.15
S(%)	0.58	0.01
ash content (%)	31.56	2.5
moisture content (%)	16.55	11.63

Source: Testing Supervision Center, Coal and Firewood Saving Product Quality, Ministry of Agriculture, PRC.

Table 2. Comparison of Test Result of Energy-Saving Stoves in Vietnam

A. Firewood Stoves

	TYPE-1	TYPE-2	TYPE-3	TYPE-4
Temperature Elevation Rate V1 (C/Min)	3.04	2.74	2.84	2.96
Vaporization Rate V2 (G/Min) Equal to Power (kW)	13.77 0.536	19.19 0.75	9.7 0.38	11.65 0.45
Temperature Regaining Rate V3 (C/Min)	0.65	0.575	0.525	0.4
Efficiency (%)	24.34	21.06	20.33	20.70
Insulation	y	n	n	n
Producer	EI	EI	EI	S. VN

Annex IV B. Coal Stoves

	TYPE-1	TYPE-2	TYPE-3
Start Burning Time Td	44 min.	31 min.	34 min.
Fire Elevation Time Ts	51 min.	41 min.	43 min.
Strong Burning Time Tw	71 min.	65 min.	76 min.
Available Fire Time Tk	105 min.	110 min.	130 min.
Total Burning Time Tr	157 min.	151 min.	173 min.
Total Vaporization Water Dz	1.74 kg	1.82 kg	2.44 kg
Average Power Intensity Hp g/min. Hp kW	 16.60 0.65	 16.55 0.65	 18.77 0.73
Efficiency %	23.09	26.65	35.41
Insulation	n	n	y
Producer			

Annex V. STATE-OWNED BRIQUETTING ENTERPRISES

Enterprise	Capacity Ton/Year	The number of pressing machines
I. Hanoi coal trade - processing company	**20.000**	**3**
1. Giap Nhi enterprise	15.000	
2. Fa den enterprise	1.000	
3. Chem enterprise	1.000	
4. Son Tay enterprise	2.000	
5. Hoa Binh	1.000	
II. Ha Bac coal trade - processing company	**5.000**	**3**
Dap Cau enterprise	3.000	
Lang Son enterprise	2.000	
III. Vinh Phu	**2.000**	**1**
8. Viet Tri enterprise	2.000	
IV. South east coal trade - processing company	**4.000**	**2**
9. Yen Bai enterprise	2.000	
10. Lao Cai enterprise	2.000	
V. Hai Phong CTPC	**10.000**	**4**
11. Cua Nam enterprise	10.000	
VI. Ha Nam Ninh CPTC	**15.000**	**5**
12. Phy ly enterprise	5.000	
13. Nam Dinh enterprise	5.000	
14. Ninh Binh enterprise	5.000	

Annex V (cont'd)

Enterprise	Capacity Ton/year	The number of pressing machines
VII Thanh Hoa coal trade - processing company	**2.000**	**1**
VIII. Nghe Tinh, CTPC	**16.000**	**4**
16. Ga Vinh enterprise	10.000	
17. Ben Thuy enterprise	2.000	
18. Cua Lo enterprise	2.000	
19. Thach Ha enterprise	2.000	
IX. South Central CTPC	**22.000**	**11.000**
20. Dong Ha enterprise		
21. Dong Hoi enterprise		
22. Cau Den enterprise		
23. Quang Ngai enterprise		
24. Nha Trang enterprise		
X. South CTPC	**1.000**	
XI. Quang Ninh CTPC	**2.000**	**1**
XII. Thai Binh CTP	**2.000**	**1**
XIII. Domestic coal trade company	**50.000**	**9**
28. Dong Anh enterprise	15.000	
29. O Cach enterprise	15.000	
30. Lac Long Quan enterprise	10.000	
31. Co Loa enterprise	10.000	
TOTAL TON/YEAR	**151,000**	

Sources: Vietnam coal trade - processing company, domestic coal trade company

Note : CTPC: Coal trade processing company

Annex VI. COAL BRIQUETTING SUBPROJECT: BUDGET BREAKDOWNS

Table 1. Tasks, costs and targets of the Test Phase.

Item	Cost (US$)	Description
Preparation		Economist, technical expert. Duration 1 month. Discussion of proposed programme with MoE. Selection of participating pilot factories. Negotiation of contribution by pilot factories. Preparation of TOR.
- Fees	36400	
- Travel	10000	
- Subsistence	7800	
Supervision and monitoring of quality management and marketing programme		Technical expert. Duration 1 year.
- Fees	150000	
- Travel	5000	
- Subsistence	30000	
Foreign training of IoE staff		3 staff members trained in energy planning (household energy, rural energy). Duration 1 month each.
- Tuition fees	30000	
- Travel	15000	
- Subsistence	18000	
Local, on-the-job, training of IoE staff		3 staff members trained in cookstove and fuels testing. No additional cost.
Evaluation		Economist/marketing expert. Preparation of TOR for dissemination phase. Duration 1 month.
- Fees	18200	
- Travel	5000	
- Subsistence	3900	
Project car	15000	
Running cost project car (driver, fuel, maintenance)	PM	Covered by GoV.
IoE staff (project manager, 2 assistants)	PM	Covered by GoV.
IoE cookstove and fuels testing laboratory	25000	
Briquette testing laboratory at 2 pilot factories	20000	
Additional staff at 2 pilot factories (a.o. laboratory staff)	PM	Covered by participating beneficiary factories.
Additional maintenance cost pilot factories	PM	Covered by participating beneficiary factories.
Additional marketing budget at 2 pilot factories	PM	Covered by participating beneficiary factories.
Contingencies	38930	
Total	**428230**	

Annex VI (cont'd)

Table 2. Tasks, costs and targets of the Dissemination Phase.

Item	Cost (US$)	Description
Assistance to and monitoring of dissemination phase by foreign expert		Part-time basis. 3 visits of 2 moths each.
- Fees	109200	
- Travel	15000	
- Subsistence	23400	
IoE staff (project manager, 2	PM	To be covered by participating beneficiary
Maintenance project car	5000	
Running cost project car (driver, fuel, maintenance)	PM	
Evaluation		Economist/marketing expert. Preparation of TOR for consolidation phase. Duration 1 month.
- Fees	18200	
- Travel	5000	
- Subsistence	3900	
Briquette testing laboratory at participating factories	PM	To be covered by participating beneficiary factories.
Additional staff at participating factories (a.o. laboratory staff)	PM	To be covered by participating beneficiary factories.
Re-investment and increased maintenance cost of participating factories	PM	To be covered by participating beneficiary factories.
Additional marketing budget at participating factories	PM	To be covered by participating beneficiary factories.
Contingencies	17970	
Total	197670	

Table 3. Tasks, costs and targets of the Consolidation Phase.

Item	Cost (US$)	Description
Assistance to and monitoring of consolidation phase by foreign expert		
Assistance to and monitoring of dissemination phase by foreign expert		Part-time basis. 3 visits of 1 moths each.
- Fees	54600	
- Travel	15000	
- Subsistence	11700	
IoE staff	PM	To be covered by participating beneficiary factories.
Extension of briquetting capacity in existing briquetting facilities	PM	To be covered by participating beneficiary factories.
Re-investment in & increased maintenance of existing briquetting facilities	PM	To be covered by participating beneficiary factories.
Contingencies	8130	
Total	89430	

ANNEX VII. ESTIMATED COST OF PRODUCING AN IMPROVED FUEL FOR THE COAL FINES STOVE

An improved fuel may be produced for the newly introduced stove for coal fines. The alternative fuel is made with a lime additive to control sulphur emissions. At present, this product does not exist on the market, neither in Vietnam, nor elsewhere. The analysis is therefore clearly on a pre-feasibility level. The economic calculations, below, serve to get an understanding on whether such an innovative product would make any sense at all. For the preliminary evaluation a number of assumptions are made. These concern:

- The product definition (contents of coal, clay binder and lime, grain size)
- The production technology and its costs
- The selling price

The product definition is reviewed in Table 1 below. The production process considered proceeds as follows. The coal and clay are ground together into a powder by means of a hammer mill. This mixture is agglomerated with lime and water inside a rotating pan agglomerator. The resulting grains are dried in a dryer which is fueled with bees-nest coal briquettes. The technology is further characterized in Table 2 below. The whole operation is supposed to be installed at a bees-nest briquetting facility. Thus management cost and production facilities are shared with the bees-nest briquette production. The same selling price is assumed as for bees-nest briquettes (on a weight basis). The financial evaluation supposes the same operating parameters as in the Improved base case for bees-nest briquettes. Results of the evaluation are presented in Table 3 below. Production costs are slightly higher than for the bees-nest briquettes under the scenario of the Improved base case. The production seems a favorable operation. However, whether or not it is economical, strongly depends on the supposed market price for this product. A price of at least 275 Dong/kg is needed to obtain an IRR of 15% and a positive NPV.

Annex VII (Cont'd)

Table 1. Product definition for an innovative coal fine product; Mass balance of the production process.

	Coal/lime/clay ratio as handled on wet basis	MCw
Coal (2% S)	80%	8%
Lime	11%	0%
Clay	9%	8%
Mass balance of the production process: Inputs to as sold composition (100% is the dried product (MCw 10%))		
bees-nest Wet Coal	78%	
bees-nest Wet Clay	9%	
bees-nest Wet lime	11%	
bees-nestAdded water	16%	
Total wet components + added water	113%	

Table 2. Technical parameters for producing an improved coal fines product.

Agglomerator	
- Capacity (t/hr), dried basis	1.50
- Electrical power (kW)	0.55
- MCw as produced	30%
- Cost (Dong)	22,000,000
Dryer	
- MCw dried	10%
- Drying efficiency	50%
- Thermal capacity (kW), input	548
- Briquette fuel (t/t product)	0.08
- Cost (Dong)	36,666,667
Grinder/mixer	
- kW	14
- Cost (Dong)	36,666,667
Based on:	
NCVw of bees-nest coal briquettes (kJ/kg)	17,325

Table 3. Cost analysis of producing an improved fines fuel.

Cost item	Annual cost (Dong/yr)
Annualized capital	174,323,382
Labour	33,271,795
Raw material	575,084,914
Consumables	809,219
Energy	15,120,000
Maintenance and repair	50,966,667
Total (Production cost)	849,575,977
Marketing cost	0
Specific production cost (Dong/t)	269,707
Selling price (Dong/t)	300,000
IRR (%/yr)	23%
NPV (Dong)	401,920,537
Investment (Dong)	1,115,104,293
Simple pay-back period (yr)	4.1

ANNEX VIII: STOVES SUBPROJECT COST BREAKDOWNS

	Year 1	2	3	4	5	Total
Proj Management	50	50	50	50	50	250
Stove/Briquette Centers	120	45	45	45	45	300
Surveys, etc	120	60	55	55	50	340
Other Activities	75	105	105	105	105	495
Consultancies	100	80	50	40	30	300
SUB TOTAL*	465	340	305	295	280	1,685
Briquette Investments:						
Test Phase	300	130				430
Dissem. Phase		50	100	50		200
Consolidation Phase				49	40	89
SUBTOTAL	300	180	100	99	40	719
TOTAL	765	520	405	394	320	2,404
Contingencies, 10%	76	52	41	39	32	240
GRAND TOTAL	841	572	446	433	352	2,644

*These subtotals represent common costs to the two subprojects

BREAKDOWNS US$000

Per Stove Center

Equipment	25	Vehicle:	15	Hanoi	Combined stoves/briquette center
Operation	15	Oper	10	HCMC	Stoves center
	40		25	Central	Combined stoves/briquette center

Breakdown of "Other Activities"		US$000
	Year 1	Thereafter
Training	15	15
M&E	5	10
Promo	15	15
Field Test	5	10
R&D	15	15
Other	20	40
	75	105

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)	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)	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)	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 (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings	09/95	175/95
Ethiopia	Energy Assessment (English)	07/84	4741-ET

Region/Country	*Activity/Report Title*	*Date*	*Number*
Ethiopia	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 (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
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)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	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
	Environmental Impact of Woodfuels (French)	10/95	176/95
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
	Energy Sector Review (English)	12/94	3643-MAS
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95

Region/Country	*Activity/Report Title*	*Date*	*Number*
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
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
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
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
SADC	SADC Regional Power Interconnection Study, Vol. I-IV (English)	12/93	--
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
	Industrial Energy Conservation Program	05/94	165/94
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
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
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)	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)	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

Region/Country	*Activity/Report Title*	*Date*	*Number*
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
	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)	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
Zambia	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)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP)	12/94	--

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
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
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
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94

Region/Country	*Activity/Report Title*	*Date*	*Number*
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)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
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)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	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
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	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)	12/88	
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	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
	Power Sector Reform Seminar (English)	04/94	166/94
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84

Region/Country	*Activity/Report Title*	*Date*	*Number*
Nepal	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Fomulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
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

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
	Energy Sector Institutional Development Study (English and French)	05/95	173/95
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)	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

Region/Country	*Activity/Report Title*	*Date*	*Number*
Bolivia	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
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	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
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)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	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)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	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	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU

Region/Country	Activity/Report Title	Date	Number
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara	11/95	177/95

01/31/96