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PERU
Guideline Study for a Short- and Medium-Term Strategy for the Energy Sector

Washington D.C., December 1990

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This report was prepared for the National Energy Council (CONERG) by a group of independent Peruvian and foreign consultants, in collaboration with a mission of the Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP).

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PREFACE

The main objective of this study is to identify and propose to Peruvian Government authorities a set of energy policy measures and institutional reforms to strengthen the energy sector's management and efficiency, after several years of neglect and/or policies that have weakened the sector and the institutions involved in energy activities. In addition, disseminating this study to the bilateral and multilateral cooperation agencies that could be interested in supporting the Peruvian energy sector will help reintroduce Peru into the sphere of international financial organizations. In this study they will find information and analyses that will help them to make energy sector decisions.

In keeping with these aims, the study will review the financial and operational situation of the various sector agencies and/or companies and their urgent rehabilitation and investment needs. This will be done bearing in mind that Peru needs resources to stabilize its economy in the short term and that the energy sector could be an important source of financial resources for the country's stabilization. In the medium and long term, these same policies would help to achieve the sector's own objectives, which are essentially geared toward ensuring the long-term supply of economical energy and its efficient use.

In the short term, since resources received by sector companies will be substantially lower (despite increased tariffs and prices) and will barely manage to cover operating costs, it is assumed that required investments and rehabilitation costs will be implemented with foreign resources obtained directly by sector companies or through the government or, eventually, through private sector involvement.

Intermediate objectives

- To analyze how to supply, at a minimum cost, the energy required for a take-off in economic growth and to meet the basic needs of the population, bearing in mind that several energy sources are nonrenewable and that they must be used with maximum efficiency.

- To define pricing, tariff, and regulatory policies which provide incentives for the rational use of energy, enable sector company finances to be put on a sound footing, facilitate the introduction of other economic agents (public, private, national, and foreign) into sector development, and generate public income to cover expenses (especially social) needed for minimum social welfare.

- To determine the extent to which demand management or administrative policies, improved planning and technology selection policies can minimize investment needs.

- To identify an urgent rehabilitation program in the electric power and hydrocarbons subsectors that could be financed by foreign funds and an investment program (for the medium term) that reflects the shortage of public financial resources and the need to attract national or foreign private resources (investments).

The first part of the study includes the following:

- a brief summary of Peru's economic situation and the energy sector's role in the economy (Chapter I), followed by a very short assessment of the sector, especially focusing on pricing and tariff-setting policies and their impacts;

- a brief summary of the rehabilitation and investment needs of the electric power and hydrocarbons subsectors;

- a note on energy conservation and substitution (and the impact of setting economic prices on conservation and substitution);

- a discussion of organizational and regulatory aspects and an introduction to the analysis of environmental problems stemming from energy sector activities.

In the second part, a deeper analysis of subsector problems is provided (Hydrocarbons including upstream, downstream and natural gas, Electricity, Woodfuels and Renewable Energy, and Coal).

The following will be presented in a series of annexes: the economic forecasts and input-output calculations which were used to achieve certain quantifications in this study; an idea for an energy conservation and substitution project; a more in-depth discussion on an organizational option for the electric power subsector; and a few statistical tables.

This study was carried out between March and August 1990 and essentially reflects the situation at that time, when a new government was coming into office. A preliminary version of this report was distributed in Lima, in August 1990. Nevertheless, the economic measures applied on August 8, 1990 are commented upon and, in certain cases, further developed afterwards since several members of the study group who were elaborating this report participated in a multisectoral mission of the World Bank that took place in October and November 1990.

Although this study does not have an executive summary as such, Chapter I (which summarizes the impact of energy sector operations on the economy in general and vice-versa) and Chapter II (which analyzes the problems of the sector in its entirety and presents the main recommendations) mention virtually all the important aspects of this study. The subsector chapters, however, enter into far greater detail.

MONETARY EQUIVALENTS

(intis per dollar, January-October 1990)

	Parallel Exchange	Single Exchange Market
January	13,013	5,804
February	13,532	7,213
March	18,553	9,663
April	27,967	13,548
May	39,45	19,259
June	74,031	28,163
July	118,000	44,215
August	316,652	-
September	430,050	-
October	447,808	-

ENERGY CONVERSION FACTORS

(net content expressed in ton oil equivalents of 10 million kilocalories)

Oil	
Crude Oil	0.138 TOE/B
LPG	0.097 TOE/B
Gasoline	0.124 TOE/B
Kerosene and aviation fuel	0.131 TOE/B
Diesel	0.138 TOE/B
Fuel oil	0.148 TOE/B
Electricity	86.000 TOE/GWh
Biomass	
Fuelwood	0.430 TOE/ton
Charcoal	0.650 TOE/ton
Bagasse	0.183 TOE/ton

ACRONYMS

BCR	Central Reserve Bank of Peru
CDEC	Centro de Despacho Económico de Carga (Economic Load Dispatch Center)
CENERGIA	Centro de Conservación de Energía (Energy Conservation Center)
CNE	Comisión Nacional de Energía (National Energy Commission)
CNTE	Comisión Nacional de Tarifas Eléctricas (National Electric Power Tariff Commission)
CONERG	Consejo Nacional de Energía (National Energy Council)
DGFF	Dirección General Forestal y de Fauna (General Forestry and Fauna Directorate)
DIGESA	Dirección General de Salud Ambiental (General Environmental Health Directorate)
FACE	Fondo Andino para Conservación de Energía (Andean Fund for Energy Conservation)
IDB	Inter-American Development Bank
IMF	International Monetary Fund
INP	Instituto Nacional de Planificación (National Planning Institute)
ITINTEC	Instituto de Investigación Tecnológica Industrial y de Normas Técnicas (Institute of Industrial Technological Research and Technical Standards)
MEM	Ministry of Energy and Mines
ONERN	Officina Nacional de Evaluación de Recursos Naturales (National Office for Natural Resources Assessment)
OXY	Occidental Oil Company
PNAF	Programa Nacional de Acción Forestal (National Forestry Action Program)
PP	PETROPERU
SICN	Sistema Interconectado Centro-Norte (Central-North Interconnected System)
SPCC	Southern Peru Copper Corporation

ABBREVIATIONS

AAI	annual average increase
APC	production sharing agreement
B	barrel
BPD	barrels per day
BTU	british thermal unit
CIF	cost, insurance, freight
CPI	consumer price index
EAP	economically active population
EIS	environmental impact study
FOB	free on board
GDP	gross domestic product
GOP	Government of Peru
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
ha	hectare
I/.	inti
IOC	international oil company
kgoe	kilogram oil equivalent
km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
LPG	liquefied petroleum gas
LRMC	long-run marginal cost
MBPD	thousand barrels per day
MMB	million barrels
MMBTU	million BTU
MMCF	million cubic feet
MMCFD	million cubic feet per day
MW	megawatt
NGL	natural gas liquids
NPV	net present value
TOE	ton oil equivalent
ton	metric ton
W	watt

I. ENERGY IN THE PERUVIAN ECONOMY

THE ECONOMIC CRISIS

1.1 The energy sector's deterioration should be analyzed within the context of Peru's general economic crisis, whose main features are indicated below:

a. Monthly inflation rates on the order of 30% to 40%, with an upward trend. In 1989, inflation was 2,775%, and in the first six months of 1990, the annual rate increased to 3,400%.

b. A slump in production, which has fallen by about 20%, compared to the first half of 1988.

c. A drop in real salaries to less than half the level of two years ago. A rise in unemployment and underemployment to more than 75% of the labor force.

d. A 4% reduction in real public expenditure in terms of GDP, as a result of a standstill in state investments and, above all, drastic cuts in public sector remunerations.

e. A persistent fiscal deficit greater than 9% of GDP completely financed by monetary emission. Tax revenues have fallen from 14% of GDP in 1985 to less than 5% in 1989. The deficit of state-owned enterprises is on the order of 2% of GDP.

f. Complete lack of international reserves in the Central Bank and the end of domestic credit even for short-term operations.

ENERGY BALANCE

Reserves

1.2 In 1988 the country's structure of proven energy resource reserves was as follows:

	TOE X 10^6	%
Hydropower (*)	142.6	35.0
Coal	42.6	10.4
Natural gas + NGL	165.8	40.6
Oil	56.8	14.0
Total	407.8	100.0

(*) Average energy from hydropower developments is taken into account, over 50 years.

Source: National Energy Plan Sectoral Commission.

1.3 Peru's 1988 energy balance is shown in Table 1. National primary energy production was 13.2 million tons of oil equivalent (TOE), of which 54% was oil, 26% fuelwood, 8% hydropower, and 7% natural gas.

1.4 Energy exports, consisting entirely of oil and oil products, amounted to 2.3 million TOE in 1988 while imports recorded 2 million TOE. On the basis of national production figures, in 1988 the Peruvian economy used 12.9 million TOE. Table 2 shows the performance of the commercial energy balance. Peru shifted from being a net energy (oil) importer to exporter in 1978, a position it has been losing to such an extent that it is now becoming an importer once again. If the downward trend of proven reserves persists, the deterioration could accelerate to such an extent as to prevent any possible attempt at recovery. In terms of foreign exchange, between 1979 and 1985, oil contributed more than US$400 million to the national economy per year. In 1989 the balance was almost zero. If the economy were to grow by only 2.5% per year, 125,000 barrels per day would be needed; since only 100,000 barrels would be produced, the cost of importing the remaining would amount to US$185 million.

1.5 The annual final energy consumption in 1988 was almost 0.5 TOE per inhabitant, including 0.15 TOE in the form of noncommercial energy. This level of consumption is similar to that of Ecuador and Colombia but less than the average for Latin America (about 0.75 TOE per inhabitant per year). This situation reflects low per capita incomes, inasmuch as the energy intensity of the Peruvian economy amounted to 0.48 TOE per US$100 of GDP in 1988, that is, 23.1% greater than the Latin American average. This higher energy intensity is a result of Peru's export structure, where mining and fishing, which are energy-intensive activities, are prevalent.

Likewise, low energy prices tend to increase the aforementioned coefficient, promoting the inefficient use of energy.

1.6 The growth of final energy consumption was 2.2% in the 1970-1980 period, was stagnant between 1980 and 1985 (-0.2% per year), and grew again to 3.5% between 1985 and 1988. The elasticity of final energy consumption in relation to gross domestic product (GDP) increased from 0.5% in the 1970-1980 period to 0.8% for 1980-1985, to reach 1.5% during the 1985-1988 period.

1.7 The consumption pattern by energy source shows a certain stability during the 1980-1985 period. It is worth mentioning that electricity consumption growth (3.8% per year) was much faster than oil product consumption growth (0.8% per year) and similarly for coal. The rate of consumption of fuelwood and residues was slightly lower than that observed during the same period in the rural population, indicating a slow penetration of oil products in this area of population.

Table 1: Total Energy Balance 1988
(thousand TOE)

	(1) Non-Com. Energy	(2) Com. Energy						(1)+(2) Total
		Crude Oil	Gas	Oil Prods	Elect.	Other	Total	
Primary Supply								
Production	3681	7137	882		1121	405	9545	13226
Export		-255					-255	-225
Import		1212					1212	1212
Inventory Var.		44	-213			-2	-171	-171
Unutilized								
Total	3681	8138	669		1121	403	10331	14012
Transformation								
Refineries		-8329	-612					
Elec. Power Stations					1161			
Other	-168				-119			
Adjust. & Losses	-135				-172			
Total Supply	3378			6939	975			
Trade Balance								
Export				-2049				
Import				752				
Domestic Supply	3378			5634	975	339	6948	10326
Financial Consumption								
Resid. Commer.	2945			1185	367	131	1683	4628
Public				229			229	229
Transportation				2607			2607	2607
Agro-Agroindust				105	18	123	246	246
Fishing				258	2		260	260
Mining-metallurgy				345	208	25	578	578
Industrial	433			902	308	60	1342	1775

Source: CONERG, 1988 Consolidated Energy Balance.

Table 2: Commercial Energy Balance, 1970-1988
(TOE X 10^6)

	Exports	Imports	Balance
1970	0.331	(1.485)	(1.154)
1978	1.922	(0.407)	1.515
1988	2.304	(2.005)	0.299

Source: CONERG, Energy Balances; 1970 and 1988.

1.8 On considering final energy consumption by sector, the prevalence of the residential-commercial and public sectors is observed, with a relative share of 46% of total consumption, although they only account for 28% of the total commercial energy consumed.

1.9 In terms of growth, during 1980-1988 the commercial sector experienced the highest rate (2% per year), due to a considerable increase in the consumption of electricity (5.2%) and oil products (2.7%). Transportation sector consumption grew by 1.9% per year, and the gasoline and diesel consumption ratio in this sector shifted from 1.77 in 1980 to 1.3 in 1988, indicating a higher degree of dieselization in the motor vehicle fleet. Consumption of the mining-metallurgical sector declined (-2.9% per year) and growth of industrial sector consumption was low (0.8% per year) but a considerable increase was seen in electricity consumption (5% per year) at the expense of oil products.

Energy demand forecast

1.10 The relative stability of the final energy consumption pattern during the 1980-1988 period enables a forecast to be made for 1995, using consumption growth rates from the aforementioned period (Table 3). This biased forecast can only be used as a reference, since it assumes that energy prices, energy conservation and substitution actions, and macroeconomic indicators will follow the same trends until 1995 as those recorded during the last decade. Thus total consumption is estimated at 11.2 million TOE for 1995.

Table 3: Biased Forecast of the Final Energy Balance, 1988-1995
(thousand TOE)

	1988	%	1995	%
Oil and Gas Products	5,635	54.0	5,925	52.9
Electricity	975	9.4	1,173	10.5
Fuelwood and Residues	3,378	32.7	3,668	32.7
Others (1)	340	3.3	437	3.9
Total	10,328	100.0	11,203	100.0

Source: Mission Estimate
(1) Includes coal, charcoal, bagasse and coke.

INSTITUTIONAL ASPECTS

1.11 The Ministry of Energy and Mines (MEM) was created in 1969. Mining activities, hydrocarbons, and electricity, regulated by the formulation of energy policies and plans elaborated by the Ministry, come under its jurisdiction. In addition, its duties include the regulation of state energy enterprises. In reality these companies play a decisive role in the preparation of such policies as they rely on a larger technical staff than the MEM.

1.12 In practice, the elaboration of energy policies and strategies has been relegated due to the more important and persistent issue of scarcity of resources, stemming from the reduction in prices and tariffs as a result of the rampant inflation being experienced by the country. The main concern of sector authorities and of those in charge of company management has been the continued negotiation of price and tariff adjustments with the Ministry of Economy and Finance, in order to ensure the operation of energy companies.

1.13 The National Energy Council (CONERG) provides advice to the minister in charge of formulating energy policies, financing and training in all energy subsectors. CONERG is composed of fifteen representatives from energy sector state companies and has a technical Secretariat divided into three sections which cover energy policy, conservation, and new and renewable energy sources.

1.14 CONERG's activities have been constrained by the economic crisis threatening the country; therefore, in practice, its role consists of providing information through the elaboration and publication of the country's annual Energy Balances.

1.15 PETROPERU, by law, is exclusively in charge of exploring and developing hydrocarbons. On the one hand, it does this directly and, on the other, through international oil companies by means of contracts to work as contractors or partners.

1.16 According to General Electricity Law No. 23406, the Electric Power Company System was created with ELECTROPERU as the central utility and a group of ten regional public power service delivery utilities providing coverage to the entire national territory. As a result of the country's regionalization policies, which began to be implemented in June 1988 with the enactment of the corresponding Base Law, the set-up of electric power group utilities was altered and ownership of the regional companies was partially or even totally transferred to regional governments, so that ELECTROPERU's status as the main governing power utility was modified. Its responsibilities were clarified through Legislative Decree No. 597 (1-5-1990). ELECTROPERU, besides being responsible for formulating master electrification plans and for approving regional investment and auto-generating projects, is responsible for the ownership and administration of the multiregional interconnected power systems and for the ownership and administration of regional systems for regional companies (distribution systems, isolated generation systems, and those power systems that have exclusively regional scope).

THE ECONOMIC-FINANCIAL CRISIS OF THE POWER SECTOR

Hydrocarbons

1.17 The current situation of PETROPERU could be described as a virtual financial standstill. Regarding operational management, inventories have fallen to dangerously low levels, and not even minimum expenditures on maintenance and spare parts have been made in the last few years, which has led to rising operating costs and declining production capacity. The fall in oil production (estimated at 16,700 barrels per day or 18% of total production capacity) has entailed larger import requirements and higher unit production and transport costs. With respect to financial management, PETROPERU is in arrears with its contractors and suppliers and with the transfer of payments for production and sales taxes.

1.18 PETROPERU's performance forecast for 1990 clearly displays its financial deterioration. Net losses forecast for this year amount to US$850 million, a figure US$255 million greater than the losses recorded in 1989. When reserve entries for compensation, depreciation, tangible exchange differences and amortizations, and intangible exchange differences (which refer to contingent liabilities) are excluded, net losses in 1989 amount to between US$320 and US$350 million. The same adjustment for 1990 reduces projected losses by US$200 million.

1.19 PETROPERU is currently receiving income from sales on the domestic market on the order of US$5.20 per barrel, whereas unit production costs for January-March 1990 are estimated at an average of US$19.6 per barrel. For this same period, total costs (excluding depreciation) were recorded at about US$17.70 per barrel. These figures provide evidence that

unit costs are not being covered, a situation that has been prevailing since 1986 and which obviously cannot continue. In contrast to international experiences, unit production costs have been increasing considerably since 1988. An explanation for this is the decline in crude oil production. It should be noted that oil operations are characterized by capital-intensive production, transport, and processing operations and relatively high fixed operating costs. In this industry, operating efficiency is achieved through high use of installed capacity and special focus on the operating costs for labor and the use of external services. Lower production capacity and lack of development of new reserves mean underutilization of capital and sector infrastructure and an increase in unit costs.

1.20 Lower earnings from sales on the domestic market, along with the erosion of net export earnings, have obliged PETROPERU to resort more frequently to financial support from the government, either directly (for example, through the payment of its liabilities to Occidental for contract payment arrears) or indirectly (for example, the loan relief granted to PETROPERU in 1987 for a seven-year grace period and exemption from royalty payments and export duties on its own production and purchases from Oxy-Bridas and Occidental).

1.21 The most important of these initiatives has been the PETROPERU Economic-Financial Recovery Program effective on December 31, 1988. This agreement provides PETROPERU with emergency working capital and entails relief on a large part of its foreign debt. The government assumes responsibility for payment of US$541.9 million, equivalent to 78% of total debt recorded at that time. It also includes a preliminary agreement for a long-term investment program for the development of the Camisea gas field, a rationalization program ("streamlining") of PETROPERU's operating divisions, and, more important, a program for the adjustment of domestic prices in line with PETROPERU's operating costs. The last three measures of the agreement were, for all practical purposes, ignored.

Electric power

1.22 In the case of PETROPERU and public service power utilities, the real drop in electricity tariffs stretched over a long period of time (since 1985), during which earnings were insufficient to cover operating costs. This has affected the efficiency of the utilities and has lead to a critical financial situation, characterized by the following:

(a) Earnings are scarcely sufficient to cover expenditures incurred for paying staff salaries and benefits.

(b) Fuel consumption has been reduced to a minimum, although this entails power supply outages for the users.

(c) Progressive cuts have been made in the system's maintenance costs in the last four years, despite an increase in terrorist activity. This has meant an effective

loss in capacity and a high percentage of system losses, aggravating the supply shortages.

(d) Lack of funds to carry out or complete crucial rehabilitation projects that would have an immediate positive impact on the system's efficiency.

(e) Service delivery and planning depend on negotiations with the government over tariffs and capital contributions, which have deteriorated the efficient management of a valuable and strategic sector for the economy.

1.23 The primary reason for the deterioration of financial performance, as in the case of the oil sector, is the decline in electricity tariffs. In real terms, electricity tariffs have fallen on average to 20% of their value in 1985; in terms of current dollars, the average reduction has gone from US$0.0423 per kWh in 1985 to US$0.0138 per kWh in 1988. In April 1990, the average unit tariff per kWh is estimated at US$0.031 per kWh.

1.24 ELECTROPERU's forecast for 1990 indicates net subsector losses amounting to US$211.4 million. The forecast is based on results adjusted for the first quarter with projected tariffs that increase at the same pace as inflation but remain at levels of US$0.031 per kWh. The projected operating costs for 1990 were US$0.049 per kWh, compared to US$0.04 per kWh recorded in 1989. The cost increases stem from personnel expenditures, which includes Compensation for Seniority. Labor costs are forecast at 62.7% of total operating costs for 1990. When these figures are adjusted for compensation, unit costs do not display a clear upward trend.

1.25 Beginning in 1986, electricity services have depended on capital contributions from the Public Treasury to finance operating deficits and capital investment. One modality to provide this kind of support has been debt service relief. The most significant initiative in this respect was the 1987 Economic-Financial Recovery Program for the Electric Power Subsector (DS 06J-87EF), a prerequisite for obtaining the IDB sector credit. The Recovery Plan included assuming the debt by refinancing arrears at December 1986 in the amount of US$472 million and the payment of US$1,360 million of debt from the 1987-1996 period. It also involved increases in electric power tariffs, the formulation of tariffs based on a marginal cost structure, and the establishment of financial income objectives for 1987-1990. In short, a comprehensive plan for the financial restructuring of the electric power subsector.

1.26 As in the case of the Oil Recovery Program, the government did not implement the complete program and continued with its policy of reduced tariffs. This has required increasingly larger contributions from the government to cover operating deficits. For example, in 1989, the government through DS 213-89-E assumed the short term debt in the amount of US$29.4 million, achieved a line of credit for US$20.4 million, and provided a capital contribution for US$53.1 million to ELECTROPERU. This has been increasingly important as a source of cash and at present accounts for 30% of total income.

FISCAL IMPACTS

1.27 In order to more clearly visualize the impact of pricing and tariff-setting policies for energy products pursued during the last few years, suffice it to observe that, in 1989, assuming the same public expenditure in real terms, there would have been no fiscal deficit if electric power tariffs and prices for oil products had remained at real 1985 levels. In other words, the additional income of energy sector companies and the State would have been on the order of 9.3% of GDP, while the fiscal deficit was equivalent to 9.0%.

1.28 In addition, if 1985 oil production volumes had remained constant, exports in 1989 would have been greater by some US$400 million, and net additional earnings for PETROPERU and the Treasury would therefore have been on the order of 1.5% of GDP, considering only the direct fiscal effect.

1.29 Finally, if hydropower stations under construction since the last decade had come on line according to schedule and if existing thermal plants had been maintained at acceptable levels, about 0.5% of GDP per year would have been saved.

1.30 In short, the fiscal impact of pricing and tariff-setting policies for 1989 was on the order of 9.3% of GDP, that is, equivalent to total public sector financial requirements for that year. These calculations do not take into account setbacks in the development of the Camisea gas deposits.

Fiscal Result	-9.0	
Public Treasury and Public Utilities (PETROPERU and ELECTROPERU)	+7.3	
Oil exports	+1.5	
Saving in electricity generation		+0.5
Total adjustments	+9.3	
Adjusted Fiscal Result	+0.3	

1.31 Fortunately, the pricing and tariff adjustments implemented in August 1990 and the reform and adjustment process initiated at the same time imply that the new government has taken the resolution of energy sector problems seriously (within the general context of macroeconomic stabilization and adjustment). If the energy tariffs and prices achieved in August 1990 are maintained in real terms, substantial fiscal earnings can be expected in the short run (in fact, they have already enabled a large part of the fiscal deficit to be covered and runaway

inflation to be curtailed), as well as a temporary solution to obtaining resources for sector companies. In the longer term, there will be substantial improvements in both efficiency of energy use and supply efficiency, especially if these pricing measures are supported by reforms that enhance competition in the sector.

II. PROBLEMS OF THE SECTOR AS A WHOLE

PRICING AND TARIFF-SETTING POLICY

2.1 The main issue, which has given rise to various other problems in the energy sector, is an unsustainable pricing and tariff-setting policy. There is a long story behind this situation, which we will not go into here. Suffice it to say that Peru made no adjustment for the first oil shock (of 1973) until three years later (by which time it was an oil importing country). Similarly, energy prices and tariffs have recently achieved a more reasonable level in 1985. Since then, Peru has become a net oil importer; regarding electricity supply, service quality and reliability, which were improving at least up until 1970-1980, have deteriorated to incredibly low levels (although terrorism should be added, at least in part, to the financial causes). In August 1990, the energy pricing and tariff-setting policy was radically altered. This new policy will have to be institutionalized so that it can become permanent.

2.2 In more specific terms, this is what has been occurring:

(a) Real prices of oil products have fallen from an index of 100 in 1985 to an average of 25 to 30 in the latter half of 1990 (that is, they are sold today at real prices that are only a third or a quarter of what they were in 1985). Likewise, PETROPERU recorded fiscal losses of US$600 million in 1989, and losses of US$800-900 million are forecast for 1990. Simultaneously, oil production has fallen from its maximum of 195,000 barrels per day in 1982 to 130,000 barrels per day in the last few months, that is January-June 1990, and proven reserves declined from some 800 million barrels in 1980 to about 300 million barrels today (that is, seven years of current production). Regarding the level of exploration investment, which reached its maximum in 1975 with almost US$400 million (with US$100 million from PETROPERU), it remained high between 1971 and 1975, then fell to zero in 1979, and rose to some US$135 million in the early eighties before dropping to almost nothing (US$40 million) in 1985-1989. After the increase in domestic prices and international prices in August 1990, it is probable that Peru will export again in the short term. Also during these years, the Peruvian economy's energy intensity has grown, overtaking the Latin American average (which is 0.39 TOE per US$1000 of GDP) by 20% (that is, 0.48 TOE per US$1000 of GDP). Similarly, the GDP-elasticity of Peru's energy consumption increased from 0.5 in the seventies to 0.8 in 1980-1985 and up to 1.5 in 1985-1988 (that is, for every 1% increase in GDP, the energy consumption increases 1.5%). All this means that energy is used inefficiently in Peru, because it is too cheap.

(b) In the electric power subsector, several recent well-done studies (funded by IDB, German Cooperation, and the World Bank, among others) indicate that the long-run marginal cost (LRMC) of electricity is between 7 and 8 US cents per kWh. In contrast with these figures, the average tariff has fallen approximately from 4.5-4.9 US cents in 1985 to less than 2 US cents since 1988 up till now (again bearing in mind the difficulties of calculating this in dollars). Predictably, income from energy sales fell from more than US$300 million in 1985 (1.5% of GDP) to US$140 million in 1988. Since 1986, the electric power subsector has had to rely on state subsidies (provided in several ways) to cover its operating costs. In comparison, as recently as 1984, ELECTROLIMA was believed to be able to cover its operating costs and to participate with 40% of its investment needs on the basis of its tariffs (and with firm financing from the World Bank). Finally, partly for financial reasons (the electric power companies do not have money to purchase fuel) and partly due to lack of safety, normal supply is impossible in Lima (Central-North Interconnected System - SICN) and in Piura and Talara (predominantly thermal systems). Thus, by combining the effects stemming from financial scarcity with insurrection and drought, Lima and the SICN suffer from load shedding, that is, a 20% electricity supply deficit (equivalent, in Lima, to more than 200 MW). This has produced an evident proliferation of small inefficient generators (more than 200 MW on small machines that range from a few kilowatts to several hundred kilowatts, or, in some cases, several MW).

(c) In addition to the catastrophic effects that these reckless pricing and tariff-setting policies have exerted on the normal development of sector companies (both electric power and oil), the effect on public finances has been disastrous. For example, in 1988 and 1989, the State had to carry out current transfers to the energy sector in the amount of US$700 to US$800 million and for 1990, this could be more than a US$1 billion (without counting the transfers for investment, which have been almost nonexistent in the last few years), if things continue as they are. Fortunately, the August 1990 adjustment makes it likely that the losses that have been predicted will not occur.

2.3 Another indication of the sector's financial problems, which have repercussions on public finances, is the 1978 **Energy Sector Recovery Program.** The proposal was that, since the sector companies could not at the time cover their operating costs and ensure their debt servicing, the State would start from scratch and assume responsibility for arrears payment and payments due in the following years. The State therefore assumed, on behalf of PETROPERU, debts and payments in the amount of US$542 million (on a total debt of US$692 million) and, on behalf of ELECTROPERU and its affiliated utilities, in the amount of US$1.832 billion. The idea was that the companies would cover all their costs (including their debt service) on the basis of a suitable pricing and tariff-setting policy. In fact this, did not occur, and currently the sector

theoretically owes the State US$2.474 billion over 20 years, free of interest (which still implies almost US$10 million per month, that is, almost equal to the electric power subsector's sales). At present, the State is not meeting these million-dollar payments (deferred and future); neither does it have the funds with which to make them. It is obvious then that these debts, which have been transferred to the State, should be covered by energy tariffs and prices. With the tariffs and prices established in August 1990, it is likely that all costs could be covered (although the part of the tariff that the power companies receive may be marginally insufficient). These prices and tariffs, clearly, should be maintained in real terms but, if possible, without making large adjustments until early 1991.

PROPOSALS FOR PRICES AND TARIFFS

2.4 The analysis presented in the following sections, where the current policies are evaluated and the effects of other levels of prices and tariffs are calculated, indicates the direction proposed by the present study. Its main ideas are geared toward adjusting the prices of energy products to ensure that they do not distort the allocation of resources and that sector companies do not go bankrupt (and that other economic agents can get involved in production and distribution, marketing, etc., of the whole range of energy products). Provisionally, the energy sector could also, through several types of transfers (once the financial costs are covered), contribute to the stabilization of the economy and to financing social costs that should be provided by the State but for which no resources are available. For these reasons, the main proposals for prices and tariffs are that electric power tariffs should be established according to long-run marginal costs (LRMC), whereas the prices of oil products should be established at between 150% and 200% of their financial costs, especially with a view to creating an incentive for energy conservation, to improve income distribution (since the richest consume the largest part of commercial electricity), to enable the recovery of energy supply costs and, to a greater extent, to contribute to the general development of Peruvian society. Increased oil prices would also contribute to channeling resources towards the development of new fields and would thus contribute to maintaining the country's export position or minimize the need for imported hydrocarbons, a certainty for the next five years, especially if no energy is saved and investment is not channeled into oil field exploration.

2.5 Electric power tariffs should be established approximately at LRMC, that is, 8 US cents (average), with some tax to the high residential consumers (while exonerating the smallest consumers, who are also the poorest, from this tax). Once tariffs are established at a correct level, the majority of taxes and/or other charges should be eliminated. In addition, once a sufficient tariff level is achieved, the current consumption structure should be rearranged, inasmuch as it currently does not reflect service costs by consumer categories (it subsidizes residential consumers and penalizes commercial and industrial consumers).

2.6 Regarding oil products, it is clear that current price levels and patterns (June/July 1990) are highly distorted and provide no incentives for the rational use of oil products. Thus,

in view of the small price difference between diesel and fuel oil, many consumers who would normally use fuel oil are using diesel (to the detriment of the domestic economy, since diesel is a much more costly energy source). The following table illustrates the absolute and relative price patterns of oil products, comparing current domestic prices to world prices.

2.7 The difficulty with current prices is not so much a matter of structure as the absolute level of difference between product prices. That is, fuel oil is fair at 60% of the price of diesel, since the ratio is more or less the same in the world market. Unfortunately, the absolute difference between these two fuels is only 6,000 intis (or 5 US cents), while in the world market the absolute difference between these two fuels is close to 35 US cents, preventing the consumers who should use fuel oil from using diesel.

LEVELS AND STRUCTURES OF OIL PRODUCT PRICES
(in US cents per US gallon)

	Current Domestic Prices (April 1990)		World Prices (mid 1990)		World Prices (end August 1990)
	Level (cents)	Stuct. %	Level (cents)	Struc. %	Level (cents)
Gasoline 84	19.55	156.2	96.7	157.0	105.8
Gasoline 95	37.27	297.7	105.1	170	110.8
Kerosene	16.36	130.7	88.9	144.3	107.7
Diesel 2	16.18	129.2	75.1	121.9	97.6
Fuel Oil	9.65	77.0	43.9	71.3	56.9
LPG	9.67	77.2	78.9	128.1	-
Average	12.52	100.0	61.6	100.0	-

Source: PETROPERU, PLATT'S and Study Group Calculations

2.8 In this table the imperfections of the current structure are emphasized: gasoline is too expensive (which is not a major problem but could produce an uneconomical dieselization) and LPG is too cheap.

2.9 These would be the only adjustments that should be implemented in the pricing structure of oil products, in addition to the obvious price adjustment.

2.10 To summarize, the pricing and tariff-setting proposal is as follows:

(a) Electric power tariffs: at LRMC, that is, an average of approximately 8 US cents, as the sale price to the public and a reduction in taxes and additional charges which are currently levied on electricity consumption. Nevertheless, a total revision of the tariffs structure, which at present does not reflect the different levels of cost of electricity supply to the different types of consumer at all, should go ahead.

(b) Oil product prices: setting the average price per gallon between US$1.00 and US$1.50 and the structure, close to international levels, would be the most logical.

IMPACT OF THE PROPOSED MEASURES

2.11 The pricing and tariff-setting policy recommended in previous sections of the study will exert an impact on the costs of other economic activities (more or less in proportion to the intensity of their energy use), on final consumption prices, on the finances of sector companies, and on public finances. To measure these various effects, several methodologies have been used, including mainly conventional financial analysis, analysis using macroeconomic models, and input-output models. Simulations and/or new studies were conducted, and the results obtained by other researchers (PETROPERU, MEM, universities, consultation firms) were used. The impact on different variables is described below.

Impacts on the costs of other economic activities and on prices (that is, inflation)

2.12 All the studies conducted and/or queried were unanimous in concluding that, except in some highly energy-intensive industries or in the case of huge increases, the impact of increases in energy tariffs and prices is minimal. For example, a calculation done for this study shows that an increase in fuel prices equivalent to twice the financial costs (twice the world price for oil products) and equivalent to the LRMC for electricity would lead to an average increase of 3.8% in industrial costs (that is, 2.4% as a result of fuels and 1.4% from electricity).

2.13 The most affected sectors, that is, those which use energy more intensively in their production processes are:

Industry	Percentage cost increase
Sugar	14.7%
Chemicals and fertilizers	10.2%
Non ferrous metals	10.4%
Water (pumping)	11.3%
Fishing, mining, fishmeal and oil,etc.	9% (approx.)

2.14 If increases were 150% for oil derivatives and 142% for electricity tariffs, the total impact on costs would be 5% (of which 1.8% for electricity).

Impact on prices of final consumption goods

2.15 Regarding the effect on final consumption prices (that is, the effect on the cost of goods in the final consumption basket in addition to the direct impact on the purchase of fuel and power), the impact of 100% increases (fuel and electricity) is estimated at 4.7% (of which 2.5% accounts for direct impact, either from price increases in energy bought directly by the final

consumer--families or households--and 2.2% accounts for indirect impact, that is, the cost increase for the energy input required to elaborate goods that enter into final consumption).

2.16 Moreover, a study carried out in PETROPERU in December 1989, using a slightly different methodology, confirms that the effects of an increase in energy tariffs and prices on general prices are minimal. In fact, this study1/ estimates that the impact of the fuel price increases of December 2, 1989 (a weighted average increase of 17.1%) was 0.68%, that is, 2% of the December 1989 inflation. In the same study, the impacts of the following were researched:

a) Price increases until the costs of PETROPERU are covered (about US$0.50 per gallon), and

b) Price increases until economic costs are achieved (that is, world market prices, FOB or CIF, depending on the case).

The results for the cases were:

a) An impact equivalent to 3.80% of the January 1990 inflation (that is, 1.13% in absolute terms), and

b) A price increase impact of 2% (that is, 6.7% of the January 1990 inflation).

The author of this study concludes:

2.17 "The most important effects of this controlled pricing policy are: (A) subsidized fuel prices with a high social cost, as an inefficient redistribution mechanism and therefore highly burdensome for the country and PETROPERU; (B) absolute distortion in the structure of relative prices since, by mid-December 1989, it was more expensive for families to drink "San Luis" table water (1700 intis per gallon) than LPG (1298 intis per gallon); (C) a setback in PETROPERU's business management and the country's hydrocarbons industry, diminishing the nation's development potential". And also "the low incidence of the (energy) item on the family budget clearly reflects considerable subsidies, which are especially aimed at LPG and kerosene, and because they do not discriminate usually benefit poor and rich families...". And

2.18 "Controlled fuel price adjustments do not explain the origin nor the evolution of inflation and, therefore, their curtailment or delay is not an adequate instrument to combat current hyperinflation; but it could make the crisis affecting the hydrocarbons industry irreversible.... It is unfair to attribute to fuels the inflationary effects generated by expectations, inasmuch as they

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1/ Tecnocopé Magazine, June/July 1990, article entitled "Impacto Inflacionario del Incremento de los Combustibles" by A. Hurtado Chiang, pp. 19-23.

stem from unapplied or poorly applied economic policy measures.... The best way to combat inflation is steady growth of domestic production. The hydrocarbons industry could become one of the major driving forces behind the national development that is being forecast for the start of the 21st century. In principle, this would require the involvement of domestic and foreign capital, above all in risk exploration investment, and, in the very short term, the application of prices that would enable a margin for productive investment." It is evident that the ESMAP/CONERG Study Group accepts and supports these conclusions.

Impact on the Residential Sector

2.19 (a) In many countries, average household energy spending (fuel and electricity) generally accounts for about 5% of total expenditures, although this figure is higher in the case of lower-income households and also in urban areas, where there is less possibility of using noncommercial fuels. In Peru, energy expenditure in 1985 accounted for only 2.2% of total household expenditure on a national level, with 0.9% for electricity and 1.3% for fuel (Annex 4, Table 15). In July 1990, it is possible that expenditure was even lower since energy prices had fallen by 400-500% although incomes had also fallen2/. Spending for services most affected by energy costs, such as public transportation and the use of private vehicles is not much higher (3.4% and 1.7%, respectively). In addition, for the poorest 30% of the population, energy spending is only 4.8% for the urban population and 2.9% on a national level. Finally, it has been observed that very poor rural population is not heavily affected by energy price fluctuations, mainly because their access to and consumption of commercial energy is lower. Likewise, goods and services with a high energy content do not play a large role in the budget of poor rural families, whose agricultural techniques are not very intensive in the use of commercial energy3/. The urban population belonging to the poorest 30% of total population, however, only accounted for 15% of total urban population in 1985.

(b) Assessment of the impact of pricing policy on different socioeconomic groups also has to take into account incomes, energy sources and equipment used, and the possibility of energy conservation or substitution, which either enhance or mitigate the effects of these policies. The rapid drop in real prices of LPG during

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2/ However, the major increase in energy prices in August 1990 along with the limited increase in earnings implies that energy expenditure has risen considerably in the budget of households that have not changed their eating habits.

3/ Assuming that critical poverty is not far from of 30% of the population, provides us with an idea of the number of families for which the impact of the energy price rise possibly has to be remedied (for example, with direct financial help).

the last three years led to a drop in average energy spending, which in 1988 was only 2% for lower-income households and 1.2% for the highest-income households; this trend has continued up until now (that is up until August 8, 1990). In Lima, most lower-income households use kerosene for food cooking, and their transition to LPG is very slow despite its current more favorable price. This is even more apparent in other large cities, where, like Lima, there is no economical fuel substitute for kerosene. The result is that the LPG subsidy, which is 50% greater than the kerosene subsidy, favors higher-income households, although a rapid penetration of LPG is observed among the middle class.

(c) In rural areas, kerosene is used almost exclusively for lighting, does not require very high spending nor does it have a more economical substitute, which forecasts a minimal reduction in its total consumption for this purpose. On the other hand, in the cities of the sierra, the rain forest, and some parts of the coast, with favorable conditions for obtaining fuelwood resources, a large increase in kerosene prices is likely to provoke a return to the use of fuelwood or charcoal for food cooking for a substantial share of the lower-income population of these cities.

(d) The informal sector, as well as the rest of the commercial sector, was affected by the poor quality of energy supply during the last two years (electric power outages and shortage of oil products) as a direct result of very low energy prices. The Freedom and Democracy Institute determined that, in 1984, 48% of Peru's work force had an informal activity and produced more than 30% of the country's GDP. In Lima, the two main types of activity that entail a high energy content are the sale of prepared food and refrigerated drinks (probably 2,000 to 3,000 stands) and informal transportation (which accounts for more than 90% of the public transportation motor vehicle fleet in Lima). An survey conducted in 1985 showed that, both in urban and rural environments, half of the households had at least one informal nonagricultural business. It should be noted that those household-based activities requiring electricity (manufacturing, refrigeration, etc.) benefit from the residential sector electricity tariff. In addition, informal business activities also benefit from subsidies granted to fuels for residential use.

Effect of an increase in energy prices and tariffs on company sector finances

2.20 Before examining the effect of the proposed tariff and price increases in this study, it may perhaps be interesting to see what would happen to the sector companies if the prices and tariffs were not increased. At current oil prices, that is, an average 12 US cents a gallon, PETROPERU would have to cope with an annual loss of almost US$800 million (about 40 US cents per gallon with a daily volume of 125,000 barrels, equivalent to 4% of GDP).

2.21 As for the electric power sector, if tariffs were not increased, total sales would remain at about US$160 million and losses, in rounded figures, at almost US$300 million, including more or less US$70 million for financial costs (equivalent to 1.5% GDP). With losses of this magnitude, the possibility that sector companies would come to a standstill because they would be unable to operate cannot be ruled out.

2.22 Finally, if these losses were covered by monetary emissions (at 120,000 intis per US$) it would generate 12 x 10^{13} intis, accounting for 5% of GDP or seven times the monetary emissions of May 1990 (1.7 x 10^{13} intis, according to the Central Reserve Bank). Using the June 1990 inflation rate of 50-60%, this issuance would be sufficient to maintain this pace of inflation for 17 months. This is much worse than the 3% or 4% that a drastic rise in energy tariffs and prices would add onto inflation, according to the indications shown in the preceding section.

PROPOSED INCREASES

2.23 It should be taken into account that, with a drastic increase in prices and tariffs, the consumer reaction may be quite substantial in the very short term and small in the short/medium term, but that this increase could exert considerable positive effects in the long term, mainly because it would reduce the energy intensity of production and consumption. Although not many indications are available on price elasticities, in 1976 when Peru raised its fuel prices to international levels, in less than a year, there was a 20% drop in consumption of oil products. Electricity consumption is probably less elastic, but with the percentage increases advocated in this study, there is no doubt that there will be some elasticity. Besides elasticity, there is at the moment a considerable amount of smuggling of oil products, mainly to Bolivia and Brazil. The quantity is not known but the boundary areas (Madre de Dios, Puno, etc.) are always out of supply because incentives to sell outside the country are irresistible (prices of US$1-1.25 per gallon). It is clear that, with higher prices, smuggling would disappear to Peru's benefit. Thus, one of the first effects of a domestic price increase might well be a recovery of this contraband oil, which could easily be on the order of 5,000 to 10,000 barrels per day in the very short term (equal to Chambira's production!, which will cost US$62 million and will take two or three years to enter into operation). This illustrates the overwhelming cost of mistaken economic policies for commodities like oil products.

2.24 Regarding PETROPERU's finances, the quantitative effects of a significant increase in consumer prices are shown in the following table. Assuming, for the time being, PETROPERU's stated current average cost (US$0.50 per gallon), a decision to increase fuel prices in the very short term to world levels (about US$0.62 per gallon), and sales of 100,000 barrels per day (a notable drop from current levels, which are 120,000 to 130,000 barrels per day), PETROPERU would generate earnings of about US$767 million and about US$386 million for the State (including the taxes currently levied and PETROPERU's surplus), that is, almost 2% of GDP. For each US cent decline on PETROPERU's costs, US$15.3 million would be saved. The main figures are seen in the following table:

OIL: FINANCIAL EFFECT CALCULATED FROM VARIOUS HYPOTHETICAL PRODUCT PRICES

Average Price (US$/g)	0.62 %GDP	1.00 %GDP	1.25 %GDP	1.50 %GDP
Sales Value (US$M)	1153 (5.8)	1533 (7.7)	1916 (9.6)	2300(11.5)
Tax (current system US$M, approx. 17%)	195	260	326	391
PETROPERU Total costs ($0.5/g,US$M)	767	767	767	767
Surplus(US$M)	191	506	823	1142
Surplus (taxes + surplus)	386	766	1149	1533
Exportable Surplus (by country)	45	45	45	45
Total	431 (2.2)	811 (4.1)	1194 (6.0)	1578 (7.9)

Notes:

- Calculations based on consumer sales of 100,000 B/D
- The exportable surplus is estimated at 20,000 barrels per day with a margin of US$6 per barrel, which would be appropriated by PETROPERU and the government, assuming a world price of US$16-18 per barrel.
- It is estimated that consumption of 100,000 B/D includes sales to large-scale mining. As sale prices to large-scale mining are higher, the last line, Total, is not strictly incremental.

2.25 The ESMAP/CONERG working group and IMF and IBRD missions made more detailed calculations of these items, for purely fiscal/stabilization purposes. Several circumstances, however, have made these figures obsolete:

(a) The sudden increase in world oil prices as a result of Iraq's occupation of Kuwait.

(b) The immediate and drastic fall in domestic consumption in Peru, from 130,000 barrels per day in early August to 60,000 barrels per day at the end of August and beginning of September.

2.26 Consequently, in the short term Peru will earn more from its exports and less from taxes on domestic consumption. It is also clear that domestic consumption will not remain at 60,000 barrels per day and that an estimated consumption of 100,000 barrels per day is still reasonable in the medium term. However, the increase in the world prices for crude oil will positively affect the prices paid to the oil contracting companies, mainly Occidental. This situation, will in turn result in increased production in the short term. The additional income, between September and December 1990 could reach US$90 million.

2.27 The electric power subsector's financial situation is also very poor, and the possibility of putting utility finances on a sound footing is far less promising. Nevertheless, the following table shows the current situation and two hypothetical cases (tariff at 4 US cents, that is, the status quo for 1985, and a tariff at a long-run marginal cost of 8 cents in round numbers).

ELECTRIC POWER SUBSECTOR: SITUATION AND FINANCIAL FORECASTS

	Current 1989 situation (tariff 1.24)	Tariff situation 4 c.	Tariff situation 8 c.	& %GDP
Sales (million US$)	162	310	617	3.1%
Costs				
With fin. expenses	448	448	448	
Surplus (deficit)				
With fin. expenses	(286)	(138)	169	0.9%
Without fin. expenses	(216)	(68)	239	1.2%

Note: Sales based on 1989 volume (about 7717 GWh). Costs: Without financial expenses: 4.9 cents; with financial expenses: 5.8 cents (approximate figures based on the IDB-funded LRMC study and study group estimates).

2.28 Nevertheless, the attempt to return to the status quo prevailing before 1985 is not going to solve the financial problem, since with current sales volume the financial year will end with losses (probably higher than those calculated in the table, since the table does not take into account a reduction in sales volume as a result of a rise in tariffs). On the other hand, economic recovery could increase demand, possibly at the beginning of 1992. In this table, the largest surplus is without financial expenses, since if these expenses cover payments to the "**Energy Sector Recovery Program**" they would already be viewed as transfers to the central government. It is apparent that a tariff-setting policy based on LRMC entails more benefits than the short-term

financial ones. This policy ensures that consumers are aware of the exact financial value of the energy they are using and so are able to make decisions without distortions. This tariff-setting policy would also help energy conservation, thus postponing the need to increase supply. This would provide more time to concretize those generating projects that have not yet been defined.

REGULATORY AND INSTITUTIONAL ISSUES

2.29 In the last few years, the quality of the sector's support from regulatory, financial, and fiscal authorities has deteriorated. The National Electric Power Tariff Commission is losing the little autonomy it previously had, and this has virtually prevented it from maintaining a reasonable tariff-setting policy (both the level and the structure). The complete absence of a regulatory authority has been felt in the hydrocarbons subsector: there is virtually no technical authority that could act as intermediary between the managerial level (PETROPERU) and the political level (MEM, Office of the President). Sector companies, both power and oil, with the loss of their self-financing capacity have lost all their autonomy even with respect to current operations. So that in addition to physical rehabilitation operations (which are described in the first chapter), the following would have to be seriously rethought, with a view to rationalizing as well as reducing (i) the State's role in the energy sector, (ii) the role of state enterprises in the power and hydrocarbons subsectors and (iii) how to increase private sector involvement in the supply of energy.

2.30 For the purposes of this study, the discussion on institutional and regulatory problems is presented in Chapter V. In order to come up with practical and applicable recommendations on how to share energy sector responsibilities between the State, public enterprises, and the private sector, ESMAP intends to continue deepening its cooperation and dialogue with the energy sector and company officials. In general, joint efforts would be made to improve the quality of regulatory institutions and orient them toward mechanisms that reward efficiency using incentives, thus enabling better management of sector companies, either public or private, and facilitating the reorganization of public companies and the integration of new, public, semi-public, and private companies into the energy sector.

2.31 This study had several objectives, including taking a look at intra-subsectoral problems (Chapters VII to X), after viewing sector problems as a whole (in this chapter), and because of this, the discussion of specific measures for the liberalization, privatization, and promotion of private sector involvement is limited. As mentioned above, ESMAP intends to do this in the next phase of this study.

III. INVESTMENT AND REHABILITATION NEEDS

3.1 For many years now neither public finances nor sector company finances have had any resources to tackle normal preventive maintenance, repairs, renovations, or new investments. Besides, with the end of access to foreign credit, turnkey projects also stopped. Likewise, stocks of spare parts and materials have almost disappeared from company stores. Stocks of finished products are well below their normal levels; for example, those of oil products are at less than 10 days consumption while their normal level is 20 days, to ensure that there is supply even when there is a breakdown in a refinery or deliveries by ship are delayed.

3.2 Sector officials are highly aware of the problem; despite this, however, there is almost no systematic information available on the need for funds to re-establish normal maintenance standards, repair what has been broken, and replace stocks of spare parts and materials which normal and necessary preventive maintenance programs rely upon.

3.3 In short, the following investments for rehabilitation and new priority projects are being proposed:

ELECTRICITY

3.4 In electricity, there are projects and ideas for projects in the amount of US$873 million, requiring an additional net financing of US$610 million (in other words, there are already US$263 million in financing). The main components of the overall program are shown in the following table.

	Financing (US$ million)		
Electricity Investments:	Required	Committed	Total
Supply increase in SICN	38.5	-	-
Rehabilitation (Hydro)	13.5	-	-
Rehabilitation (Thermal)	43.5	-	95.5
Rehabilitation & Expansion (transmission, distribution substations, etc.)	404.8	211.0	615.8
Rural Electrification, distribution, provinces	90.0	52.0	142.0
Loss Reduction (SICN)	20.0		20.0
SUBTOTAL	610.3	263.0	873.3
200 MW Gas Turbines for the SICN-Lima	n.a.	n.a.	100.0

Source: ELECTROPERU; ELECTROLIMA; study group estimates.

3.5 A more detailed study on investment needs, conducted as part of the World Bank's multisectoral mission (October/November 1990), reveals that US$328 million would be required for emergency investments between 1991 and 1993 (which essentially include rehabilitation and some small capacity increases, above all to improve supply reliability of the National Interconnected System). In addition, two other lower-priority, albeit important and profitable, investment programs were identified, for US$406 million and US$734 million, respectively.

3.6 Thus, the investment requirements over the next three years (1991-1993), assuming there were no financial constraints, could amount to US$1.468 billion (this would include all the projects listed in the preceding table).

3.7 An important consideration for electric power planning and for decision-making on the most immediate-term investments is uncertainty over the Camisea gas field development. The discovery and eventual development of the Camisea gas fields are a real alternative to the purely hydropower guidelines of the SICN expansion program. It seems clear that generation expansion based on natural gas is much cheaper than hydropower. There are at present major uncertainties about the time that this natural gas will be viewed as available for generation. Likewise, it is apparent that, by the end of 1991, there will be more information on the eventual availability of natural gas. In the very short term, the only urgent investments are some gas turbines for the SICN (especially Lima) which would be required anyway (that is, with or without gas). For obvious economic reasons, these turbines should burn fuel oil (since the opportunity cost of diesel is the CIF price while fuel oil is estimated at its least price plus FOB).

3.8 In order to avoid risks, it is suggested that any decision on the next hydropower station should be delayed for another couple of years or until more is known about the Camisea gas situation. If prospects of having gas, for example, in 1997 or 1998 are not very good, it is then likely that the hydropower alternatives should be considered or, perhaps, other thermal solutions.

Lima-Callao Urban Area

3.9 Lima suffers from a large deficit and will be the first to suffer from an energy shortage, once the economy begins to stabilize, and therefore calls for greater attention. In the very short term, it is urgent that repairs be made to the Santa Rosa thermal power station (US$0.5 million) to increase its maximum firm capacity by 25 MW (from 75 MW to 100 MW) in five months and that the rehabilitation of Moyopampa be implemented (US$2.5 million), enabling the recovery of 6 MW in about one year. Obviously, starting the Santa Rosa turboelectric power station (which is not operating at present because ELECTROLIMA does not have the funds to purchase fuel) when electricity tariffs increase would help to increase the capacity available in Lima. Another idea that should be mentioned would be to replace 150,000 public street lights with other much more efficient sodium vapor lights. This would cost some

US$20 million and (within a few weeks) could achieve savings of 19-20 MW (that is, about US$1000 per kW). Since the consumer pays for public lighting, this measure, besides saving capacity, would lead to financial savings for the consumer.

HYDROCARBONS

3.10 As for hydrocarbons, the urgent rehabilitation and new project needs are summarized in the following table. **The priorities are clear:** First, it is essential to start a general rehabilitation process in the refineries (or better said, undertake the maintenance and/or repairs that should have been done in the last four-five years) and wharves, and to launch projects to recover production in the oil fields already being developed. Finally, new projects should be considered. Rehabilitation investments in the north and northeast rain forest could add 1,500 barrels per day to current oil production, almost US$10 million per year, at current crude oil prices (US$18 per barrel in July 1990). Chambira, however, could increase production by 5,000 barrels per day in the very short term (or in two years) and by 21,600 barrels per day in three years (a peak of 25,000 barrels per day would be achieved toward 1994 and a decline in production thereinafter).

3.11 A project for the rehabilitation of associated gas production in the northeast and continental shelf has been prepared by PETROPERU. However, investments of US$30 million seem high, bearing in mind the condition of PETROMAR installations, the decline in oil production, and the growing reinjection requirements. The most profitable aspects of the project should be focused on (for example, repair of compressors) and granted priority. The project could produce in the medium term some 6 million cubic feet per day of dry gas and 1,500 barrels per day of liquids. It should be noted that the increases in production mentioned as direct effects of the projects are not equivalent to net increases of total production since ongoing fields will continue current declining trends. In general, if all the aforementioned investments were implemented, total oil production could reach a peak of about 150,000 barrels per day towards 1992-1993 (starting from the current 130,000 thousand barrels per day) and then drop again immediately thereafter. Durable increases in production can only be based on the development of new discoveries.

Hydrocarbons: Rehabilitation Requirements and New Projects
(US$ million)

Priority Investments		1991-1994
Rehabilitation of production projects (upstream)		148.0
Refinery and Wharf Rehabilitation		47.0
Subtotal		195.0
New and ongoing projects (small) (including north and central rain forest, etc.)		206.6
New large projects		
Camisea	965.0	
Aguaytia	53.4	
Financed by the private sector	1018.4	
Total public investment in hydrocarbons		401.6

3.12 PETROPERU is not paying its suppliers or its contractors. An injection of funds for new acquisitions could provide it with the flexibility to negotiate an arrangement for its overdue payments (rescheduling).

3.13 With respect to refineries, for the moment no expansion seems necessary. Maintenance, small repairs, and substitution of small machines and/or equipment should be undertaken. The demand for products is sluggish because of the economic recession and will decline even more with the increase in prices (which will also discourage smuggling, which in turn will enhance the downward trend of demand).

3.14 Before making any kind of substantial investment in refining, a new exploration campaign should be launched aimed at determining how much oil there might be and its condition. For this very reason (and for other technical ones--see the section on "downstream" oil below), it is recommended that the catalytic cracking project not be implemented (either in Talara or La Pampilla). It would be advisable to wait before making any decision, so as to avoid unnecessary risks. This wait would not entail a higher cost, because in the next two-three years there will be excess capacity in refining activity. Likewise, just as there will be small exportable

surpluses, the limited volume of oil products that could eventually be needed could be imported without any major difficulty.

Oil Exploration and Development

3.15 A reasonable objective, that of achieving about 1 billion barrels of proven oil reserves in the next five-seven years (excluding the current reserves of 300 million barrels and those of Camisea), would require an investment on the order of US$1.5 billion in exploration and perhaps the same amount for development. It is recommended that PETROPERU (PP) virtually not get involved in exploration due to the high risks (except for certain cases in well-known areas and where risk is lower), that it take advantage of its purchasing prerogatives, for example, 20% of development fields identified by international oil companies (IOC), and that it reimburse the IOC for their share of exploration costs. On this basis, PETROPERU's financial requirements for exploration and development in the next six-eight years would amount to between US$400 million and US$500 million (that is, US$150 million for the reimbursement of exploration costs and US$250-300 million for its 20% share in development investment).

CAMISEA GAS

3.16 As a result of the exploration campaign started in 1981, in the southeast Peruvian rain forest, Shell Company discovered important hydrocarbons reserves on the borders of the Camisea River. Estimates of proven and probable reserves in these two structures amount to 10.8 x 10^{12} cubic feet of natural gas and 725 million barrels of natural gas liquids (NGL), equivalent to more than 2.5 billion barrels of oil. If timely decisions are made, the Camisea project should generate, in four or five years, gas and condensates equivalent to 80,000 barrels of oil per day, a considerable volume of energy, which will gradually increase as new domestic and export markets open up for these resources. This report recommends that the project be implemented using private investments since the State does not have, nor can it obtain in the short term, the immense resources that would be required.

The Project

3.17 According to its current definition, the project includes the construction of pipelines towards the coast, through the Andes mountain range, towards the south and to Cusco, for the large-scale transport of gas and condensates. The initial investment is estimated at US$1.485 billion (1989). The project has been reviewed by national and foreign specialists, and they agree that it is feasible and should be developed as soon as possible.

3.18 The gas deposits will be developed through the recycling system of gross gas production, after separating the liquid fractions that the gas contains, to obtain two products: dry gas and natural gas liquids.

3.19 The gas would first be used as a fuel for industry located in the central area and to generate electric power, thus resolving in this very economical fashion the shortage of generating capacity, until the beginning of the next decade. Second, the gas could have applications in decentralized industries like petrochemicals, fertilizer manufacture, and spongy iron production, if these activities turn out to be economical after being thoroughly studied.

3.20 The liquids will be fractionated in a 60,000-barrels-per-day capacity unit close to Lima, and LPG and condensates (gasoline, naphtha, kerosene) will be produced. These products, along with the substitution of fuel oil by gas, will generate exportable surpluses.

3.21 For supply of the southern region another fractionating unit of 7500 barrels per day should be installed, in Cusco, close to the southern railway network. If this were economical, it would enable PETROPERU to save the high cost of freight to transport fuel to this region. Once these first investments are implemented, the utilization of gas and its condensates could continue to be developed, through pipelines and additional fractionating units.

Financial Analysis

3.22 A financial assessment of the project yields rates of return, in terms of constant dollars, which fluctuate between 16% and 29%, assuming that, during the project's lifetime, oil prices will vary between US$15 and US$25 per barrel on the world market. Sensitivity studies show that the project yields more than 15% in constant values, even when income is reduced or investment is increased by 20-30%. Elimination of the two pipelines towards the south of Camisea and the branches on the coast (project's planned extension) reduces the initial investment, but does not substantially improve the estimated return. On the other hand, by delaying earnings one year (which may happen if market penetration estimates are optimistic), the internal rate of return would drop by about 20% (that is, from 22.76 to 18.86). These calculations show that the project is technically feasible and promises a potentially high return.

3.23 Implementation of the project requires undertaking some prior work:

(a) An assessment program of the structures that have been discovered, in order to establish the optimum development strategy.

(b) An environmental impact study, including proposals for the development of the native communities who inhabit the area.

(c) A study on the development of the Cusco-Quillabamba-Camisea road network in order to establish the most suitable logistics.

(d) A plan to substantially increase the use of LPG on the domestic and industrial markets.

(e) To determine up to what point lack of security could be a real threat to implementation of the project and see what solutions could be reached.

3.24 From the point of view of financing, the August 8 changes in domestic market energy prices aimed at making them compatible with the economic costs of energy are essential. For example, the gas produced in Camisea, transported and distributed in the industrial area of Lima, would cost less than US$2 per million BTU. At the domestic prices of fuel oil or diesel prior to August (at US$5 per barrel), that is, less than US$1 per million BTU, substitution on the industrial market would be impossible. However, compared to the opportunity cost equivalent to exporting these fuels, that is, more than US$14 per barrel (more than US$2.35 per million BTU), Camisea gas would generate significant profits.

3.25 The experience gained in negotiating with Shell should not be lost. Along with the above-mentioned activities and pricing adjustment, it is important for Peru to reestablish relations with those contracting companies capable of being interested in a project of this size, particularly Shell and international financial institutions. As for any important project, Camisea requires bank financing (in addition to its own capital) to spread the investment risk. It is therefore essential that management of the foreign debt problem and reinsertion of the country into the international financial community be positive, as soon as possible.

IV. ENERGY CONSERVATION AND SUBSTITUTION

SITUATION

4.1 In view of the deficiencies and inefficiencies as well as the increased marginal costs of energy production and distribution in Peru, along with the scarcity of resources for investment in energy supply, energy conservation actions have to play an important role in the sector because they generally promote measures that are:

(a) Low cost, compared to the equivalent increase in energy supply.

(b) Financially very profitable.

(c) Rapidly implemented.

4.2 In addition, these measures contribute directly and indirectly to improve the operating efficiency of the main economic sectors, supporting overall structural adjustment. Moreover, the attempt to facilitate and foster substitution possibilities between energy sources helps to minimize energy costs in the economy since it promotes the most economical energy source for a determined use.

4.3 Facilitating users' access to energy conservation or substitution measures enabling them to reduce their energy costs is also a very efficient tool to partly offset the effects of price adjustments. Energy conservation and substitution problems and prospects *in terms of the user only* will be assessed below1/.

ENERGY CONSERVATION

CENERGIA

4.4 The Energy Conservation Center (Centro de Conservación de Energía - CENERGIA) was created in 1985 as a nonprofit institution to implement a rational use of energy program. The CENERGIA program may be qualified as successful and advanced, compared to similar programs in Latin America. The institution's strength lies in a combination of three factors:

1/ *The aspects of improving efficiency and rehabilitating production, transportation and energy distribution installations are shown in chapter III.*

(a) The active participation of private sector entities and the largest energy sector companies.

(b) The broad availability of financial and human resources.

(c) Political autonomy.

4.5 With a team of about 30 professionals and a large amount of metering equipment and instruments, CENERGIA conducts a wide range of activities but focuses mainly on two:

(a) Performing energy audits in the major industries and companies in the mining-metallurgical sector.

(b) Starting training, promotional, and information actions.

4.6 CENERGIA obtained UNDP financial support for three successive two-year periods (in the amount of US$452,000 for the last two-year period 1989-1990) and also from the CEC (in the amount of almost US$1 million for 1989-1990)2/. It has also relied on contributions from its four main partners (PETROPERU, ELECTROPERU, COFIDE, Banco Industrial) and managed to cover 16% of its operating budget in 1989 using earnings (US$33,000) for its energy auditing services. Several framework agreements were signed, particularly with the mining-metallurgical industry.

4.7 CENERGIA also prepared a draft bill of the **Law for the Rational Use and Substitution of Energy**, aimed at establishing responsibilities and obligations for companies, in particular energy audits for the largest companies, instructive labelling for energy machinery and installations, and review (by CENERGIA) of projects that involve large increases in company consumption.

4.8 Thus, CENERGIA has managed to identify and quantify the most interesting savings potential (a period of return on investments of less than two years); it has also gradually raised the awareness of technical experts and managers of companies, has gained credibility in the area of energy savings, and has been developing a market for audits (Table 1). Nevertheless, only a part of the recommended measures have been implemented, according to a recent evaluation of the 26 audits conducted between 1986 and 1989 confirms: 9% of the total consumption of these companies was effectively saved (equivalent to 23,000 TOE per year), compared with a total potential saving of 26%. In view of this situation, in 1990 CENERGIA

2/ *This financing was obtained after a joint project with PETROPERU, CENERGIA and the World Bank was postponed.*

supported the creation of the Andean Fund for Energy Conservation (Fondo Andino para Conservación de Energía - FACE), made up of contributions from the CEC and CAF (US$1.8 million and US$0.75 million, respectively), to finance with nonreimbursable funds up to 25% of investment projects in energy conservation measures in Andean countries; in Peru, COFIDE will finance 75% of the remainder with soft loans.

Table 1: Energy Savings Potential Implementation 1991-1994

	1988 Energy Consumption					Potential Saving			
			Electricity				Electricity		
SECTOR	bbl (1) kTOE	%	GWh	%	(2)	Fuels kTOE	Elect. (2) %	GWh	Total kTOE
PRODUCTION	1,821	31	7,070	62	27	500	10	707	561
Industrial	964	16	4,419	39	12	295			295
Mining-metal.	370	6	2,419	21	6	75			75
Agro	229	4	209	2	13	70			70
Fishing	258	4	23	0	11	60			60
TRANSPORT	2,670	45	0	0	12	320			320
RESIDENTIAL/ COMMERCIAL & SERVICES	1,426	24	4,267	38	9	130	8	341	159
TOTAL	5,854	100	11,337	100	16	950	9	1,048	1,040

Source: CENERGIA

(1) Oil, gas, coal and bagasse products
(2) In % consumption in 1988
(3) Potential saving with measures without cost or with a period of return of less than 3 years
Does not include technology improvements, process changes and high cost equipment.

ITINTEC

4.9 The Institute of Industrial Technological Research and Technical Standards (Instituto de Investigación Tecnológica Industrial y de Normas Técnicas - ITINTEC), created in 1970 and partner of CENERGIA, is in charge, among other duties, of elaborating and proposing technical standards for national products (recommended or obligatory) and granting quality seals3/. There are very few standards for the main energy equipment manufactured in Peru (kitchen stoves, refrigerators, washing machines, televisions), except for LPG cylinders and

3/ *ITINTEC does not have product and equipment testing stores, for which it resorts to other research centers.*

valves, batteries, incandescent lamps (which are the only products that entail obligatory standards), and fluorescent tubes4/.

4.10 The ITINTEC budget comes mainly from the 2% levied on the profits of industrial companies that do not have a technological development project and, to a lesser extent, from earnings for services provided.

Constraints and Hindrances for the Conservation Program

4.11 Several obstacles have slowed the energy conservation program implemented by CENERGIA and limited its possible impact on final energy consumption. The most significant constraints are listed below:

(a) Basically, the low prices of all energy products and the distortions of relative prices. The first does not foster the efficient use of energy, and the second provokes the uneconomical substitution of selected energy products (for example, the use of household kerosene in other sectors); this situation aggravates the other obstacles to energy conservation.

(b) Managerial and consumer priorities and motivations. Energy is generally not a major concern in the decision-making process of economic agents, whose investment priorities focus more on increasing market share, improving productivity, replacing equipment, increasing working capital, as well as speculative considerations.

(c) The generally low impact of energy expenditure on production costs, especially in the case of companies whose profits are: (i) high compared to the value of forecast energy savings; and (ii) fixed or assured in the case of a protected market (limited budgetary pressure).

(d) Lack of knowledge or understanding by managers or users of the practices or processes that lead to the inefficient use of energy, as well as the options and profitability of conservation actions.

(e) The deficiencies of the regulatory and standard-setting framework: for example, efficient definition and application of standards and information for the user.

4/ *The Ministry of Industry, an entity that should have better coordination with ITINTEC, is in charge of verifying the fulfillment of standards and approving industrial products.*

(f) The lack of innovative facilities to finance conservation measures to compensate for, in particular, the current lack of acquaintance, on the part of the domestic banking sector, with the importance and benefits of energy-saving measures (third-party financing, revolving funds, etc.)

(g) The current limited capacity for providing advisory and promotional services. CENERGIA, for example, can only conduct 12 audits per year, although it has been estimated that there are about 150 auditable companies.

Production sector

4.12 The energy consumption of the production sector is concentrated in a relatively small number of companies, especially in the case of the mining-metallurgical subsector, thus facilitating the application of energy conservation measures. Therefore, 170 companies account for slightly more than 70% of total consumption of the production sector, and the six largest mining-metallurgical companies account for more than 80% of total subsector consumption. In addition, for several subsectors, energy has a substantial impact on direct production costs (mainly mining-metallurgical, iron and steel, cement, bricks, paper, glass, chemicals). There is a great deal of variation in the figures that assess the impact of energy on production costs due to the absence of analytical accounting in many companies.

4.13 Moreover, there are only a few companies that have an energy conservation program; among them, however, there is the Southern Peru Copper Corporation (SPCC, a private company that accounts for about 50% of mining-metallurgical sector consumption) and CENTROMIN. Within the current context of the economic crisis, it is more complicated to launch these types of programs. The following are the main obstacles:

- Aging of the production infrastructure.
- Inertia of state enterprises (which are the largest consumers, excluding SPCC).
- Frequent arrears of state-owned enterprises in paying their energy bills.
- Auto-generation of electricity by some companies in the mining-metallurgical sector, which neither facilitates nor justifies electric power savings.

4.14 Since 1987, CENERGIA has performed about 30 audits in the following branches of the industrial sector: fishing (PESCAPERU), milk products, glass, textile manufacture, sugar/paper (PARAMONGA), metal products, etc.; and also four audits in the mining-metallurgical sector (CENTROMIN and three of the four MINEROPERU companies). The results of these audits indicate the following levels of savings attainable, depending on the industrial process involved: operating improvements (20-40%); networks and steam consumption (15-40%); combustion processes (15-30%); process improvements (5-50%); steam generation (15-20%); electric power (5-15%).

Transportation sector

4.15 This sector, which accounts for a substantial share of final energy consumption (almost 40%, of which 30% is for land transportation in the Lima-Callao area) and in which energy spending accounts for a large part of total expenditures (16 to 28% according to CENERGIA audits), offers a theoretically high potential for fuel savings due to its low energy efficiency, which stems from the following factors:

- age of the motor vehicle fleet,
- inefficient motor vehicle management,
- lack of maintenance,
- lack of technical training.

4.16 Besides the problem of the large number of entrepreneurs, there are structural obstacles that are difficult to eliminate and that restrict the scope of energy conservation measures, such as:

- lack of capital,
- low motivation of state enterprises (monopolies requiring minimal business and technical efforts),
- instability of the private sector (more than 90% of the fleet),
- type of service and routes (frequent stops and overloaded vehicles),
- poor condition of the road infrastructure, except in Lima and on the coast.

4.17 CENERGIA audits have determined that, with only one driver training and motor vehicle maintenance and monitoring program, a saving of up to 20% on the consumption of public transport companies participating in the program could be achieved. Apart from the necessary adjustment of fuel prices (a key element for obtaining the efficient use of light vehicles), several other measures would exert a considerable impact on total sector consumption:

- efficient renewal of the motor vehicle fleet with more economical vehicles;
- rationalization of routes and modalities for public transportation;
- improved maintenance of road infrastructure;
- eventual reestablishment of regular vehicle inspections.

Residential/Commercial/Public sector

4.18 In the residential sector and, to a lesser extent, in the commercial sector, the users are numerous, dispersed, with low energy consumptions and a wide variety of rationales.

Therefore, the price adjustment policy is the most efficient instrument to make these consumers reduce their consumption. In addition, awareness-raising and information campaigns will be necessary, but even so only a small percentage of these consumers will really be receptive to an energy conservation policy. In the public sector, however, despite the inertia of bureaucracies and the frequent existence of problems that have greater priority than energy saving (for example, in hospitals), there is a considerable potential for reducing the consumption of fuels (boilers) and electricity (lighting).

4.19 In the metropolitan area, CENERGIA has conducted 10 detailed audits in the commercial and public sector (hotels, hospitals, and buildings), as well as pre-assessments using surveys in 546 households, 116 businesses, and 76 government entities. These studies determined a potential saving in the Lima/Callao area of about 8% for electricity consumption (mainly in lighting and water heaters) and 5% for fuel consumption (mainly in boilers), as well as a 5% reduction in electricity demand during peak hours. The measures recommended by CENERGIA include:

- shift from incandescent lamps to fluorescent tubes or fluocompact lamps,
- rational use of hot water,
- improved use of household appliances (refrigerators, kitchen stoves),
- lighting control in buildings, etc.

4.20 A study on electric power load shedding conducted in Lima in 1988 for ELECTROLIMA showed that the control of water heaters in households would be a very effective measure. A potential 40,000 households were identified where water heaters could be equipped with a remote-control turn-off system during the daily 4-hour peak demand period, including the option for the user to switch the heater on at a higher tariff (unit cost per house at US$120 in 1986). The total investment required by ELECTROLIMA was estimated at US$5.5 million, to save 18 MW of demand during peak hours (with a gradual implementation over eight years), with a negligible reduction in consumption. Implementation of the program would nevertheless require a prior user awareness-raising campaign5/. It was also estimated that, in the metropolitan area, the replacement of street lamps (about 150,000) by sodium vapor lamps would save about 20 MW for an investment on the order of US$20 million.

4.21 The improvement in energy efficiency of inefficient and most widely used household appliances (kitchen stoves, refrigerators, water heaters, lamps, etc.) is another possible action; a series of equipment tests would be needed to determine consumption. Efficiency standards also need to be defined and applied, with quality seals indicating consumption of the equipment. Imports should be limited to more efficient equipment. Finally, the design and

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5/ *A request for financing has been presented to the IDB for the overall load reduction program (US$20 million for a total reduction of about 100 MW)*

application of architectural standards and energy installations for large buildings also offers interesting potential savings.

ENERGY SUBSTITUTION

4.22 The economic rationale behind energy substitution is the search for minimum cost and, therefore, there should be no distortion among prices. Also businessmen and users need to be informed and advised, bearing in mind their priorities and preferences. The main problem is often the cost of replacing equipment, due to the lack of capital, and frequent customs duty distortions.

Residential sector

Situation and consumption trends

4.23 For cooking food (which is one of the activities that consumes the most energy in the residential sector and offers scope for substitution), kerosene is the prevailing fuel. In urban areas (especially in the metropolitan area), however, a rapid substitution for LPG is taking place, while in rural areas fuelwood and residues are almost the only fuels used (Annex 4, Table 1 and charts).

4.24 In Lima, the progress made by LPG is notable: from 34% of households in 1986 to 48% in 1989 (part of them also using kerosene and being part of the transition group), while kerosene fell from 57% to 45% during the same period, electricity being limited to the highest-income households (frequently combined with LPG due to electric power supply problems). In other cities, kerosene has displaced fuelwood and coal (in about 75% of households), but LPG has not managed to penetrate due to a lack of distribution channels, except on the coast.

4.25 In rural areas, fuelwood and residues are and will continue to be, almost exclusively, the cooking fuels, whereas kerosene is used mainly for lighting.

Comparative cooking costs

4.26 A comparison of useful energy costs helps to explain the trends observed (Annex 4, Tables 2 and 3). In terms of useful energy in Lima, the prices of LPG and kerosene (US$2 and US$3.4 per useful GJ, respectively) are clearly lower than the prices of electricity and coal (US$7.9 and US$8.3 per useful GJ), and much lower than the prices of fuelwood and charcoal (US$20 and US$22 per useful GJ), the use of the latter being limited to very specific applications (restaurants and barbecues). In terms of financial costs of cooking (including the cost of equipment), a fairly similar pattern is observed, and the impact of equipment cost is noted in the total cost, urging consumers to increase replacement time and contributing to energy inefficiency which is added to the inefficiency produced by low prices.

4.27 Regarding economic costs, LPG and kerosene are at the same level (US$19.3 per useful GJ), that is, nearly 20% more than the approximate cost of cooking with coal briquettes (US$15.3 per useful GJ), which, bearing in mind the drawbacks of the latter fuel, strongly limits its marketing potential in Lima even in low-income households.

4.28 In the cities of the sierra, kerosene replaced fuelwood despite its higher cost (US$3.4 per useful GJ in contrast to US$1.8 per useful GJ for fuelwood). The cost of LPG is almost twice that of kerosene due to high transport costs (Annex 4, charts). If prices of modern fuels increase to their economic costs, kerosene would become eight times more expensive than fuelwood (US$14.7 per useful GJ), which will foster a return to the use of fuelwood and coal in the lower-income households, with a consequently greater pressure on the forest resource bordering these cities. This trend can be halted by progressively increasing taxes on the transport of fuelwood fuel to lessen the difference in prices between kerosene and fuelwood.

Substitution

4.29 Substitution trends in the residential sector must cope with the problem of initial investment (in the case of cooking, which is the most important final use, the initial investment is 1.5-2 times higher for LPG than for kerosene, depending on the equipment used). The consumer intuitively applies a discount rate that reflects his access to capital. Besides, comparison in terms of cost per useful energy is only indicative, since the efficiency of cooking equipment used is not accurately known and does not include subjective aspects such as consumer preferences and motivations. Finally, the quantity of useful energy utilized is assumed to be constant for all equipment, regardless of changes in cooking techniques and culinary habits when the energy source is changed.

4.30 It is forecast, however, that LPG will be the prevailing fuel in urban areas of the coast in the medium term and possibly also in the sierra if demand and authorized distribution margins become sufficient for the private sector to develop a distribution infrastructure in the sierra, including the construction of bottling centers. In fact, with the development of the Camisea project, about 650,000 tons of LPG will be available every year starting with the latter half of nineties. Thus, the economic cost of LPG (part of which will be exported) will fall to its FOB price, which was on the order of US$11-12 per barrel in July 1990. Assuming a penetration of 70% in the metropolitan area and 30% in other urban areas, demand for LPG in the residential sector is estimated at 300,000 tons for the year 2000 (with an estimated consumption of 160 kg per household per year).

4.31 With increased kerosene prices, there are good prospects for developing a market for coal briquettes in the main cities on the northern coast. In fact, due to high transport costs, the cost of briquettes to supply these cities is estimated to be 30% less than the cost for the metropolitan area. In these cities, the economic cost of cooking with coal (US$10.7 per useful GJ) would be almost half the cost of cooking with kerosene (US$19.4 per useful GJ), which is

theoretically sufficient for a substantial share of low-income households to shift to using coal. The design of efficient, safe, and cheap kitchen stoves is one of the preconditions for successfully developing this market. Regarding this, the lessons learned from the experiences of CENTROMIN (in La Oroya) and PROCARBON should be incorporated.

Kerosene and LPG distribution systems

4.32 Distribution systems for kerosene and especially for LPG entail a series of major problems. The LPG market is already rapidly expanding (10% per year since 1986) due to its low price, nevertheless leading to serious financial difficulties for the distribution companies, in addition to the losses of PETROPERU. In terms of market size (160,000 tons in 1988, 85% of which in 24-pound cylinders for the household sector), there is a relatively large number of distributors (31, but two accounting for 63% of the market). Insufficient distribution margins in July 1990 (Annex 4, Tables 10a, b, and c) impeded expansion, replacement of transport means, and the purchase of new cylinders.

4.33 The distributors are remaining mostly in Lima but keep going because of the prospect of the Camisea development and indirect help from PETROPERU (in the case of SOLGAS). Fraud is widespread in many phases of the distribution chain (cylinders with less gas than the quantity sold, use of colors from other brands). Marketing possibilities for small cylinders of 6 and 12 pounds (more accessible for low-income households due to lower equipment cost and lesser amount of money needed for each refill) seem very limited: consumers want kitchen ranges with two burners, which are difficult to adapt to small cylinders, and the distribution cost for small cylinders is greater than the cost of distributing the 24-pound cylinders.

4.34 The conditions of some bottling centers are distressing: for example, the SOLGAS plant in Lima is obsolete, inefficient, and dangerous, and should be moved. The poor quality of valves and pipes in cooking appliances enhances the risk of accidents, in addition to deteriorated cylinders, and standards need to be strengthened. Finally, there is a plethora of institutions in charge of the sector: an entity to control all the components of the distribution chain and to provide the user with information is needed.

4.35 As for kerosene, the margins granted by PETROPERU at authorized sale outlets were insufficient in July 1990. Nevertheless, margins for unauthorized distributors are probably higher (absence of competition in a small market), but impossible to control, with the consequent impact on consumer prices in rural areas. Finally, the constant increase in kerosene sales since 1986 (following a period of sluggishness since 1983), along with the probable decline in the number of households using kerosene both for cooking and lighting, cannot be entirely attributed to the effect of low prices (moreover, the elasticity of kerosene consumption to its price is low). It is very likely that there is smuggling towards Bolivia and certainly local fraud (household kerosene used in the industrial sector, and maybe mixed with gasoline or diesel for transportation).

Transportation sector

4.36 The "dieselization" of the vehicle fleet is generally beneficial in financial terms, even when gasoline and diesel are at international prices. It should also be noted that the sale of diesel decreases as the age of the motor vehicles increases. The majority of informal transport vehicles (minibuses) use gasoline.

4.37 CENERGIA, has begun a study on the use of compressed natural gas (with the prospect of Camisea) for in-water fleets in Lima, freight vehicles on selected interprovincial routes, and for private vehicles which do not travel outside of Lima. Its technically feasible potential accounts for 10% of the motor vehicle fleet in Lima, which would enable substitution of 3% to 9% of total consumption, depending on the degree of acceptance. The economic feasibility remains to be seen, in a difficult situation: low cost of the substituted fuel (surplus gasoline), small market size, variety and age of the motor vehicle fleet, and high cost of the gas distribution infrastructure.

Production sector

4.38 In the production sector, there are some interesting prospects, in economic terms, for the substitution of fuel oil by natural gas and, to a lesser extent, coal. Despite current uncertainties over the costs of large-scale production of national coal, this fuel could be competitive in industries close to production areas, mainly on the northern coast (Ancash and La Libertad). The possibility of modifying current equipment (involving the need for sufficiently large boilers) also enhances the substitution potential. In addition to its potential for generating electric power, Camisea natural gas may replace oil products in the production sector with significant economic, ecological, and technical advantages, especially in the case of large consumers that are concentrated geographically. Greater details are provided on the market potential of these fuels in the chapters focusing on coal and natural gas, respectively.

RECOMMENDATIONS

Energy conservation

4.39 Strengthening the ongoing energy conservation program is totally justified in terms of economic and social benefits. In fact, the energy conservation opportunities that are being proposed to consumers enable them to counteract the impact of energy price increases on their total expenditures. Nevertheless, one should be aware that, in view of the above, the total potential saving is relatively limited and could amount to 15% of total consumption over a period of four years (with investments with periods of return of less than three years). In view of expected GDP growth (3-4% in the next five-year period) and growth of urban population (3% per year), which is the largest energy consumer, expected savings would be absorbed in about

three years, indicating the need to place greater emphasis on efficient planning and diversification of energy supply.

4.40 The success of a conservation program is based on the need for energy prices to reflect their real economic costs and to limit price distortions between energy products and/or sectors as much as possible. In this case, conservation and substitution measures are really possible, with a part of the users implementing by themselves the majority of measures without cost and some measures with very short periods of return. Depending on the sector, however, and the elasticity of consumption, savings will tend to fall after the initial pricing effect. And even more important, many consumers react neither suitably nor quickly to the signals provided by prices. This is partly due to the difficulty of identifying and implementing energy-saving measures. Energy audits therefore have to be conducted, as well as awareness-raising campaigns aimed at strengthening and maintaining the affect achieved by prices. In addition, loans at commercial rates should be available on a national level to finance the identified saving measures.

4.41 On the basis of these conditions, the government should seek **foreign financing** to expand and strengthen the existing energy conservation program. The suggested actions are as follows:

(a) Finalize a detailed evaluation of the results achieved by the conservation program up till now, especially regarding the extent of implementation of the measures recommended in the audits; to evaluate the behavior of users who are coping with energy price adjustments.

(b) Establish degrees of priority for conservation actions: select the economically viable companies which rank at the top of their subsector and in terms of total national consumption, and also consider the share of energy expenditure in production costs, the level of margins, the nature of the company's capital, and all the other aspects which enable a company's expected motivation to be assessed.

(c) In the companies selected, perform detailed audits and promote measures with a period of return of less than three years. Mechanisms must be established to bill the beneficiaries for these audits.

(d) Develop technical capacity and enhance the motivation of company managers and technical experts (for example, by appointing a person in charge of energy saving in the companies).

(e) As for the legal structure, joint review and update of the draft bill with the relevant entities and sectors are recommended, especially with respect to the eventual obligations of managers for energy audits and technical standards for

equipment, and also regarding the responsibilities of CENERGIA concerning other companies. It would be equally important to include in the law a definition of the role of the private sector in the promotion and implementation of energy conservation and substitution, and their relation with CENERGIA.

(f) Grant more responsibility to the private sector regarding promotion and marketing of conservation measures and substitution with managers and the users. Achieve an improved communication policy on the problem of saving (professional publicity, celebrity sponsorship, prizes for efficiency, etc.)

(g) Inform and increase awareness of national financial institutions about the opportunities and profits stemming from energy conservation financing.

(h) Foster the active participation of authorities and appropriate public/private entities in those regions where there is a large concentration of industrial activity (for example, Grau, Centro, Arequipa, Huari).

(i) Define efficiency and quality standards for household electric appliances that consume the most, that is, LPG and kerosene kitchen stoves, refrigerators, lamps, etc. This implies the implementation of a series of tests, possibly in ITINTEC. Monitoring systems and the application of standards are needed, as well as strengthening CENERGIA's capacity to inform the consumer.

(j) Continue assessment and auditing services, as well as training (manuals, seminars), dissemination (leaflets, catalogues), and demonstrations and set up a data bank and an information center (in the charge of CENERGIA).

(k) Broaden the capacity of the private sector (consultants) to perform audits, including financial facilities to acquire the equipment and instruments required (CENERGIA facilities are insufficient).

4.42 According to a CENERGIA estimate (Annex 2), program implementation over the 1991-1994 period would require about US$4.5 million, including technical advice, national specialists, equipment and instruments, promotion, information campaigns, and training. The maximum saving that could be achieved would be on the order of 950,000 TOE and 1,050 GWh per year (Annex 2, Table 1), equivalent to nearly US$200 million in July 1990. The investments needed to cover the cost of energy conservation measures in the production sector (with repayment periods of less than three years) were estimated by CENERGIA at approximately US$45 million. The total investment required for the three sectors (production, transportation, and residential/commercial) was estimated at about US$100 million.

4.43 An assessment should be conducted as soon as possible to determine the program's detailed objectives and components, as well as the modalities of implementation, the organizational and managerial aspects, the costs, and financing plan, as well as the plan's benefits and impact.

Substitution

4.44 To improve the potential for LPG and coal substitution6/, the following actions and measures are recommended:

LPG

- Adjust the margins to enable (i) profit and maintenance of the distribution (new cylinders and means of transportation); (ii) a greater development of the LPG market in urban areas outside Lima, preparing for the future increase in national production (Camisea).

- Improve competition in the market to prepare for its future development. In particular, seek broader involvement of private capital in SOLGAS, perhaps in the form of financing the new bottling plant scheduled to be built in Lima.

- Improve standard-setting and regulatory framework, particularly by implementing the following actions, under the responsibility of the General Hydrocarbons Office:

  - Strengthen control of distribution networks (in particular, the fraud with respect to the quantity of gas sold); regarding this, LPG should be traded through dense networks of patented distributors.

  - Make the 24-pound cylinder model uniform and control the application of this size.

  - Strictly control the quality of nationally manufactured valves.

- Creation of a cylinder replacement fund managed by PETROPERU, applying to the cost of the gas a percentage included in the LPG consumer sale price (with a useful life expectancy of 15 years for the cylinders, about an extra US$0.01 would be needed for each refill of one 25-pound cylinder); in addition, of the 2.5 million cylinders currently in circulation, about 0.5 to 1 million should urgently

6/ *In the subsector chapters more detail is provided on the substitution potential of natural gas, LPG and coal.*

be replaced (according to estimates of the two bottling companies), which would entail a cost on the order of US$10 to US$20 million; the initial replacement could be planned over a period of three years.

Coal

- In the residential sector: Study the coal briquette market as a substitute for kerosene in lower-income households in the cities on the northern coast (mainly Trujillo, Chimbote, and Chiclayo): (a) design and test a stove with briquettes adapted to the cooking preferences and practices of these households; (b) assess the consumer target group's willingness to pay; (c) determine the economic and financial feasibility of the activity. In addition to the potential coal market in the services and small business sector, it is estimated that the residential sector market could reach an annual consumption of nearly 120,000 tons for about 160,000 families.

V. ORGANIZATIONAL AND REGULATORY ASPECTS

5.1 The institutional aspect of the Peruvian energy sector, that is, the sector's organization and regulation, shows several gaps and/or structural peculiarities. For example, there is no technical and financial agency, either of the sector or of the government in general in charge of studying, expressing opinions, and making recommendations on proposals to alter prices of oil products. Moreover, PETROPERU (PP), which is an executing company in the sector also plays a regulatory role for the operating companies which are, basically, its competitors. In PETROPERU, the government's managerial activity (PP is a company with managerial objectives) is mixed with its political duty as supervisory and ethical agency (since PP rules, sanctions, and sets incentives for the performance of other oil companies).

5.2 Regarding the electric power subsector, although it reckons with a reasonable technical and operational institution, the National Commission of Electricity Tariffs (Comisión Nacional de Tarifas Eléctricas - CNTE), this Commission has neither the political leverage nor the economic autonomy to really act, on behalf of society, as a supervisor of the operativeness and efficiency of the country's electric power utilities. Because of this, the CNTE has been unable to effectively implement any of the so-called **Electric Power Sector Recovery Programs**, although normally the CNTE should have played a major role since tariff-setting is crucial for recovery.

5.3 With the wider incorporation of natural gas (optimistically) into the national energy outlook and its corollary, a much larger share of private capital in the sector, a regulatory structure that would enable state, semi-private, and totally private companies to operate on a parallel and fair basis will be even more imperative. All these companies will have to adapt to the same requirements and be judged according to the same criteria. The State's managerial activities will have to be clearly differentiated from its regulatory and standard-setting duties. If this does not take place, the foreign capital flows so urgently needed by Peru to break away from its more than twenty years of economic stagnation will not become available.

5.4 In short, this study proposes an institutional reorganization of the sector, aimed at minimizing purely political interferences in many matters that are essentially technical. In the short term, to promote private capital inflows (domestic and/or foreign) into the energy sector, the obstacles to introducing new financial agents will have to be removed. Legal monopolies have to be changed and prices liberalized; at the same time, the economy has to open up, import restrictions abolished, and quantitative limits and/or prohibitive customs duties eliminated. It is clear that, in order to deregulate prices, excessive protectionism has to be abolished and all stages of production, processing, and marketing of energy products have to liberalized.

5.5 Regarding oil pricing policies, it is clear that the normal reference will be the international market (modified by certain taxes levied by the government for efficiency and equity reasons). With respect to electricity, it would be simpler to have the LRMC and total average production costs available.

5.6 The present study's core **institutional proposal** is the creation of a technical, standard-setting organization, referred to as the **National Energy Commission** (Comisión Nacional de Energía - CNE) whose role would be to supervise, on behalf of the nation's best interests, the energy sector as a whole, using economic efficiency and respect for technical standards as criteria. The proposal is elaborated in greater detail in the following paragraphs.

5.7 The energy sector's special characteristics entail a long-term development perspective, which implies the establishment of coordination mechanisms for the numerous sectors with which it interacts: on the one hand, state and private companies and, on the other hand, various legal, technical, commercial, economic, and financial government regulatory agencies. In order to design an adequate institutional structure for the energy sector geared toward rationally adapting its natural political requirements to the situation, as well as the restrictions stemming from the Peru's present situation, a clear understanding of its special nature is essential. In order to form concrete policy proposals and an appropriate institutional organization, a conceptual approach that enables designing an energy strategy that can be implemented within a certain common framework for discussion must be relied upon.

5.8 This common conceptual framework, within which political, social, and economic considerations may be discussed and adapted in a rational and orderly fashion, should be defined prior to designing and implementing an effective energy strategy that would have the suitable institutional support to fulfill its duties. The country should be made aware that there are no miraculous, easy, rapid, or low-cost solutions to cope with current energy problems and that they can only be dealt with successfully if there is broad support and understanding from all related sectors. The road that has to be taken is difficult and long and therefore will have to be orderly and gradual.

5.9 Proposals should be made and objectives defined, which are closely coordinated with the often difficult measures that need to be adopted, to ensure sound performances, bringing concrete, rational, and equitable solutions and not short-term, high-cost improvisations for some sectors of the population. The clear definition of objectives will facilitate the consensus needed to resolve these problems.

5.10 Besides design and acceptance of a rational energy strategy, there should be an institutional structure to implement it. However, there must always be organizations and legal structures relying on, as a last resort, the capacity of the human resource forming and administering them. For this, it is crucial, for the stability and effectiveness of any organization, that its participants be selected strictly for their professional skills and capacity to perform their duties.

5.11 In terms of natural resources, Peru possesses an abundance of potential hydropower resources, hydrocarbons, and natural gas reserves, in addition to poorly known coal deposits. Moreover, even more important, the country has qualified human resources with a wide range of experience in all energy sector activities, especially the electric power sector. In this sense, the conceptual tools of electric power planning, maximum operation of interconnected systems, and efficient tariff setting are widely known and applied at the technical levels, although not necessarily implemented on the political level.

In other words, although the technical and economic concepts associated with the design of a rational energy strategy exist, the poor definition of an appropriate technical and political "interface" appears to be the main reason why this strategy is not implemented.

5.12 Everything up to now points to the need for an explicit energy strategy, as well as institutional organization of the sector, that would enable its coordination, planning, and regulation to be dealt with rationally so as to ensure an economical and stable energy supply. Both an energy strategy and the institutional structure capable of achieving it are essential. The first reflects the government's decision to deal with the energy problem in a coherent and stable way, whereas the second, the willingness to carry it out. The first without the second is only a declaration of good intentions. The second without the first indicates the prevalence of short-term contingent political realities over the long-term perspective needed for proper functioning of the energy sector.

5.13 When the true scope of the technical and political framework that should govern the sector's development is misunderstood, the sector tends to evolve on the basis of short-term decisions strongly influenced and conditioned by factors such as:

(a) The political willingness of the government to mitigate legitimate and valid social pressures in the very short term.

(b) Demands from industrial, private or state interest groups, whose productivity is jeopardized or who are simply aware of the possibility of lowering their costs for an essential input such as energy, by shifting a part of them onto the State.

(c) The stance adopted by the trade union associations of energy sector companies, which on seeing their job security and privileges threatened naturally react by asking for greater guarantees and sometimes even intervening in technical and operational matters although they are not qualified to do so.

(d) The commercial banks and international creditors which would like to ensure repayment of their loans.

(e) The suppliers of equipment who see opportunities to sell their products during emergency situations, fully aware that, in such cases, the severity of the problem overrides basic economic considerations, etc.

5.14 It is curious to note that the customary official reaction consists of one of the two following: tariff setting and price controls and direct or indirect state intervention in energy production and marketing.

5.15 The first responds to the political and social aim of subsidizing certain consumers to absorb the impact that a change in relative prices may have produced. The second is to a certain extent

the result of the first, since business profits are affected by price distortions, and lower profits in turn restrict the capacity of utilities to invest in new projects and, in extreme cases, even limit necessary maintenance and operation of existing installations. Under this scenario, a natural but not necessarily rational way for governments to internalize the problem is to participate in the sector directly or through state companies. This type of decision normally stems from the concept that the profits that should be generated are equivalent to subsidies provided, thus combining the State's role with that of the utility. Unfortunately, the history of many countries indicates that this is not the case.

5.16 In fact, due to substitution between energy products and since relative prices are the main element on which the user relies to make decisions on a personal and industrial level, the permanence of these measures produces an economic distortion effect whose political cost is increasingly more difficult to overcome.

5.17 Moreover, this price distortion has negative effects on the technical and administrative efficiency of utilities, since they are state-owned and are not in a position to question the rationality of tariff measures adopted. Quite the contrary, as the utilities are managed by political appointees, they tend to operate the utility as if nothing had happened, use its capital and resort to local short-term loans, with state guarantee, to generate the cash needed to sustain its operations, granting natural priority to the payment of remunerations to company personnel. As this situation continues over time, its impact on the utility is unavoidable:

(a) Budgetary constraints limit the intellectual capacity of the human group in charge of looking at the future, that is, the utility's planning capacity.

(b) The utility is obliged to delay maintenance programs; although this provides apparent temporary relief, it inevitably creates a problem for the future.

(c) The billing capacity is weakened, since as the utility is managed along political lines it is frequently subject to all kinds of pressures, which ultimately prevent it from cutting supply to large groups of nonpayers.

(d) Finally, all the above affects the companies' human resources, who, because they are unmotivated and lack direction, tend to look for new jobs and, naturally, the most capable are always the first to exercise this option.

5.18 In short, it is appropriate to point out three significant effects that the aforementioned policy, or lack of it, ultimately has on the government:

1. Price distortions as a subsidy mechanism invariably lead to inefficient price allocations since the State does not have, or it is very costly to implement, sufficient control to ensure the social objective that initially motivated this measure.

2. The State, and consequently the government, becomes directly and exclusively responsible for the operation, and therefore financing, either directly or indirectly, of the sector and has to bear the political and economic cost of the aforementioned situations.

3. The economic, and oftentimes legal, conditions created by the State exclude, or at least do not foster, the search for decentralized solutions in which private capital and companies or other state companies could participate.

5.19 Each and every problem mentioned here is exemplified in the multiple analyses and assessments recently developed on the energy situation of Peru. In different ways, they all indicate that the lack of a long-term and coherent energy and institutional strategy is to a large extent responsible for the current difficult situation.

5.20 As a framework of reference for analyzing the institutional situation of the Peruvian electric power sector, the central components that should be envisaged to design an energy strategy are shown below.

COMPONENTS FOR AN ENERGY STRATEGY

5.21 In general terms, an energy strategy must aim at achieving the maximum well-being of the community by establishing conditions of economic efficiency in the operation and development of the sector, within a framework of private/state involvement as defined by the State. In this context, the concept of economic efficiency involves the following aspects:

1. The decentralized decisions of energy users and producers must be economically efficient. This implies that the prices of different energy products must reflect their real economic value, so that consumption, investment, and substitution decisions are taken to obtain the lowest real cost for the country.

2. The production cost of each type of energy must tend to be the lowest possible. This means that technology used in the country to produce, transform, and distribute energy must perform in keeping with the state of the art in the rest of the world. To achieve this, the natural framework is that of an open economy, real prices, and market competitiveness that penalizes inefficient producers. In those cases where part of the prices are controlled, a technical and legal regulatory structure is needed that is in keeping with the country's general pricing structure and the government's political, economic, and social objectives.

3. Energy supply availability and security must be adequate. This implies that it is not acceptable to have unmet demand or supply uncertainties under circumstances where consumers are ready to pay the costs that their supply requires. It also assumes that

supply sources must be diversified, thus avoiding excessive dependence on a single supplier. This does not necessarily imply self-supply, since this may be extremely costly.

5.22 The framework that has defined the State's role involves, on the one hand, possible direct aid for the poorest population groups, who because of a lack of resources cannot meet their basic needs and, on the other hand, the concentration or support of state effort in those activities not carried out by private individuals. This also implies that the State must make every effort toward eliminating obstacles and distortions and establishing clear and stable rules of the game so that the private sector may gradually involve itself in those managerial activities where the State maintains a dominant share.

5.23 It is important to emphasize that the State may maintain subsidies, although this should not necessarily entail control over managerial activities, which should be measured in terms of performance. For example, in the case of electricity distribution, this is relatively easy because it can be clearly specified who should be subsidized and how much by using a meter. This subsidy may be explicitly indicated in the user's monthly bill, and the company can be compensated directly by the government, thus avoiding artificial billing distortions. In political terms, this carries the advantage that the user is made aware of the government support received, and in terms of the company, this does not produce distortions.

5.24 In addition to the promotion of efficiency, rules should be established that would limit the participation of the State in those activities that could be developed within a normal business framework by the private sector. An energy strategy should be aimed at supporting objectives that enable the scheme to be consolidated institutionally, giving it stability and solidity. These approaches, which at the same time achieve long-term political objectives, are basically as follows:

1. *Deconcentration.* This means avoiding systems consisting of only state or private companies, which tend to:

- be used as power centers (power purchaser, power seller, employment or trade union monopoly, etc., with objectives that may differ from the highest public interest).

2. *Decentralization and regionalization.* Decentralization implies establishing conditions that would allow valid and effective production and energy use decisions to be taken at the level of producers and users, and not at higher levels. On a territorial level, decentralization is indispensable for promoting regionalization in the country. To be effective, decentralization and deconcentration are mutually beneficial.

3. *Private participation.* In addition to providing the system with decentralized subsidiaries, private companies or private capital in state utilities foster competitiveness and stability in price-setting policies, since they have good reasons to oppose the establishment of arbitrary tariffs by government officials. Moreover, if companies are structured as joint stock companies, it is possible to distribute ownership, especially to institutional investors such as insurance companies, workers, and customers, thus making

the interests of the company coincide with those of the population, which tends to give permanence and stability to the scheme.

5.25 The principal mechanisms which should be designed to achieve the objectives pointed out earlier are as follows:

1. Establishment of nondiscriminatory legal standards and rules of the game that would facilitate the incorporation of private initiatives into the energy sector and enable an effective coexistence of state and private companies. To achieve this, it is essential to clearly separate the State's role as a standard-setting and regulatory agency from that of the state-owned enterprises, all of which must be subject to the same common rules.

2. Active state involvement in the assessment of energy resources, when their outlook for use justifies it.

3. A coherent and economically efficient pricing policy in terms of production and energy use. This entails free-market prices for negotiable goods, such as fuels, and electricity tariffs based on marginal supply costs.

4. Coordination of investment decisions and operation of state and private power utilities using a global approach in keeping with national interests.

ENERGY POLICY AND INSTITUTIONAL STRUCTURE OF THE SECTOR

5.26 Due to the aforementioned features of the energy sector and its close linkage to many sectors such as the economic, social, and political sectors, the development and implementation of a coherent and competitive long-term energy strategy is only possible if there is a clear and hierarchical institutional structure. This structure must be capable of establishing technical priorities and resolving political conflicts.

5.27 It is important to emphasize that, although the rationality of this proposal may appear to have broad support, its effective implementation is usually a task that requires a vision of the future and great political will. There are two reasons for this approach: first, the various government agencies and organizations involved in the different aspects of the problem (tariffs, investments, environment, technical regulations, financing, etc.) have, by the nature of their duties, a biased view of the sector and they therefore tend to deduce its overall performance without the appropriate perspective or information available. The opinions of these agencies, although they may be partially correct, are generally not inserted within the overall context of the problem and, therefore, provide partial solutions that are ineffective. Even more important, as these opinions are channeled through high-ranking political and administrative public officials involved in these agencies, they inevitably end up in the hands of the President of the Republic, who is unable to take an effective decision inasmuch as he cannot rely on an integrated and general view of the problem and its ramifications.

5.28 The second interference comes from the state companies themselves that operate in the sector. Similar to the preceding situation, in view of the size and importance of these companies in national economic activity, their top-level executives usually have direct access to the highest political decision-making levels, thus enabling them to convey their opinions and particular solutions concerning the technical and financial aspects arising from their company's specific situation, but which do not necessarily take into account the country's best interests.

5.29 The above points to the need of relying on an ad hoc agency that has, on the one hand, high political leverage and, on the other hand, the autonomy and capacity to conduct directly, or through third parties, technical projects and the economic assessments needed to elaborate realistic energy policy proposals, as well as controlling their implementation. There are many ways of creating an agency of this nature; however, the experience in other countries appears to advise small and flexible structures with direct reliance on the highest authority of the country, instead of a new Secretary of State with a heavy bureaucratic structure and technical professional staff, which tend to duplicate those available in the utilities.

5.30 A reasonable solution is the formation of a **National Energy Commission** in charge of elaborating and coordinating plans, policies, and standards for the proper functioning and development of the sector and to advise the government on all energy-related matters. This Commission should report to a Council of those Ministers whose duties are related to the sector's activities. To ensure high-level political involvement, the Commission should have the rank of State Ministry and should be directly accountable to the Office of the President of the Republic or the Prime Minister's Office.

5.31 On the other hand, the presence of various Ministries of State involved in the energy problem enables the focus, discussion, and solutions to the proposed problems to be made with an overall perspective combining the interests and emphasis of the various parties involved. The Commission's technical and administrative duties must be assigned to an **Executive Secretariat**, which would report to the above-mentioned Council and would consist of a small qualified group of professionals. These professionals must have a solid background in technology and economy, as well as experience in project assessment and formulating and using mathematical models customary for sector planning. In addition, they must be capable of acting as counterparts for specialized technical studies, which might eventually be contracted out to foreign consultancy services. This allows the consultancy screening process, whether domestic or international, to respond to each specific requirement and ensures the most highly qualified consultants and the technical quality of the analysis, thus avoiding the potential risk of opening up a political discussion over technical matters, in which the participants generally have little competence. Professionalism and high quality are a prerequisite for technical studies so that public officials can make an adequate and well-based political decision.

5.32 In addition to these two conditions, that is, the political leverage and technical and economic analysis capacity, there are certain basic requirements that the structure of the so-called National Energy Commission (CNE) must meet if it wishes to consolidate a true capacity for performing its duties. The first is budgetary independence: the Executive Secretariat must rely on its own budget

to cover its daily costs and to contract relevant studies on energy planning, policy designing, and tariff structures and the support from government decision-making concerning those specific requests made by the government. This point is crucial since, if the CNE has to resort to more or less voluntary contributions from State Ministries or sector companies, it will not only lose its autonomy as a specialized technical agency but also lose its effectiveness to quickly study and propose solutions in response to specific queries from the government's executive branch.

5.33 The second point deals with the centralization, in the CNE, of the technical and economic studies on regulated price- and tariff-setting and the high degree of substitution between energy products, in case they exist. As prices are crucial for energy sector performance and development, it is of the utmost importance that the procedures for setting regulated prices are based on clear, technically rational schemes that include an explanation of the amounts and benefits of eventual subsidies.

5.34 A third point focuses on CNE coordination of large investment projects in which the State or its enterprises are involved, using a global sector approach and in keeping with the country's best interests. CNE's duty would therefore be to ensure that there is no overlapping or duplication in the projects under consideration and that priority be given to those projects that provide economic advantages and truly show potential for development, on an individual basis.

5.35 The last crucial point is that state companies, or those in which the State is a large shareholder, must be linked to the executive branch of government exclusively through the CNE, thus differentiating the government's ownership interests from its political duties. Moreover, the CNE should be the technical agency in charge of supervising compliance with the laws, rules, and regulations that govern the sector. The CNE is therefore also the agency in charge of discussing the possible conflicts that might emerge over the interpretation of these laws and regulations and acting as technical arbiter in such situations, without superseding, of course, the competence of normal judiciary channels or any other supervisory agency that regulates the daily activities of enterprises, basically to settle conflicts between them and their users. This is an important point, especially with respect to implementing an energy strategy, since the transition from a highly distorted initial situation and the more regulated scheme that is being sought will require considerable educational efforts to achieve a degree of consensus, as well as understanding and sacrifice to make this politically and socially feasible.

5.36 The timely intervention of the CNE may prevent misunderstandings or erroneous interpretations from turning into political situations that become difficult to control and in which the rational approach is discarded. Moreover, the CNE should be empowered, during this transition period, to respond firmly to all the arguments that will be raised by utility and trade union pressure groups aimed at maintaining the distortions that are to their advantage.

VI. ENERGY AND THE ENVIRONMENT

6.1 The extraction, processing, transport, and use of energy products, as other economic activities, expose the environment to various risks. The energy sector exerts a severe impact on the ecology, although far less than that stemming from shifting agriculture and mining.

6.2 In this section, the main environmental problems stemming from energy products are briefly introduced and several measures are recommended to prevent and/or mitigate ecological damage.

MAIN ENVIRONMENTAL PROBLEMS IN THE ENERGY SECTOR

Hydrocarbons

6.3 It is possible to produce and utilize oil without incurring many environmental risks or causing serious damage. At present, the technology is well known and is not prohibitive. At every stage of oil activity, however, there are "small" spills of petroleum, oil, and refined or distilled products. This is aggravated by the absence of information sources to quantify or reliably study the amount and impact of the spills on the environment.

6.4 Hydrocarbons operations are mainly carried out in two productive areas: the northwest (Tumbes, Talara, and Cabo Blanco onshore and offshore) and the northeastern and central rain forest. Here, the greatest problems are due to oil spills during sea transport, which can substantially affect marine life productivity, especially if they occur on coastal upwellings. Two large oil spills have already occurred in the last five years: in 1984 on the beaches of Conchán, with 16,000 barrels discharged, affecting beach organisms and local subsistence fishing. In May 1990, 14,000 barrels of kerosene were spilt in front of Supe1/.

6.5 In the north, small oil and petroleum spills are constantly occurring, from the 99 offshore rigs, as well as the Talara petrochemical complex. The latter discharged an annual volume of about 72,311,327 cubic meters of waste and/or oil-polluted waters, affecting the marine ecosystem. Other critical areas are ports, like Callao and Pisco. In the latter, the pollution has started to affect fishing activity and even local tourism.

6.6 In the Peruvian northeast, spills of petroleum, oil and products are contaminating forest soil, lakes, and rivers and affecting the wealth of typical vegetation, marine life and the landscape. The Tigre and Corriente rivers are affected, since they receive more substances in higher concentrations than permitted levels. In 1990, this last river began to receive a discharge of 14,600 cubic meters per day with

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1/ In both cases, the Contingency Action Plans, which should have been effective, were severely constrained by lack of resources and sufficient equipment.

a chloride content of 130,000 ppm. During 1987 the amount of acid water discharged rose to 646,342 barrels with salinity levels higher than 50,000 μohms per square centimeter and a temperature of 70° C.

6.7 In the central rain forest, there are similar problems: water effluent mixed with oil and petroleum is produced, which contaminates springs and streams used for spawning fish. The reserve of Pacaya-Samiria, affected by deforestation and the loss of its fauna and flora, should be emphasized.

6.8 Deforestation is another consequence of oil activities in the rain forest, as a result of road building and the subsequent land clearing by settlers who generally follow behind hydrocarbons exploration and exploitation activities. In Peru, however, as the oil fields are quite far from populated centers, the problem is not as severe as in other places. Therefore, although it is acknowledged as a problem, the control of population movements and/or settlement goes beyond the energy sector's sphere and must be viewed within the much broader context of economic and social policy.

6.9 Besides oil, Peru possesses another important potential energy product, coal, which entails several disadvantages from the environmental point of view. Its extraction produces an acid drainage which reduces or eliminates water life and alters the landscape. Its use as an energy product produces large amounts of SOx, NOx, CO, hydrocarbons, aldehydes, organic particles and compounds, and ash. Nevertheless, it is still possible to use coal responsibly, especially if it contains little sulphur (less than 1%), if it is burned optimally and basic precautions are taken (filters, baghouse filters, precipitators, etc.), and if it has cost advantages over other possible energy sources.

6.10 Lima's total motor vehicle fleet is causing atmospheric pollution problems that could become a risk factor for the health of about 7 million inhabitants. This contamination is also fostered by the capital's topographical and meteorological conditions although sea breezes help to alleviate the pollution. The problem is further aggravated by the obsolescence of most vehicles. The amount of harmful gases and particles produced is greater than the amount produced by industry itself. It is calculated that Lima receives 375,335 metric tons of CO each year, without considering levels of NOx, hydrocarbons, heavy metals, dusts in suspension, and other toxic pollutants that are inhaled by the population and whose concentration has not been calculated, as there are no air quality assessments.

6.11 On the other hand, natural gas is the least pollutant source of hydrocarbons, and there are substantial proven deposits. Its costs are lower than those for oil, and it has greater calorific efficiency and entails less expenses for maintenance in kitchens and engines. Gaseous emissions from a thermoelectric natural gas plant are significantly lower than those from coal- or oil-fired plants. This energy source does not emit waste solids or ash into the environment (only CO2 and water vapor). However, the emission of considerable amounts of methane (natural gas) into the atmosphere is harmful and should be avoided.

6.12 Finally, comments on standards and institutions should be made. Concerning spills, legislation has specified actions to be taken as part of the National Contingency Plan but they are only applicable in navigable waters. There is a legal void that should filled by the General Waters Law. This

law does not take into account the discharge of various pollutants into riverbeds or the soil as a result of oil operations (nor thermal pollution).

6.13 Another limiting factor is the replication or inefficiency of different organizations with environmental protection and monitoring duties. The Environmental Affairs Office of the Ministry of Energy and Mines needs to be strengthened and should have greater authority, autonomy, resources, and decision-making capacity.

Forest Biomass and Energy

6.14 Part of the wood produced in the country is used as wood for burning. The consumption of fuelwood for energy purposes exerts a negative impact on the environment and therefore contributes (at not a very high level in this country although the extent is not accurately known) to plant cover destruction and desert formation. This is not, however, the main cause of deforestation, which is attributed to shifting agriculture, intensive livestock farming in the rain forest, and overgrazing.

6.15 It is not known for sure what part of biomass utilized annually for energy contributes to the 300,000 hectares of forest that are deforested every year. Campesinos do not necessarily resort to felling trees for their energy needs but use other resources like branches, underbrush, and plant residues. Besides, deforestation above all occurs in the rain forest (in other words, where there are still forests, but few people) and not in the sierra where biomass is more widely used as an energy source. Information should improve with greater research.

6.16 In other cases, as a result of the scarcity of fuelwood or where fuelwood can no longer be found, campesinos resort to manure for energy purposes, which affects the soil's natural fertility, as well as its sustained productivity. Consumption will rise to about 400,000 metric tons of manure, which could be replaced by other energy sources. The consumption of fuelwood has consequences on the soil's fertility and quality, reducing the country's agricultural potential.

6.17 Other problems should be indicated, such as risks to human health, mainly that of campesino women as a result of burning fuelwood. Some studies show that a woman who devotes 35 years to household activities is exposed to the emission of 84 kg of substances such as CO_2 and NO_x, as well as particles, which affect the cardiovascular, respiratory, and nervous systems and produces eye and throat irritation, as well as pulmonary problems. Moreover, certain substances are considered to be carcinogenic, tetrogenic, and mutagenic and reduce life expectancy. In other countries, the addition of a chimney (where feasible) has effectively controlled this damage.

6.18 There are legal standards and regulations that include a series of felling prohibitions or closed seasons; these should preferably be converted into proposals for sustained forest management. There is also a reforestation levy, which is a payment that only affects lumber extractors, exempting them from the obligation to reforest. Most (75%) of the income from the levy was used to pay personnel. In addition, the authorities did not continue to update the amount of monetary sanctions established by the

law on a permanent basis, so that the latter amounts became derisory quantities. Finally, the agency in charge (DGFF) did not assume its role as entity adviser and technical assistant, among its other duties, and therefore did not promote the multi-purpose reforestation and biomass management programs, especially for energy products.

Electricity

6.19 Concerning the environment, the main risks assessed in the large scope projects are those dealing with the alteration of the water system. These projects modify underground water levels, flooding previously dry areas and lowering the level of the water table, with the ensuing difficulty of exploiting underground water resources. Another problem is the transport of sediment in the upper part of the basin. Even though they do not necessarily stem from energy project construction, these sediments lead to increased equipment and infrastructure maintenance costs, decline in their useful life, and less efficient production. Likewise, there may be disruptions in the development of forest fauna and flora, as a potential risk for the surrounding ecosystems, such as those mentioned in the Mantaro water transfer project.

6.20 With respect to sanitation, increased disease and mortality rates can be observed, as the reservoir's surface waters, especially the flooded bank areas, which are usually quite shallow, provide a habitat for disease-bearing insects. The more important social aspect, however, is related to the construction of reservoirs and the concomitant displacement and resettlement of populations. On the other hand, basin protection measures can be applied, such as reforestation which carry the added benefit of generating jobs.

6.21 In the case of thermoelectric power stations, one of their greatest environmental risks is atmospheric pollution with SOx, NOx, soot dust, unburnt products, and hydrocarbons. Another problem could be the production of acid mists. In view of the few large thermoelectric power stations, in this country such effects are not substantial.

6.22 With respect to standards and institutional structure, the agency in charge of environmental issues is the General Health Directorate (Dirección General de Salud - DIGESA). Regarding ELECTROPERU, which handles electricity generation and transmission, the lack of specialized units focusing on environmental control is conspicuous. The situation in the regional energy companies is identical, since these companies have only been created recently.

STANDARDS AND INSTITUTIONAL STRUCTURE

6.23 In Peru, there is no clear environmental policy nor are there standards to systematize current legislation and provide orientation for the enactment of new laws. The prevailing standards and institutional framework for environmental protection are scattered throughout a plethora of legal ordinances and agencies whose efficiency is considerably curtailed by overlapping, gaps, and shortage

of material and human resources. Likewise, current energy sector legislation is fraught with many gaps, duplications, and even conflicts, which indicate the lack of systemization at the time of legislation.

6.24 The task of establishing standards for environmental protection, which comes under the jurisdiction of the Ministry of Energy and Mines, is severely constrained by the noncompliance with current legislation, as well as the lack of effective procedures for its efficient enforcement. Monitoring organizations, such as the General Hydrocarbons Directorate (Dirección General de Hidrocarburos), do not impose penalties; little attention is paid to the Environmental Affairs Office (Oficina de Asuntos Ambientales); coordination with other sector agencies such as DIGESA, ONERN, etc., is quite limited. Effective environmental protection cannot be expected if environmental issues are not granted, from the very start, the space they deserve in sector activities and agencies.

6.25 Deficiencies in the sector have reached critical levels: for example, it limits its work to receiving reports on environmental disruptions caused by energy activities, without taking any action whatsoever. This is the institutional framework in which the current limited standards are not applied.

6.26 National institutions that can take action with respect to the environment in the energy sector (even though they do not depend on it) are as follows:

(a) National Office for Natural Resources Assessment (Oficina Nacional de Evaluación de Recursos Naturales - ONERN), a decentralized public organization that reports to the National Planning Institute (Instituto Nacional de Planificación - INP), which is technical and advisory.

(b) General Environmental Health Directorate (Dirección General de Salud Ambiental - DIGESA), which replaces DITESA and is part of the health sector, but in charge of setting standards, supervising, and evaluating sanitation and pollution.

(c) National Institute of Environmental Protection for Health (Instituto Nacional de Protección del Medio Ambiente para la Salud), in charge of coordinating and proposing policies and standards for environmental protection.

(d) General Directorate of Captaincy and Coast Guards (Dirección General de Capitanías y Guardacostas), in charge of surveillance, monitoring, prevention, control, and imposing penalties for pollution produced in navigable waters, although formally speaking it is bound to report to DIGESA, so that it can adopt suitable measures.

(e) General Forestry and Fauna Directorate (Dirección General Forestal y Fauna - DGFF), an agricultural sector agency for setting standards and administering the use of forests and biomass, including forest fauna and flora.

6.27 There are also energy sector organizations or agencies that are responsible for environmental protection. These are the General Hydrocarbons Office, ELECTROPERU, PETROPERU, and the Environmental Affairs Office (Oficina de Asuntos Ambientales) of the Ministry of Energy and Mines (MEM). They are briefly described as follows:

(a) The General Hydrocarbons Office, entity depending on the Ministry of Energy and Mines, in charge of proposing national policy for the exploitation and processing of oil, gas, and similar hydrocarbons, supervising and evaluating its implementation, as well as proposing and, in this case, issuing the relevant set of sector standards. It does not have an environmental section.

(b) ELECTROPERU is the company in charge of electric power generation, transmission, transformation, and marketing activities. It does not have a specialized environmental protection and/or control section.

(c) PETROPERU is a decentralized public agency, in charge of petroleum exploration, exploitation, transport, and marketing activities, as well as other hydrocarbons subsector operations. It has an environmental protection department with staff and equipment constraints.

(d) The Environmental Affairs Office of the Ministry of Energy and Mines (MEM) is responsible for providing advisory services and, until April 1990, it reported to the General Mining Office. Since then, it has been upgraded to General Environmental Affairs Office (which already existed) and answers to top-level management of the Ministry of Energy and Mines. At present, in operational terms, this agency's scope of action is highly constrained (it only has four engineers and three assistants), although it has technical support from the Japanese Government.

GENERAL RECOMMENDATIONS

(a) To establish legal standards with the force of law which would make it obligatory to conduct an Environmental Impact Study (EIA), the scope of which would depend on the characteristics, nature, and magnitude of the energy development project that is being planned.

(b) It is proposed that the Environmental Affairs Office of the Ministry of Energy and Mines (MEM) should be strengthened or transformed into an environmental control agency, with the standing or authority of a General Directorate (that is, the General Environmental Affairs Office duly upgraded), which would perform coordination, assessment, and monitoring duties, supported by the various sector-related agencies as well as other institutions that have advisory, measurement, and/or control responsibilities over energy sector environmental concerns. This organization should continue to be

directly answerable to the Minister's Office so as to ensure greater efficiency, speed, and authority in its actions; so that the sanctions proposed by this Office can be effectively applied, they will thus be approved by its highest authority in close coordination with the legal system. The necessary budget must be provided as well as the minimum number of personnel sufficiently qualified for the general tasks of supervision and support, resorting to foreign consultancies when specific technical assignments need to be conducted.

(c) Establish a fee on marine, river, lake and land pollution by hydrocarbons, which must be paid for by the ships that transport these substances as well as the sea and land installations that pump them.

(d) The State would have to ensure that the entities and/or organizations for environmental control and/or protection (such as the National Contingency Plan) will rely upon a minimum of resources for acquiring facilities, equipment and material, as well as personnel duly trained to carry out their respective duties.

(e) Establish a monitoring system for the gas emissions produced by the largest thermoelectric power stations, as well as by the total motor vehicle fleet in certain critical zones, notably the Lima/Callao urban area.

(f) Consider the possibility of increasing electricity consumption tariffs and fuel prices, to a value nearer to economic costs, which would contribute to improving the precarious finances of energy-producing utilities, and part of these resources could be used for the purpose of environmental protection, monitoring, and control. Likewise, this measure would facilitate reducing unnecessary energy consumption by the population, which would also help to reduce environmental pollution.

(g) Foster campaigns for the recovery and management of basins through reforestation systems to reach at least the proposed aim of 20,000 hectares per year. Coordinate such initiatives with the DGFF and make them compatible, to the extent possible, with a proposal for temporary job creation, as well as producing a sustained forestry resource for fuelwood and charcoal.

(h) Elaborate and enact an environmental code which would contribute to overcoming the dispersed nature and filling the gaps in environmental legislation, granting the priority that the EIA deserves in environmental projects.

(i) Create and strengthen sections and departments specialized in environmental protection and control in the main energy-producing enterprises on both a national (PETROPERU, ELECTROPERU) and a regional level.

(j) Upgrade and strengthen the authority of national technical, advisory, and standard-setting agencies such as ONERN, DIGESA, by providing them with the necessary resources (to the extent possible) for such a purpose.

(k) Conduct feasibility studies (incorporating the EIA), in the search for energy projects and giving priority to those that exert a lesser environmental impact, particularly for the exploitation of water and natural gas resources.

(l) Facilitate channels for technical training and academic education in EIA procedures and methodology.

VII. HYDROCARBONS SUBSECTOR

7.1 This report summarizes the importance of the hydrocarbons subsector in the Peruvian economy and in the stabilization program. Likewise, it assesses the current situation and puts forward recommendations and proposals for a medium-term action plan.

IMPORTANCE OF THE HYDROCARBONS SECTOR IN THE ECONOMY

7.2 There is close correlation between growth of the economy and growth in demand for oil products. In order to grow, the economy needs oil products supplied at the lowest possible cost. The supply cost of products is mainly influenced by the oil product pricing policy of the Peruvian Government, but also by its policy of attracting international oil companies (IOC) and by the efficiency of PETROPERU (PP).

7.3 The hydrocarbons subsector is capital intensive and, in the past, has required large public sector investments through PETROPERU. Unless the investment needs of PETROPERU are minimized through private sector participation, the Peruvian Government's economic stabilization program will be negatively affected by large investments like those needed by PETROPERU.

7.4 The net import of oil products has already drained large amounts of resources from the economy. This trend could deteriorate in the near future due to the lack of investment in exploration, production, refining, and distribution activities in the hydrocarbons subsector. If such a trend is not corrected, it will become an obstacle for the stabilization program.

7.5 A high percentage of public debt stems from hydrocarbons subsector obligations. This share should decline in the future as a result of privatization and the private sector's growing involvement in petroleum investments.

7.6 The Peruvian Government's fiscal deficit has been heightened by an irrational pricing policy for oil products, which is aimed at providing PETROPERU subsidies to consumers and incurring government losses in terms of fiscal earnings.

7.7 A short time ago, the hydrocarbons subsector was the only subsector to attract foreign risk investment by international oil companies. This should be continued by using incentives through policies that ensure contract stability (or, at least, it should be improved, compared to the last five-six years).

HYDROCARBONS SUBSECTOR SITUATION

7.8 The decline in crude oil production and reserves (eight years at current production levels) has partly lead to the net import of oil, which has affected the balance of payments.

7.9 Inadequate levels of investment in exploration and production in the last few years will subsequently lead to a decline in production and the reserves-to-production ratio in the medium term (that is, in the next three-five years). If pending problems are not resolved with the only large oil production company, oil production will decline even more in the short to medium term.

7.10 Large reserves of natural gas and natural gas liquids (Camisea) remain unexploited, even though this deposit was discovered several years ago.

7.11 Application of the aforementioned low pricing policy for oil products forced the country to import expensive middle distillates and export fuel oil of little value, producing problems in the balance of payments and increasing the Peruvian Government's fiscal deficit, while the financial situation of PETROPERU has worsened because its products are sold at below breakeven prices.

7.12 For lack of financial resources, PETROPERU has not maintained its production and refining installations, so that large potential increases in production of almost 20,000 barrels per day (northern rain forest deposits, new fields of Chambira and Talara) have not materialized.

7.13 PETROPERU has inherited an activity with high operating costs due to the nationalization of BELCO and its incorporation into a subsidiary company (whose production, although very costly, is declining). In addition, the compensation problem remains pending but has good prospects of being resolved since one of the objectives of the new Government is to attract new foreign investment in hydrocarbons exploration and production.

7.14 Although PETROPERU's statutes guarantee its technical, administrative, and financial autonomy, in reality its operation is deficient due to the interference of several government agencies (MEM, CONADE, the Comptroller's Office, COFIDE, the Office of the President of the Republic, etc.) in its daily activities. Due to a lack of oil products, which are both unpredictable and insufficient, PETROPERU needs to obtain transfers from the Treasury to be able to continue operations.

Recommendations for a medium-term action plan in the hydrocarbons subsector

(a) The Peruvian Government should implement a rational pricing policy for oil products so that prices of individual oil products reflect their opportunity costs (importation and exportation plus transport and distribution costs), and a relatively uniform tax. In addition, the price adjustment mechanism should be developed in such a way that the real prices levels are predictable and in keeping with international levels. Subsidies should be clear and, preferably, be paid directly by the Treasury and not by "lucro cesans" of the oil company.

(b) The Peruvian Government should settle pending matters with Occidental so that the latter may rapidly increase its production.

(c) PETROPERU should be able to obtain financial resources to implement the rehabilitation program for its Selva and Talara fields, as well as the basic maintenance of its refineries, so that production of crude oil and oil products may increase rapidly within the next three years.

(d) The Peruvian Government should consider privatization of its fertilizer, carbon black, and lubricating oil plants in Talara and the lubricating oil plant in Callao and the refineries in the rain forest, in addition to the other PETROPERU subsidiaries. One precondition for these sales is the start-up of a rational pricing policy for oil products, reflecting their opportunity costs and the prior restructuring of these utilities.

(e) The Peruvian Government should consider privatization or equivalent and appropriate contractual arrangements, implying private sector management of the high operating cost Talara fields (both onshore and offshore) and possible secondary recovery projects in the fields operated by PETROPERU.

(f) The Peruvian Government should reorganize PETROPERU, converting it into a holding company, with production and refining units defined as cost and profit centers. PETROPERU should contract out all services, especially maintenance, to the private sector and should seek maximum private sector involvement through partnerships or joint ventures for all activities (exploitation, production, transport, and refining). PETROPERU should particularly seek association contracts with private companies that take on exploratory risk investments.

(g) The Peruvian Government should grant real political autonomy to PETROPERU with minimum interference from government agencies, except when it is necessary to ensure that PETROPERU complies with policy guidelines and sectoral objectives, such as investment and pricing levels and the role played by the Peruvian Government as PETROPERU's only shareholder.

(h) PETROPERU should be allowed to share in sector profits through a predictable mechanism, so that PETROPERU can plan its investments better and self-finance a fair percentage of them.

(i) The Peruvian Government should use incentives to exploit the Camisea natural gas field, including transport, liquid fractionating, and natural gas distribution, as well as gas-fired electric power generation, with maximum private sector participation in the entire process.

(j) Natural gas distribution should be specifically carried out by a private company, which would be awarded a concession for this activity.

(k) The Peruvian Government should consider the possibility of a gas-based electric power plant, constructed and operated by the private sector (with B.O.O. or B.O.O.T or other similar mechanism), with a Peruvian Government guarantee for a long-term purchase and sale contract, with payments in any hard currency or its equivalent in exportable surplus oil products.

(l) Through the Ministry of Energy and Mines, the Peruvian Government should prepare and disseminate regulations for the distribution of natural gas, liquified petroleum gas, and other liquids. These regulations should apply to tariffs and designing and security standards for distribution systems and to environmental protection. The regulations governing natural gas distribution, however, should provide incentives for open competition between authorized distributors (of which several are currently private companies).

A. UPSTREAM OIL SUBSECTOR

Objectives and Strategy Guideline

7.15 With the Peruvian economy in a virtual state of collapse (annual inflation currently amounting to more than 3000% and constantly declining incomes), the administration is aware that it must adopt austerity measures. It is certain that rehabilitation of the petroleum subsector could substantially contribute to the country's economic recovery.

7.16 Regarding upstream oil activities, the basic prerequisite for attracting risk capital, that is, high geological potential of several already proven areas such as the Loreto basins in the Amazon (rain forest), which produces the largest share of production, and a promising outlook for coastal and offshore areas (which are already yielding considerable production), has been met. There is also a potential in offshore waters more than 100 meters deep.

7.17 Certain additional conditions, however, are required for the international oil community to be persuaded to invest risk capital in this country. These conditions are as follows:

(a) A stable financial environment in the country (and in PETROPERU), which would ensure companies prompt payment of their fees for services provided or for sales of their share of oil on the domestic market (whichever the case, depending on the type of contract).

(b) Facility for companies to repatriate their investments and profits freely.

(c) Safe operating conditions (guerrilla).

(d) Attractive contracting and legislative conditions.

7.18 The bulk of petroleum resources hidden under Peruvian soil, because of the huge exploration effort required, needs to be developed with major foreign investment. Within this context, PETROPERU (PP) should focus on the following:

(a) Allocating its meager resources to exploring low-risk areas.

(b) Taking advantage of its optional right to participate (with a 20%-25% share) in the operations of foreign investors, after the exploration risk phase is over.

As to the contribution of local private capital, this will be limited, due to the element of risk inherent in this type of activity and the enormous amounts of capital required.

7.19 The priority actions PETROPERU should initiate in the short term are as follows:

(a) To quickly undertake rehabilitation and repair of enhanced production systems in damaged oil wells and equipment and in depleted primary energy wells/fields, as long as these projects are not deemed sufficiently important to be carried out by the involved companies themselves (although secondary recovery is very expensive and it is debatable whether PETROPERU should participate in this activity).

(b) To complete infill and extension wells in fields already bounded or requiring assessment of their possible area for expansion to increase their productivity.

(c) To assess discoveries (for example, Chambira) and undertake development work for fields which are deemed economically viable.

The above would in the short term assist Peru in maintaining its self-reliance in view of the prospect of increased domestic demand and, possibly, in becoming a moderate net exporter with a positive oil trade balance.

7.20 Additionally, as an **immediate objective**, PETROPERU should strive to attract foreign risk capital, via promotional actions (presentations and establishment of acceptable contractual terms, comparable to the most favorable ones in force in neighboring countries). This would enable intensive exploration to be resumed and perhaps, to increase declining proven oil reserves, with the **long-term objective** of producing substantially more oil, to continue exporting and therefore reckon with large amounts of foreign currency from oil activities.

7.21 In the *medium to long term*, the already identified gas potential (from the small Aguaytia field to the large Camisea field) should be considered and, on the basis of this, the possibility of implementing a development project. While the Aguaytia project is within the financial reach of PETROPERU (US$50 million as part of a larger loan from a Mexican bank), implementation of the Camisea project, valued at US$1.860 billion, cannot be conceived without the intervention of a major foreign company (or consortium). It is recommended that contacts be resumed as soon as possible to attempt different approaches and so bring the deal to a close.

7.22 The long-term availability of gas and condensates (mainly for local consumption, power generation, household uses, and petrochemicals) will displace oil products and allow for higher oil exports, benefitting the country's economy.

SUMMARY OF SUGGESTED ACTIONS

(a) An improved and stable economic environment is a prerequisite for attracting international oil companies (IOC).

(b) The bulk of the country's oil potential may only be developed through the intervention of foreign risk capital. Promotional campaigns ought to be launched, possibly on a continuous basis; the Ministry of Energy and Mines or a PETROPERU representative, with the assistance of experienced advisors, should individually visit international oil companies, since a better response may be obtained with this approach.

(c) It is advisable for PETROPERU to limit its exploration effort to low-risk areas and to rehabilitation and enhanced recovery projects.

(d) The already identified gas potential (specifically the large Camisea field) should be developed at a fast pace. Contacts with appropriate and willing international oil companies should be resumed quickly.

(e) Solution of the pending Belco (and its insurance company) problem would contribute to improving the country's image for potential foreign investors.

(f) The major issues concerning the PETROPERU/Occidental relationship should be resolved amicably. These are:

- Changing the reference basket of crude oils (which determines Occidental's fees) to a higher price, probably excluding Loreto crude, which reduces the average with its low valuation.

- The controversy over whether Occidental's production is old or new oil, which involves different tariffs (a lower and a higher one).

These issues may be resolved by complying with the terms of the contract.

(g) The main debatable issues in the legislation which have affected the contracts, are:

- The compulsory surrender of companies' foreign exchange to the Central Reserve Bank, which can lead to difficulties when companies wish to repatriate their investments and profits.

- Depreciation of capital investments at an annual rate of 20%, applying it to preproduction disbursements, should also be extended to post-production investments. This would stimulate companies to implement enhancement (secondary recovery) projects with the prospect of being able to recover significant investments in time (that is, before the end of the contract).

- It would be in keeping with general practice to pay income tax in cash (rather than in kind), with the condition that PETROPERU would have the right to

demand that producers supply the local market, on a pro-rata basis. With respect to the company's obligation to supply the local market, it would be desirable to establish a limit regarding the percentage of its oil allocation to be sold locally; some companies are vertically integrated and need their share of oil (in oil).

- PETROPERU should consider refunding its share of exploration costs when acquiring a share in the production rights of the contractor.

- Income tax advances, pending final settlement, at the rate of 40% of gross income, are considered too high, since the profits tax rate is 45%.

Not all these points need legislative changes, but for several of them results could be obtained through administrative methods.

THE IMPACT OF LEGISLATION ON EXPLORATION INTENSITY

7.23 The sharp increase in overall exploration activity in the first half of the seventies was initiated by enactment of the 1970 Petroleum Law, stipulating use of the production sharing contract and a favorable fiscal system: that is, a fixed 50% share of gross production was to accrue to the company with no tax liability on marginal profit (PETROPERU would pay this tax on behalf of the international oil company).

7.24 The upward trend of oil prices allowed for potentially good returns. Consequently, over the 1971-1975 period, exploration investments grew from an initial US$30 million to a peak of US$380 million in 1975, with PETROPERU contributing little to the exploration effort (25%). Toward the end of 1976, however, investments fell to some US$110 million and, in 1979, to virtually zero. This decrease was the result of two factors: first, the effect of a new law obliging companies to pay their taxes directly1/. Second, although Occidental (OXY) and PETROPERU were successful in the rain forest area and Belco was successful on the northern coast, there was also the negative combination of unsuccessful exploration and the effect of the new US tax code establishing that deductibility for foreign losses would not be allowed beginning in 1976. This persuaded most US companies to leave the country.

7.25 In 1980, due to a favorable provision whereby exploration was partially financed through a "reinvestment tax credit" (40% of capital investments were deductible for income tax purposes), US$135 million were invested. Beginning with the annulment of the tax credit in 1985, exploration investment fell to an average of US$40 million per year.

7.26 A similar trend occurred in terms of recoverable proven oil reserves, which reached a peak level of 830 million barrels in the early eighties and then fell to about 350 million barrels in 1989.

1/According to this law, the payment of tax is transferred to PETROPERU.

Production also increased to a peak level of 195,000 barrels per day in 1982 and then declined to its present level of 130,000 barrels per day.

7.27 Under present conditions, maximum efforts should be made to attract foreign risk capital. The country needs an immediate and intensive exploratory campaign in order to increase, in the medium term, oil reserves to their historical peak of 830 million barrels or to 1 billion barrels as a minimum objective (in addition to what is known about Camisea). When these reserves are developed and put on stream, it is assumed that an eight-year reserves-to-production ratio would enable additional production of 300,000 barrels per day, with 200,000 barrels per day available for domestic consumption, and 100,000 barrels per day for export. A steady exploration effort would clearly be necessary to maintain for as long as possible (or optimistically increase) the reserves to production ratio.

THE PETROLEUM CONTRACTS

Historical background

7.28 Up to the mid-sixties, companies were operating in Peru under the accepted contractual model, the Concession Agreement. This model was in keeping with the lack of local experience and the need to attract risk capital in remote unproven areas. The companies were financing their operations, paying royalties and corporate taxes, and supplying the domestic market with part of the obtained production. The broad power enjoyed by companies under such arrangements created an atmosphere of mutual distrust and confrontation, leading to the nationalization, in 1968, of I.P.C. (an Exxon subsidiary), which was the producer of 90% of Peru's crude oil production, which gave rise to the creation of PETROPERU in 1969.

7.29 Due to the stagnation of production in the coastal area, the government took measures (legislative and contractual) to stimulate exploration with foreign capital, with particular emphasis in the Amazon basins. Invoking the principle of sovereignty and exclusive ownership of its underground resources, the government passed a law in 1970 prohibiting the direct granting of oil rights to foreign companies (end of the "concession" era). Likewise, it empowered PETROPERU as the exclusive title holder for both oil exploration and production and to supervise contracts with oil companies, using a "maitre d'oeuvre" (overseer) type of approach.

7.30 In Peru, this was the beginning of the production sharing agreement (total financing of operations and exploratory risk assumed by contractor, shared production in case of success)2/. A number of companies were attracted by the simplicity and convenience of the newly proposed terms, and about 16 companies/consortia signed production sharing agreements (PSA). In the early seventies, there

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2/The basic guidelines of the production sharing agreement (PSA), under the 1970 Law, were the sharing of gross production ("no cost oil"), 50% for PETROPERU and 50% for the contractor, who would recover his costs and receive a profit from his 50%, and PETROPERU would retain the other 50% but would have to pay out of this the contractors' corporate tax on behalf of the contractor.

were several discoveries made by Occidental and PETROPERU itself in the Amazon, and by Belco in shallow offshore waters of the northern coastline. Many other companies, however, terminated their contracts because their exploration efforts had come to nothing.

7.31 Due to reduced exploration activity, incentives were then established to reactivate the interest of international oil companies towards the end of 1980. The most important ones were:

a) An accelerated depreciation rate for capital investments over a five-year period rather than according to the unit production method, limited however to capital costs incurred in the pre-production phase.

b) A reinvestment tax credit, that is, 40% of investment was allowed to be deducted from income tax, under the obligation to reinvest the tax saving in further exploration.

7.32 In the late seventies, it was established that the contractor should pay his income tax directly out of his 50% share (rather than PETROPERU paying it on the contractor's behalf). While this seemed to be contractual support for the US companies, it was affected by the decision of an IRS ruling in 1976 that tax payments not directly incurred would not be eligible for tax credit in the US. Consequently, the companies liable to taxes (Occidental and Belco) would receive no advantage, since, with an unchanging share, tax paid in Peru was simply offset against taxes owed in the US. As for non-producers, the new US tax code provided for deductibility of losses incurred in foreign operations up to the end of 1976. The result was that many US operators in Peru preferred to leave the country while there was still time to take advantage of this deduction.

7.33 In an erratic approach involving both liberal provisions and conservative countermeasures, in 1985, the government accused Occidental and Belco of not allocating their reinvestment tax credits to active exploration work, but using it for field development instead. The tax credit provision was revoked and Belco was nationalized, following its refusal to reinvest its tax savings in additional exploration. Occidental accepted the restoration, committed itself to implement extra exploration investments in its 1A block and acquired the new block 36, under a renegotiated contract in 1985, whose basic fiscal guideline was that Occidental did not continue to share production but would receive a "service fee" per barrel produced and delivered to PETROPERU. The 1989 Mobil contract is based on the most recent Peruvian model and differs from Occidental's previous contract.

Ongoing contracts

7.34 Major exploration/production arrangements presently in effect are the Occidental (Lots 1AB and 36), Occidental-Bridas, and Mobil contracts.

7.35 As mentioned above, Occidental's 1985 revised contract (Lot 1AB) stipulates providing a "service fee" to Occidental (in cash) per barrel of crude oil produced and delivered to PETROPERU, with Occidental covering all expenditures.

7.36 The Occidental-Bridas contract is based on Occidental's 1985 contract, but it is limited to enhanced production only, under secondary recovery operations in the depleted northeastern onshore fields, with no exploration commitments.

7.37 The Mobil 1989 contract is based on the most recently applied model, which stipulates a gross in-kind compensation (in oil), in terms of a declining percentage of production obtained as a function of an "R" factor (share or ratio of the contractor's accumulated income to accumulated expenditures, since the start of operations), with Mobil covering all expenditures.

7.38 Recently signed contracts (early July 1990) are based on the new model (R factor) and involve: (a) Petromineros (a minor US independent--Edward Cullan), (b) Vera Gutiérrez and (c) Graña y Montero, the latter two representing private local capital. It is worth mentioning the wide gap in exploration commitments between Occidental and Mobil (US$180 million over ten years and US$107 million over six years, respectively) and the two local companies (some US$3.5 million), which confirms the aforementioned expectation that local capital's contribution to the exploration effort would be marginal.

A. Occidental contract (1985 renegotiation)

7.39 In terms of Peru's contractual situation, this contract deserves priority because it is at an advanced stage of implementation and already shows the implications stemming from the provisions governing it, since Occidental has been a producer for a long time. Its main features are:

- *Type of contract*: gross income sharing, in the form of a service fee to Occidental per barrel produced and delivered to PETROPERU.

- *State involvement*: PETROPERU has the option to participate in the contractor's operations by acquiring a minimum 25% interest, after the discovery is declared commercial, that is, after the exploration risk phase. The option is to acquire 50% in Occidental's block 36 (not in 1AB). PETROPERU does not refund its share of past exploration costs.

- *Duration*:

  - four years exploration plus two years extension (total six years);

  - thirty years overall contract duration, comprising exploration, development and exploitation, if there is oil production;

  - no special mention of the unassociated natural gas exploitation period is made, but it should be longer than the one allowed for oil.

- *Area:* Under the present law, from one to three or four blocks, each block covering different surfaces depending on location (larger in the rain forest and progressively smaller in the sierra, offshore, and the coast). The accumulated surface may range from a minimum 2,000 square kilometers (one block on the coast) to a maximum 40,000 square kilometers (four blocks in the rain forest). Occidental currently owns two blocks under two contracts (1AB, 36).

- *Pipe and gas lines*: PETROPERU has the option to participate with a 50% stake in the construction of the main pipelines. In practice, PETROPERU owns the North Peru Oil Pipeline (856 kilometers long, 36 to 24 inches in diameter, capacity of 200,000 to 500,000 barrels per day, and a cost of US$670 million in 1975 US$). It also owns the 250-kilometer northern branch oil pipeline. Both connect the rain forest with the Bayovar loading terminal.

- *Relinquishments*: 50% of each block at the end of the exploration phase; total area (less oil field areas) at the end of the sixth year from expiration of the exploration phase.

- *Work commitments*: These are negotiable, on the basis of actual exploration work required to assess the contract area's potential. In its 1985 contract, Occidental committed a total of US$180 million in blocks 1AB and 36, for 10 years.

- *Bank guarantee*: To cover contractor's work commitments.

- *Production*: Totally supplied to PETROPERU.

- *Petroleum expenditures*: Totally incurred by the contractor.

- *Service fee (tariff)*: Cash payment for a certain amount of dollars per barrel produced and delivered to PETROPERU, such fee to cover Occidental's reimbursement of expenditures and its marginal profit. Due to Occidental's operations, started in the early seventies, the 1985 renegotiated contract had to consider the partial depreciation of Occidental's previous investments, whereby two different fees were set. Referring to a market price of **US$24.25 per barrel**, corresponding to the then market value of a basket of four reference crude oils, a fee of **US$11.50 per barrel** was set for the so-called "basic production" (oil reserves discovered and developed before 1985, labelled "old oil" for our purposes) and a fee of US$14.80 per barrel for "surplus production" (previously undeveloped reserves and new reserves discovered and developed after 1985, labelled "new oil" for our purposes). Chart 1 shows the production curve separating old oil from new oil, in keeping with the agreement that oil accumulated would have a reserve level of 106 million barrels. In practical terms, the two fees are the same as a 47/53 sharing of gross income for **"old oil"**, and a 61/39 sharing for **"new oil"**. The aforementioned fees were to be adjusted upwards or downwards through a formula considering oil price

variations above or below the historical US$25.25 per barrel reference price, in such a manner that the 47/53 and the 61/39 sharing of gross income would remained unchanged.

- *Taxation*: Present legislation stipulates an overall tax rate of 45% (income plus withholding tax). In the case of Occidental (1985 tax law), taxation was (and still is) applied at a 68.5% rate, with a formula in the contract which partially readjusts the negative impact of this higher rate on Occidental's net after-tax fee.

- *Ring fencing*: No ring fencing per block for tax purposes. Unsuccessful exploration in a block may be offset against positive results in other blocks.

- *Depreciation for tax purposes*: Intangible assets are treated as expenditures in the year they are incurred; (tangible) capital expenditures are depreciated over the productive life of the field, according to the "unit of production" method.

- *Domestic supply obligation*: By definition, all production is delivered to PETROPERU under this contract.

Issues to be discussed concerning the Occidental contract

7.40 Occidental's present share is more than 50% of current production. The first short-term action to promote higher output is to encourage Occidental to boost its present production level and undertake aggressive exploration. Admittedly, Occidental could increase its production with infill drilling in its fields. Chart 2 (source: Occidental) shows the production increase that would be achieved by means of development drilling alone, raising total production back to 180,000 barrels per day in 1992. For this to be done, however, Occidental should be allowed to make a profit from its current operations, which has not been the case over the last four years (no corporate tax has been paid during this period).

7.41 The main issues and respective solutions proposed are as follows:

(a) As the reference price has fallen to its present level of US$14.5 per barrel, corresponding tariffs have dropped to a weighted average (old plus new oil) of US$7.2 per barrel. With a current production cost of US$8.3 per barrel (verified in PETROPERU's records), Occidental claims it is losing some US$1.1 per barrel even though it can cover operating cost (US$6.0 per barrel) and partially defer depreciation (US$2.3 per barrel). Occidental's view may be overly pessimistic, but it could still be stimulated to do better. The main solution is to change the price of the reference oil basket to a higher one. Loreto crude oil which has no export quota and contributes, with its low valuation of US$9.3 per barrel, to depress the average reference price, should be excluded from the reference basket.

(b) The PETROPERU/Occidental controversy over what part of production is old and what is new should be resolved. The 106 million barrels of reserves of old oil, agreed upon in the contract, are now questioned by PETROPERU. The latter claims that the largest share of production is old oil, implying payment of a lower tariff. Occidental and PETROPERU have to comply with the contract and may have to resort to an extreme compromise based on the assessment of impartial expert advice (which is an initiative generally to be avoided).

(c) The "tax on inflation" should be abolished. Under the Occidental contract, accounting should be carried out in the national currency, Peruvian intis. As there is a month delay between the moment that Occidental presents its bills and the moment it is paid in intis, the increase in the amount of intis which Occidental is paid in excess of the initial value (in dollars converted to intis due to inflation and the consequent rise in the dollar) is considered exchange rate gains and, as such, is subject to income tax.

(d) Since Occidental's fees are paid in intis at the MUC exchange rate (1/3 of the free-market exchange rate), the company is penalized on expenditures incurred locally, since such expenditures are increased by the inflationary process. It would be fairer for Occidental to obtain intis at the free-market exchange rate for the part of its proceeds which are spent locally. Repatriated proceeds are converted to US dollars at the MUC exchange rate.

(e) Further procedural difficulties have been experienced, such as:

- Frequent lack of foreign exchange when funds are to be repatriated.
- Obligatory use of Armed Forces aircraft for air transport for field operations (payment in free-market dollars).
- Lack of punctuality in payments (of tariffs or anything else).

FIGURE 1

OCCIDENTAL CONTRACT (1985)

PRODUCTION CURVE (PROVEN RESERVES)

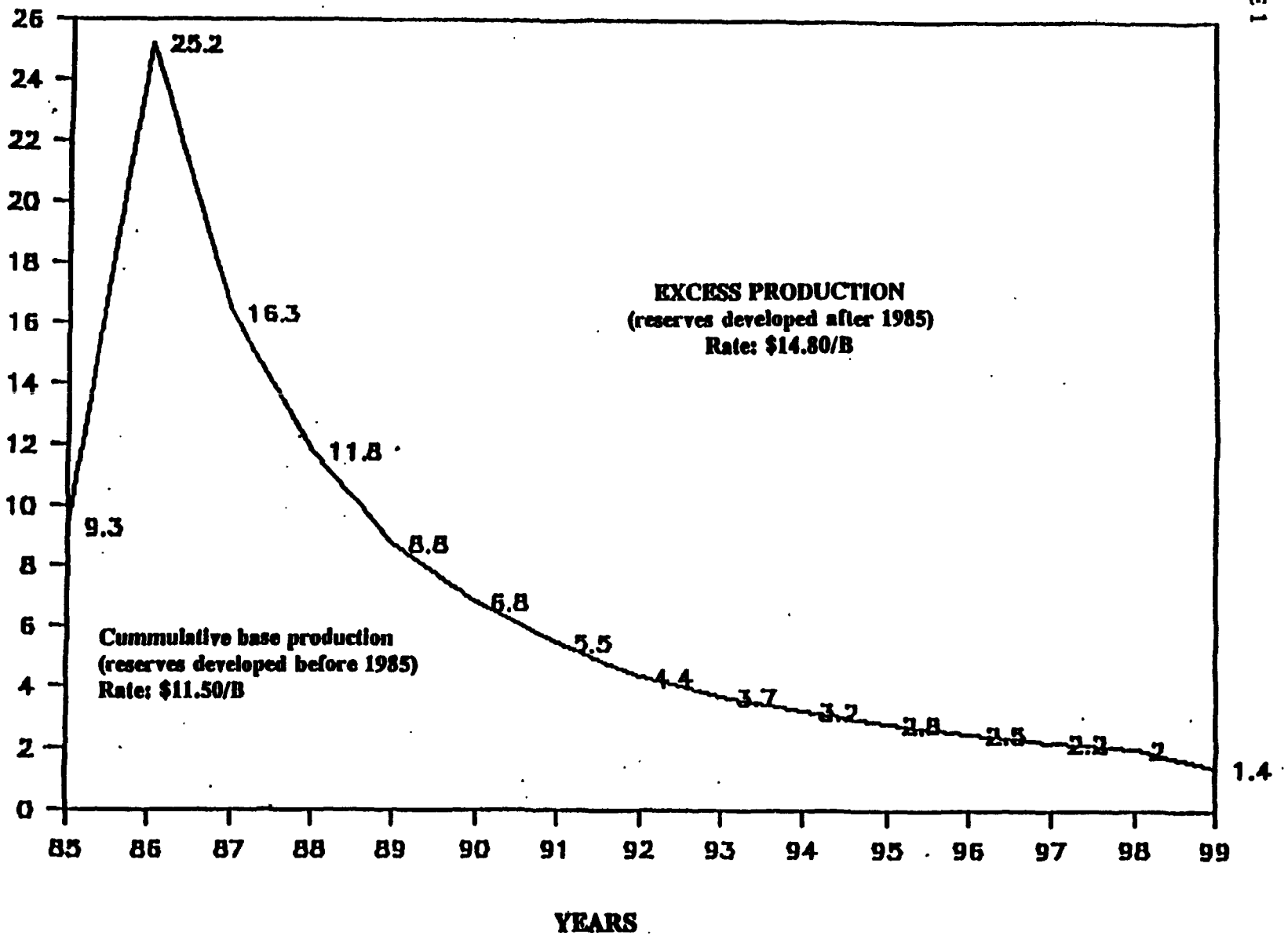


FIGURE 2

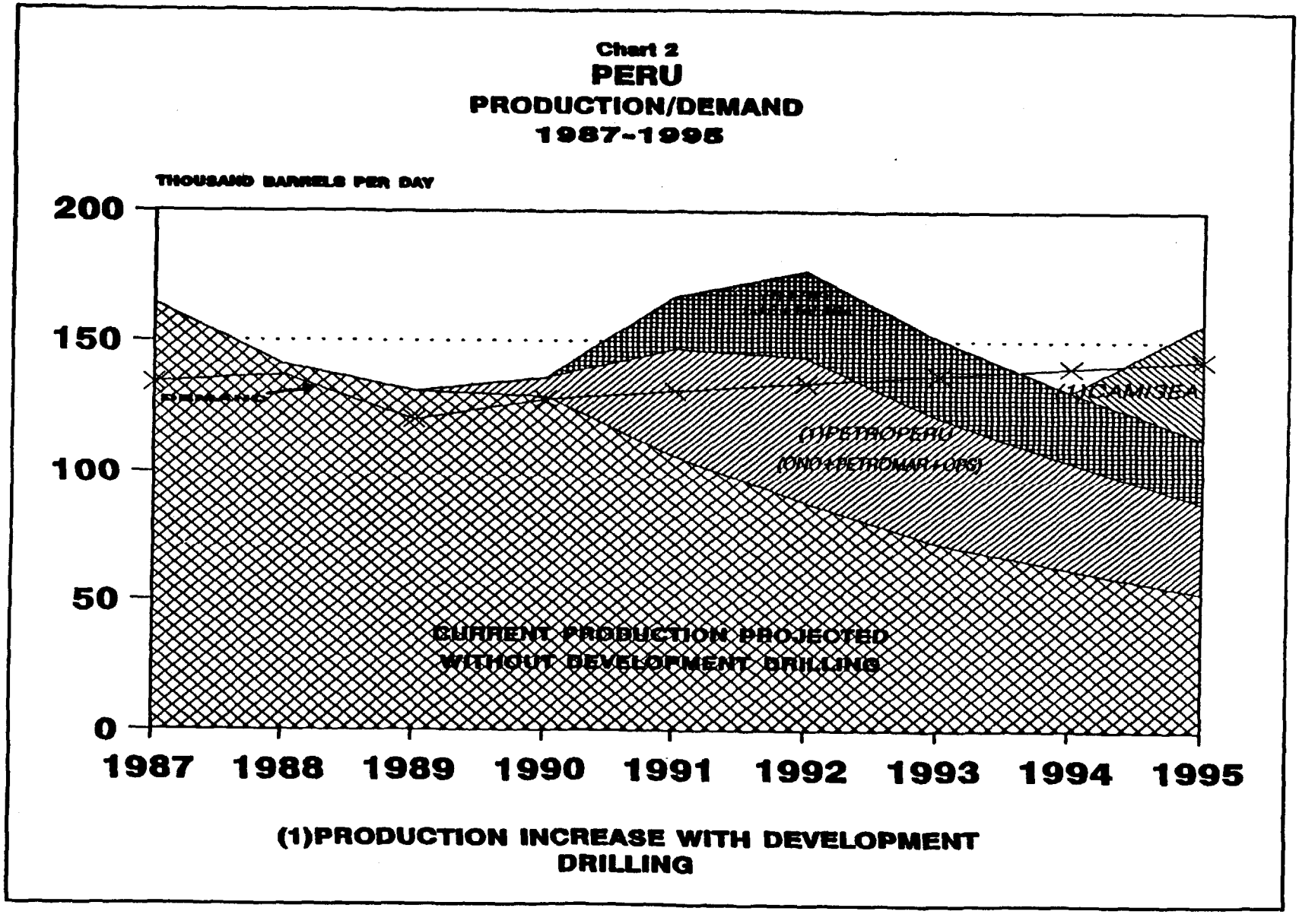


Chart 2
PERU
PRODUCTION/DEMAND
1987-1995
THOUSAND BARRELS PER DAY
200
150
100
50
0
1987
1988
1989
1990
1991
1992
1993
1994
1995
(1)UCAMI/SEA
(1)PETROPERU
(ONO+PETROMAR+OBS)
CURRENT PRODUCTION PROJECTED
WITHOUT DEVELOPMENT DRILLING
(1)PRODUCTION INCREASE WITH DEVELOPMENT
DRILLING

B. Mobil contract (1989)

7.42 This contract was signed under the revised 1987 legislation, which introduced some alleviations. While its formal approach differs from Occidental's contract, it is in essence a shared gross production agreement (rather than shared gross income), with the contractor's share of production progressively decreasing as a function of the "R" factor (rather than a flat distribution, as is the case in Occidental's contract). Mobil's contract is considered more favorable to the company than Occidental's contract, in that it encourages development of marginal fields while limiting excessive gains on larger ones. Under Occidental's agreement, marginal fields may not be economically viable in a low oil price environment, while significant benefits may be achieved with high prices. The main features of Mobil's contract, compared with Occidental's agreement, are shown as follows (for equivalent terms, refer to Occidental's contract).

- *Type of contract*: Gross shared production.

- Duration of exploitation period (non-associated natural gas): 30-year exploitation period, which may be extended to 40 at the end of the exploration phase.

- Production: Shared between PETROPERU and the contractor, the latter receiving its production entitlement in accordance with a variable scale.

- Compensation: Part of accumulated production (in kind) to contractor, so that he recovers his expenditures and makes a profit. The contractor's share of production is based on a variable scale, whose percentages are set as a function of an "R" factor. "R" is given by the formula R=X/Y, where X is equal to the contractor's accumulated revenues (up to a given year) and Y is equal to the accumulated expenditure from the start of operations to the year in question. Accumulated expenditure is not reduced by depreciation/amortization; it includes transport fees paid for the use of PETROPERU's main pipelines, but not interest on loans. The "R" factor is determined on a field-by-field basis (not by reference to total revenues and disbursements over the entire contract area). Unsuccessful exploration costs anywhere in the contract area, however, are allowed as expenditures in calculating the "R" factor. Compensation for the contractor is as follows:

"R"	Contractor's compensation
0 - 1	69% of production
1 - 2	59% " "
2 - 3	49% " "
Over 3	40% " "

- *Taxation*: Under present legislation, at an accumulated rate of 45% (income plus withholding tax).

- *Depreciation for tax purposes*: Intangible assets are treated as expenditures; tangible assets are depreciated at a maximum rate of 20% per year for pre-production capital expenditure and in accordance with the general tax law (over the useful life of the asset) after production commences.

- *Accounting*: revenues and expenditures are allowed to be entered in the accounts in US dollars.

- *Domestic supply*: pro-rata among all producers, to the extent required for local consumption.

- *Exports*: If the contractor has oil available for export, this will be sold at the international market price.

- *Customs duties*: PETROPERU pays the customs duties on items imported for oil activities.

- *Transport fee for use of PETROPERU's pipelines*: according to a formula which considers depreciation on investment (over 20 years), operating costs, the price of crude oil, and a marginal profit.

Remarks on the Mobil contract

7.43 Under the 1987 Law, incentives were introduced in the new model contract, as to:

- Accelerated depreciation for pre-production capital investments.

- Dollar accounting.

- Longer exploitation period for non-associated natural gas. Nevertheless, no guidelines were provided (neither in the law nor in the contract) concerning the negotiations aimed at setting the terms and conditions which would govern natural gas at the time it is discovered in commercial quantities. It is important that this clause stipulates:

- A more appropriate compensation formula for the development of marginal fields and allowing the contractor a higher share of income in the initial production stages.

7.44 A comparative analysis (Occidental versus Mobil) on their respective compensation formulas, leads to the following remarks:

(a) Occidental receives a straight 47% (old oil) and 61% (new oil) of total revenues, while Mobil receives 69% during the cost recovery period (R=0 to 1). In fact, since

depreciation is deducted from expenditures in calculating the R factor, the 69% provided to Mobil extends beyond the actual cost recovery period.

(b) At the time Mobil enters a profit-making phase with an R value between 1 and 2, it receives 59% of total income (much better than Occidental's straight 47% and comparable to the 61%).

(c) Mobil's share of oil production is somewhat protected against oil price variations; the lower the prices the higher the share Mobil receives, since R factor values remain low for a longer time. Occidental is exposed to such variations with its flat share (which is worse when prices fall and better when they rise).

In any case, improvements would be desirable in the new contract model. These will be treated in the framework of suggestions concerning the current petroleum law.

THE PETROLEUM LAW

7.45 The main debatable points concerning petroleum legislation are indicated as follows: The provision establishing that tariff payments to the contractor (Occidental) are made in local currency and that foreign currency proceeds accruing to the contractor from export sales (Mobil) have to be deposited at the Central Reserve Bank for conversion into local currency, is an unjustifiable constraint. Apart from this being a strong deterrent for foreign companies to operate in any developing country (including Peru in its current economic situation), such requirement is unusual in international industry.

7.46 Moreover, the guarantee, under the law, that foreign currency for repatriation purposes would be available, either through the currency originating from export sales of national crude oil or through direct supply of such crude oil to the contractor, is not credible. Peru is not an exporter (at least for the time being) since it needs all its crude oil to satisfy domestic demand. This problem ought to be resolved, one way or another, by establishing the payment of fees in foreign exchange and by allowing the contractor to retain its local and export revenues abroad. A widely applied practice is that the company has the right to timely and freely transfer its proceeds from local services or sales and retain the proceeds from export sales abroad, except for what is needed to meet local expenditure and tax payments.

7.47 The currently permitted practice of dollar accounting removes the "tax on inflation" but does not solve the foreign exchange availability problem.

7.48 Depreciation at the present rate of 20% per year on capital investments made in the pre-production period should also be extended to capital costs incurred in the post-production phase. The much slower amortization rate of the latter under the provisions of the general tax law discourages investment such as the replacement of machinery and equipment or secondary recovery operations by the companies, due to the possibly too short time limit (contract expiry) to recover them.

7.49 The system of paying income tax in kind, that is in oil, is unusual. It should be paid in cash, with PETROPERU retaining the right to request the contractor to supply the domestic market with the latter's crude oil. A possible explanation on why taxes are to be paid in oil (or in kind) is that PETROPERU has direct access to additional production, whereas its cash equivalent would normally go to the government and could be used for other purposes.

7.50 Advances on income tax at the rate of 40% of gross income (subject to adjustments upon final settlement at fiscal year end) is excessive, considering that the tax rate on profit is 45%.

7.51 For a vertically integrated company, freedom to dispose part of the oil belonging to it is desirable. Obligation to supply the local market should be limited to a reasonable percentage of the company's share.

7.52 PETROPERU shareholding in contractor rights, by acquiring an interest in them after the exploration risk phase is over, is a good policy for PETROPERU. However:

(a) Such share should never exceed 30 to 35% (at present, it is at a minimum level of 20% with no ceiling), granting due consideration to the contractor's legitimate financial expectations in view of the exploration risk incurred.

(b) PETROPERU should refund its share of past exploration costs already incurred by the contractor, instead of the present situation whereby the share acquired by PETROPERU does not entail any exploration cost.

7.53 Problems arising from the two main exchange rates of local currency ("MUC" and "CLC") have been dealt with under "Issues to be discussed concerning the Occidental contract". Such problems should be resolved either by eliminating the double exchange rate (a macroeconomic policy issue) or by stipulating that payments due to companies be made in foreign currency.

7.54 A sort of contradiction has emerged in PETROPERU's relationship with the government, concerning dues and taxes.

(a) On one hand, PETROPERU must pay an 8% royalty to the State on all oil production, whether its own oil or oil produced by contractors (at present, PETROPERU has been temporarily exonerated from this obligation, due to its critical economic situation).

(b) On the other hand, the Public Treasury transfers the income tax paid by contractors to PETROPERU, as a contribution to PETROPERU's exploration effort.

7.55 Although the royalty is an unavoidable payment (since it is a tax on production in order to produce), income tax is dependent on whether contractors make a profit or not. In conclusion, to

facilitate PETROPERU's economic recovery, it would be wiser to exempt PETROPERU from royalty payment rather than attempting to help it with uncertain tax transfers (if and when they are received).

EXPLORATION EFFORT TO ACHIEVE STEADY PRODUCTION OF 200,000 BARRELS PER DAY

- Reserves should be increased and maintained at a level of 1.46 billion barrels (including present reserves of 335 million barrels and excluding those identified in Camisea), in order to maintain reserves for 20 years, at a production rate of 200,000 barrels per day. If these replacement reserves are not found, the reserves-to-production ratio cannot be maintained and would start to decline.

- The current level of reserves is 350 million barrels, which accounts for a production of 4.8 years at the aforementioned rate of 200,000 barrels per day. Further reserves of 1.11 billion barrels should be discovered and put on stream by 1995. Optimistically assuming an average of 250 million barrels of reserves discovered under any contract where exploration is successful, some 4.5 contracts should be entered into. If again we optimistically assume a 50% success rate (that is, one out of two contracts is successful and makes commercial discoveries), some nine contracts would be required. This should take place as soon as possible, in order to have the extra reserves on stream by 1995.

INVESTMENT REQUIREMENT

7.56 For each successful company (discovering reserves of 250 million barrels), exploration (geophysical and drilling) may require some US$400 million (US$1.5 per barrel, according to historical experience), production and development facilities some US$1 billion (US$4.0 per barrel) and operating expenses some US$1 billion (US$4.0 per barrel); the unit production cost would amount to US$9.6 per barrel.

PROFIT SHARING

7.57 Under the new model contract, net profit sharing between the country (PETROPERU plus income tax to the government) and the contractor will depend on the oil price assumed.

(a) Under such a contract (financially analyzed by PETROPERU), a price of US$25 per barrel would give the following table:

Income (a)	US$25.0/B		
Technical cost	US$ 9.8/B		
Project profit	US$15.2/B		
Share of PETROPERU			US$ 8.2/B
Income tax (government)		US$ 2.5/B	

PETROPERU plus government (*)	US$10.7/B
Company share	US$ 4.5/B

(a) With an oil price of US$20 per barrel the above formula would lead to a country/company shared profit ratio of 80.6/19.4.

* Country/company profit ratio (%): 70.4/29.6

7.58 Peru's geological potential (particularly in the rain forest) is good. PETROPERU's assumptions on reserves to be found by Mobil and E. Callan are:

Mobil:	500 million barrels
E. Callan:	205 million barrels

7.59 The reserves produced by Occidental (1989) are 371 million barrels (B1. 1AB), with some remaining 50 million barrels, which could be produced towards the end of 1995 with infill drilling. This prompts us to state that, in a large promising area, an average of 250 million barrels could be discovered.

B. HYDROCARBONS DOWNSTREAM SUBSECTOR

SUPPLY AND DEMAND OF OIL PRODUCTS

7.60 The demand for refined products in 1989 was about 126,000 barrels per day in the first half of the year, falling to 50,000-60,000 barrels per day after the August 1990 price measures. Table 1 shows that the domestic supply of crude oil is slightly higher than the demand for oil products, that is, 148,000 barrels per day were processed, 22,000 barrels per day were exported and about 126,000 barrels per day were consumed on the domestic market. There are net exports of gasoline and fuel oil, as well as modest imports (by volume) of middle distillates and liquified petroleum gas (LPG). It is now estimated, however, that Peru is a net importer in monetary if not fiscal terms, since a large amount of light crude oil is imported to balance refining loads.

Table 1: **Summary of Supply and Demand in 1989**

Oilproduction	MBD		
Northeast	47.9		
Eastern rain forest	82.5		
Total	130.4		
Exports	1.0		
For refineries	129.4		
plus imports	18.8		
Total refined	148.2		
	Domestic Sales	Imports	Exports
LPG	4.7	0.5	
Gasolines	24.6		4.5
Middle distillates	55.1	9.3	
Fuel oils	32.8		36.0
Total	117.2	9.8	40.5

7.61 As is common in developing countries, the ratio of middle distillates to gasoline is more than 2.2. This is aggravated by the price of gasolines, which are very high in comparison to the price of middle distillates:

Gasoline	95	14,000 intis/gallon (April 1990)
Gasoline	84	8,400
Kerosene		6,600
Diesel		6,600

7.62 Apart from this distortion, product prices have been below their opportunity costs and often below their production costs for many years, depriving both PETROPERU and the government of needed earnings. Thus, the aforementioned diesel price amounts to about US$3 per barrel, compared with the production cost, including refining, of about US$8-10 per barrel and an opportunity cost of US$26 per barrel. It is generally agreed that correction of this situation is top priority.

7.63 Forecasting growth in demand in the present unstable situation is difficult, but it may be assumed for planning purposes that if an increase in prices is established, then growth in demand will be lower for the next few years (it is assumed for fiscal purposes that demand will fall to about 100,000 barrels per day if the average price of oil products is about US$1 per gallon or more).

PRODUCT SUPPLY ALTERNATIVES

7.64 Peru has the following alternatives for supplying oil products to the domestic market:

- Importation of products from one or more of the export refineries, with those in the Caribbean probably being the most logistically suitable.
- Elaboration of products, in existing Peruvian refineries, on the basis of domestic crude oil.
- Elaboration of products, in existing Peruvian refineries, on the basis of imported crude oil.

In practice, under present conditions, it is probable that a combination of these alternatives is used, considering the limited flexibility of the refineries to balance supply and demand.

7.65 Peru's six refineries fall into two categories; the three refineries on the coast which may be supplied with both domestic and imported crude oil, and the three small refineries situated in production fields in the eastern Amazon. The coastal refineries (Talara, La Pampilla and Conchán) must compete with the alternative of direct import of oil products by tanker. The freight costs associated with both the export of crude oils and the import of products should give these refineries a competitive advantage over imports, but these refineries are relatively small and technically less sophisticated than the Caribbean export refineries. In addition, they are in very poor physical condition as a result of the lack of funds for maintenance and modernization. Moreover, the coastal refineries account for more than 90% of the installed capacity and supply the coastal region and the sierra.

7.66 The Talara refinery is a special situation since it is the base of a petrochemical complex (solvents, fertilizers, greases and lubricants, asphalts and carbon black). Each one of these has the potential of adding more value to the petroleum feedstocks and reducing import requirements. Likewise, associated gas is available in the area and is exploited for refinery, industrial and feedstock fuels to produce fertilizers.

7.67 The three inland refineries (Marsella, Iquitos and Pucallpa) are simple distillation units, designed to produce some fuels and possibly asphalt, mainly for use in oil fields and to supply small villages near the fields. These refineries can balance the supply of individual products with demand and return excess products to the crude oil mixture to be pumped to the coast. In the case of Iquitos, exports and imports stemming from refinery operation are transported by tankers via the Amazon. Although these plants have relatively high costs due to their uneconomical size and to the additional costs stemming from their isolation, they are often economically justifiable due to the high costs of alternative supply, since the transport costs from the ports and coastal refineries are very high.

IMPORT AND EXPORT OF OIL PRODUCTS

7.68 Logistically, the major Caribbean export refineries are probably the cheapest source for importing oil products to Peru via the Panama canal, although Brazil may also be considered, via the Amazon, as a source of supply for the eastern area. The freight costs are lower from Venezuelan refineries and slightly higher from the US Gulf coast and the Bahamas.

FREIGHT COSTS TO TALARA
US$ per ton, Worldscale

Amuay	4.05
Cardon	4.06
Curacao	4.18
Beaumont	5.15
Bahamas	4.92

The transit cost for the Panama Canal, at US$4.00 per ton, should be added to these freight costs.

7.69 A difference of US$1.00 per ton (between the several possible purchase points) is equal to a mere 15 US cents per barrel, which is not particularly significant when choosing the product's source within this supply region. A recent estimate of the cost of oil products imported from Curacao, based on prices announced in February and at the end of August 1990, is as follows:

1990 IMPORT PRICES

Product	US$ per barrel CIF	
	February	August
Gasoline 95R	28.93	46.54
Kerosene DP	29.11	45.33
Diesel 45 CET	27.56	40.99
Bunker C	14.84	23.91

Details of the calculations are shown in annex 5, table 2. PETROPERU's current import prices could vary slightly due to specific commercial arrangements.

7.70 LPG is currently imported from the Caribbean through a supplier who also supplies Ecuador and Chile. The CIF price is estimated to be US$22.83 per barrel in July 1990.

7.71 Regarding the export of surplus products, the United States is the most likely market, despite sales currently being possible to other countries in the region. For example, Central America is a net importer and may provide an outlet, particularly on the Pacific coast, which is supplied by the Caribbean or Mexico. However, for financial analysis purposes, the market is assumed to be the United States (USA).

7.72 The opportunity costs should be the basis for financial refinery calculations and for the product pricing structure in the local market. Therefore, crude oil and residual fuels should currently be estimated at FOB export values, but middle distillates and LPG should be estimated at import parity. Gasoline exports are currently low, so the export price margin is relevant, however, for the financial analysis of refining, import parity is more appropriate. The low local prices in Peru lead to an inadequate cost recovery and a lack of incentives for oil conservation. The most important factor for Peru's future energy strategy should be the increase in price levels to at least the opportunity costs of the refineries, plus marketing and domestic transportation costs.

OPTIMUM LEVEL OF REFINING IN PERU

7.73 In many developing countries, oil refineries operate although the market may be supplied more economically by imported products. This is partly due to inertia and political reluctance to close an industrial plant with trained employees, symbolizing industrial development. In some cases, the real absence of profit is concealed by poor accounting and\or errors in financial analysis regarding supply alternatives. This situation is more common in countries which do not produce crude oil and which possess small hydroskimming refineries of the type that were frequently installed in the decades before the rapid escalation of crude oil prices.

7.74 Peru is in a position where local refining has more likelihood of being justified, with its local source of crude oil and two large refineries equipped with catalytic crackers. However, Peru should analyze the performance of each one of its six refineries to ensure that importing products is not the most economical option and if they are to be operated, that the best crude oil is selected. The alternative of consolidating refining in a smaller number of larger refineries should also be born in mind.

7.75 PETROPERU currently reviews its refining strategy on a monthly basis using a linear planning model of the refining system. The strategy should reconcile any contractual agreement for the purchase or sale of crude oil and/or oil products. Generally, this analysis has indicated that the best strategy is that of operating lighter refineries at maximum load with local crude oil and complementing it with imported crude oil from Ecuador according to requirements. Normally the model does not examine the option of closing one or other of the refineries.

7.76 The tables in annex 5 (tables 4 to 8) illustrate examples of current profit calculations for each one of the five refineries now operating. These are based on the opportunity costs of the aforementioned products, the current import and export values of crude oil and the refinery operating costs taken from PETROPERU's operating reports in 1989. They do not consider all the details of each refinery operation, but provide a general view on profitability under present conditions, valuing production at opportunity costs.

7.77 These calculations indicate that all the refineries currently operating are profitable (on a country rather than a company basis) despite the profitability of Conchán being marginal and that, in the medium to long term, it should be shut down along with the next expansion of La Pampilla. The refining sector, as a whole, generates net earnings of about US$269 million per year in economic terms (taxes have not been considered in the financial analysis).

PETROCHEMICALS AND NON ENERGY PRODUCTS

Fertilizers

7.78 The basic problems with the Talara urea plant are similar to those of the refineries; inadequate product pricing and a consequent scarcity of funds for necessary supplies, materials and maintenance. PETROPERU figures demonstrate that the Talara plant's production costs are marginally higher than the imported product before import duties, excluding packaging costs in both cases (the packaging and marketing costs should be considered separately and should be the same for the imported as well as for the domestic product). PETROPERU confirms that its overall costs are less after packaging and general expenditures, but this clearly does not mean that there is a justification for operation of the urea plant.

7.79 If costs were roughly equal, there would be a case for operating the plant to save foreign currency. However, this is extremely unlikely if the economic cost of gas is considered (which is currently scarce) and in that it marginally substitutes diesel. If there were a surplus of gas in the Talara

region there would be more justification for operating the plant. However, this plant is currently marginal and probably does not justify any new investment unless a private investor is ready to rehabilitate and reorganize it. Its privatization could, however, present certain difficulties due to the close integration between this plant and the Talara refinery. For example, when there is a scarcity of gas, as at present, PETROPERU grants certain priority to this plant, which could not happen if it were privately owned (although if it paid the financial cost it would suit PETROPERU to grant it priority in the supply of gas, instead of supplying it free to the distribution network).

7.80 Likewise, there is a water desalination plant and a thermal power station (Malacas) connected with the urea plant, which also supplies the refinery. Appropriate contractual agreements which are acceptable to all the participants would be required to sell these installations.

7.81 Thus privatization should probably be delayed until these difficulties are resolved. If the gas supply and other services were adequate and satisfactory prices could be negotiated, there would be no reason for this plant not to operate independently and more efficiently. Essentially, the new privatized fertilizer company should have the option of manufacturing or purchasing feedstocks (urea) abroad, packaged more conveniently for the local market and selling it at a free-market price. It would be in competition with other potential suppliers (probably foreign, with low customs duties!), which would provide an incentive to improve the plant's efficiency.

7.82 Where there are a number of industrial plants in the same area, as in Talara, there may also be justification for maintenance to be carried out by contract, so developing a market for services accessible to all current and potential companies. The formation of a couple of private maintenance companies offering metal-mechanical, soldering, inspection, instrument repair and civil works services etc., could also be envisaged.

7.83 Another benefit which could be obtained by separating fertilizer operations could be the establishment of a managerial capacity. Its first responsibility would be the fertilizer business, providing a great opportunity to develop specialized experience in this activity. Likewise, this would allow the management of the refinery to concentrate on its main duty of producing fuel.

Carbon Black

7.84 Carbon black is a substantial input in tire manufacture and if not produced locally has to be imported. It is advantageous to link its manufacture with an oil refinery since a product of catalytic cracking (clarified oil) is used as a feedstock. This feedstock may also be mixed with fuel oil but it is a low value product and its conversion to carbon black significantly increases its value.

7.85 This plant represents a specialized operation which may easily be separated from the refinery and privatized, provided that adequate services are available at satisfactory prices. PETROPERU has shown that the operation is economically feasible, despite a lack of working capital for materials and

maintenance. If this plant were privatized, its maintenance should be carried out on a contract basis by a third party, and not by its own maintenance personnel or by the refinery.

7.86 For the financial analysis of the plant, feedstock should be valued at the FOB export price of Fuel oil 6. PETROPERU indicates production costs in the range of US$543 to US$618 per ton, while the import cost is US$670. The profitability of this plant is marginal under current management.

Solvents

7.86 The solvent plants' feedstock is propylene, a catalytic cracking product which may also be contained in LPG. Supply to the factory has been restricted due to the scarcity of LPG. Conversion to solvents adds value to LPG. LPG is imported and its economic cost is high (could exceed US$200 per ton). At this feedstock price, it is not clear whether the saving in solvent imports like isopropyl alcohol or acetone justifies operation of this plant. When there is surplus LPG available (after Camisea, maybe in 1996-1997) the profitability of this type of plant should be reassessed. Financial analysis of the plant, conducted by PETROPERU for the January-July 1989 period, shows that it is marginally profitable.

7.87 PETROPERU is opposed to the separation of this plant (with or without privatization) from the refinery, mainly because it is physically situated within the refinery and is closely connected to the refinery system. Moreover, the feedstock is normally produced directly from the catalytic cracking unit and as the feedstock is in a gaseous form, it cannot easily be stored in large volumes. These are valid reasons for keeping this plant as an integral part of the refinery, if its operation is confirmed to be economically feasible.

Gas and LPG processing

7.88 This installation processes associated gas to produce dry gas for fuel and/or feedstock for the urea plant, propane for the production of LPG, butane for gasolines and LPG and condensates as part of the refineries' general feedstock. Presently it is operating far below its design capacity due to a scarcity of feedstock. This equipment urgently needs maintenance, particularly the steam boilers. It produces high value products and therefore its rehabilitation should be top priority. This equipment is essentially an integral part of the production and refining operations and could not be separated from the latter.

Lubes, greases and asphalt

7.89 The main problem of these plants is reported to be a scarcity of raw materials. The feedstocks for producing lubes and greases are basic olefins, some of which are locally manufactured while others are imported and mixed with specific additives, the majority of which are imported.

7.90 These plants have an overcapacity with respect to domestic demand and must be operating at a loss. For this reason, PETROPERU is considering opening up export markets with neighbor

countries, although this is not easy, since the subsidiaries of the large oil companies control many of the markets.

7.91 As the asphalt plant is closely integrated with the main part of the refinery, it is suggested that it should remain as such. However, separation and privatization of the grease and lubricants plant in Callao may be considered. This is a very specialized field which may be easily separated from the refinery and is also very different in nature. It would be advantageous to be able to separate its operating costs. The grease plant would purchase materials from the refinery and would contract maintenance out to a third party as previously proposed.

NATURAL GAS

7.92 The natural gas deposits in Camisea have been identified as the most significant new source of hydrocarbons in Peru. The development of this field is described in another section of this report. An investment of about US$1.4 billion is envisaged for initial production of natural gas amounting to 900 million cubic feet per day and a recovery of 50,000-55,000 barrels per day of liquids, of which 35-40% will be LPG and the remainder C5+ hydrocarbons. The liquids must be fractionated to supply an expanding LPG market which may include exports. The C5+ hydrocarbons will form part of the naphtha for local conversion to gasoline (which may also be exported). The domestic market for oil products is currently 130,000 barrels per day. The Camisea gas has the potential of satisfying a substantial share of Peru's demand for petroleum, provided that the necessary substitutions can be carried out, for example:

- LPG for domestic use instead of kerosene
- Use of more gasoline for transportation instead of diesel
- Natural gas for industry instead of fuel oil and diesel

7.93 These substitutions will require a different pricing policy to the current one, which is proposed in the first part of this report. The result will be to free about the same volume of crude oil and/or refined products for export. The effect on the balance of payments will depend on the net effect between exports, debt servicing and the remuneration for foreign capital financing the project.

7.94 It is estimated that the natural gas distributed in Lima will have costs approximately equivalent to the value of fuel oil for export (US$2.00 per million BTU). Many of the other substituted fuels will have substantially higher values (LPG at US$23 per barrel or US$6.3 per million BTU). In addition, natural gas is a clean, versatile and efficient fuel, also usable as a feedstock for the chemical industry.

7.95 The transport of gas from Camisea to the coast will have a significant effect on Peru's optimum refining strategy. Presently, Peru imports middle distillates and exports surplus gasoline and fuel oil. The decline in demand for kerosene and diesel will lower the amount of crude oil that has to be refined, which in turn, will reduce crude oil imports (or will increase exports). Fuel oil exports will increase as a result of the availability of condensates but, as less crude oil will be refined, this will tend to lower the export of fuel oil. Finally, the supply of gas to the La Pampilla refinery will avoid the use of fuel oil currently needed for processing and will provide an economical source of hydrogen, which could be used for hydrocracking.

REHABILITATION

7.96 PETROPERU reports indicate a scarcity of materials and supplies for maintenance and operation. The first priority will be to correct this situation and restore a reasonable mechanical condition. It is estimated that PETROPERU needs the following funds for its rehabilitation:

Refineries	US$20 million (US$80 million if the catalytic cracking units are included)
New Talara Wharf	US$47.0 million

7.97 The first priority will be to identify and cost all the individual items making up the above-mentioned headings and confirm their financial justification. In particular, a more detailed study of the sizeable investment in the Talara Wharf is required. These additional studies will be the first component of the proposed rehabilitation program.

MODIFICATIONS AND EXPANSION

7.98 The entire plan for investment in downstream activities (refining, processing, industrialization) must bear in mind the following three important elements:

- Substantial price increases that will affect demand.
- Additional exploratory efforts to increase reserves and production.
- Potential effect of Camisea gas.

7.99 The price increases recommended in this study will raise the prices to at least the opportunity costs plus local transport and marketing costs. This will cause a reduction in general demand and will modify the demand structure for individual products. For example, industrial plants now using middle distillates, will have a strong incentive to convert to fuel oil.

7.100 It is also recommended that taxes be added to fuel prices or increased, mainly to produce public income but also to direct the demand toward specific fuels and to create more incentive for energy saving and conservation. If, for example, demand could be diverted from diesel to gasoline (when it can be substituted) there could then be a saving in refining, so reducing the need to import distillates and export gasoline (which will help to reduce the supply costs).

7.101 PETROPERU also reports that there is smuggling, wastage, adulteration and uneconomical substitution due to the low prices of middle distillates. For example, these fuels are used in industries where fuel oils can also be used more economically. Incentives must be created via the pricing structure to ensure that the heaviest fuels possible are used.

7.102 The effects of these changes is considered in relation to the expansion plans of the different refineries as follows:

Talara refinery

7.103 The following improvements have been proposed:

- Construction of a new wharf (US$47 million)
- Conversion of the Catalytic Cracking unit to a system and cracking riser (US$0.8 million)
- Expansion of the vacuum distillation and catalytic cracking units and installation of a crude oil desalinator (US$71 million).

7.104 PETROPERU regards the new wharf to be essential for operation of this refinery, since one of the existing wharves was damaged in an accident and is unsafe and the other is out of service. As previously mentioned, this enormous investment requires a study to seek cheaper alternatives.

7.105 Currently, the future supply of crude oil to this refinery is uncertain, depending on the success of efforts to find and produce more crude oil in the northeastern fields. This knowledge would be an important parameter in determining expansion plans. The investment and expansion costs in this refinery should therefore be limited to basic maintenance (or to small investments avoiding bottlenecks) until a better idea of the crude oil supply is available. It is clear, therefore, that installation of a large catalytic cracking unit cannot be justified (since there is a surplus of gasoline, a light oil may be found in the future which does not need cracking and the current refining capacity is more than sufficient).

7.106 The availability of associated natural gas is important for the financial assessment of this refining and petrochemical complex, either for low-cost fuel or for feedstock. This gas is currently scarce, due to inoperative field compressors whose rehabilitation is priority.

La Pampilla Refinery

7.107 The following projects are under consideration:

- Removal of the bottleneck in the catalytic cracking and vacuum distillation units
- Setting up a third wharf for tankers (US$1.6 million).

7.108 La Pampilla is Peru's largest and most up-to-date refinery and is closest to the major markets. When the Camisea gas field is developed there will be access to an excellent source of light hydrocarbons. It should therefore be considered the best candidate for future development and expansion.

7.109 The refinery is currently undersized in its conversion capacity compared to its crude oil distillation capacity. The capacity of the catalytic cracking unit is a mere 8% of the total crude oil transformation capacity, while in many developed refineries this usually exceeds 40%. Nowadays, high capacity conversion refineries are the most profitable.

7.110 Currently, Peru's refining capacity is balanced with general demand. However, it is out of balance with individual products so conversion capacity is needed. As catalytic cracking basically produces gasoline, while middle distillates are more scarce, hydrocracking is the probably the best option, since it maximizes the production of middle distillates.

7.111 The major cost element in hydrocracking is the hydrogen source. This cost would fall considerably if a source of low cost natural gas was available, so that the arrival of Camisea gas in La Pampilla will be very favorable to the future development of hydrocracking in this refinery.

7.112 The crude oil produced in Peru in the last few years has become heavier, with Loreto crude amounting to about 22-24 API. This trend would also justify, in due time, major investment in conversion and possibly hydrotreatment, which is not currently practiced, since sulfur levels are favorably low.

7.113 Such investments need massive resources and in times of uncertainty, may only be considered (and will only be necessary) in the long term. In view of this, catalytic cracking investments should be minimized.

Conchán Refinery

7.114 With present capacity of only 8,000 barrels per day, this refinery, which also supplies the Lima region, is too small to be economically compared with La Pampilla. This refinery was shut down for a period after La Pampilla was expanded, but was later recommissioned.

7.115 Bearing in mind that this plant is economically marginal, closure of this plant in the medium term is probably justified, along with the next expansion of La Pampilla. The storage and loading installations could be kept in use to receive, store and distribute finished products.

7.116 Currently, Conchán is a large-scale asphalt producer. The vacuum unit of La Pampilla does not have the capacity to produce asphalt. Therefore, the closure of Conchán should be linked with the new vacuum capacity of La Pampilla, designed for asphalt. The vacuum unit could also be moved to La Pampilla.

Iquitos Refinery

7.117 Although the refineries in the eastern rain forest are small, they are economically feasible due to the high cost of transporting products to these regions and to the local availability of low cost crude oil. Iquitos balances production with demand and the import and export of products by tanker via the Amazon. The following projects are under consideration for Iquitos:

- Asphalt plant (moved from Talara) (US$3.0 million)
- In the long term, a catalytic cracker and a catalytic reformer.

7.118 Bearing in mind the small size of the market, it is unlikely that the asphalt plant is justified unless the region undergoes enormous growth. Nor is a catalytic convertor justified in a refinery of this capacity. A catalytic reformer may be more appropriate since naphtha is currently transported from coastal refineries to meet the octane requirements of Iquitos gasoline. The most economic way of obtaining octane is probably tetraethyl lead, with the possibility of using relatively low octane content products. Lead levels, however, are currently above acceptable levels, about 4.0 ml per gallon. A reformed module could be considered, whose cost is on the order of about US$5.0 million. The reformer will be discussed further below.

Pucallpa refinery

7.119 Installations to produce turbo fuel have been proposed for this refinery at a cost of US$0.1 million. This small investment could be justified.

Marsella refinery

7.120 There is a proposal to transfer this plant (which is not in operation) to station 7 of the North Peruvian Oil Pipeline to supply part of the fuel required for the pump compressors. This is probably feasible in view of the high cost of moving fuel overland from Talara by road to supply the station. Alternatively, an agreement could be reached to restart operations in its present location.

Catalytic Reforming

7.121 The Peruvian refinery industry is exceptional for its low capacity for catalytic reforming: only 1,700 barrels per day in La Pampilla or less than 1% of the crude oil load capacity. The majority of modern refineries include a catalytic reformer with a crude oil loading capacity of about 10% to 20%. About 40% of the gasoline sold in the United States is catalytically reformed.

7.122 The catalytic reformer increases the octane index at the expense of the gasoline yield, producing byproducts like hydrogen and LPG. Alternative sources for obtaining octane are tetraethyl lead and catalytically cracked naphtha. These three sources are generally used to control octane levels (except lead-free gasoline which normally uses other components with a high octane content).

7.123 In the medium- to long-term development of Peru's refineries, particularly La Pampilla, the installation of a catalytic reformer should seriously be considered. With a surplus of gasoline low in octane and a scarcity of LPG, a catalytic reformer could balance refinery yields, reduce the import costs of tetraethyl lead and improve the quality of the gasoline. This would also make BTX (Benzene, Toluene, Xylene) production possible for the manufacture of solvents and petrochemicals.

REMARKS ON THE PRIVATIZATION OF PETROPERU'S SUBSIDIARIES

7.124 Although a final decision regarding the privatization of State companies is of a political nature, the reasons for doing it are basically of a technical, administrative, economic and financial nature. In this respect, the different points of view regarding the possible privatization of the subsidiaries of PETROPERU S.A. are presented below.

PETROLERA TRANSOCEANICA S.A.

7.125 Its privatization is operatively feasible. The change in relationship with PETROPERU S.A. would not alter the operations of both companies; the only difference with this change being that PETROPERU would develop freight tendering where TRANSOCEANICA would participate as a supplier of services in open competition with others (including the Commercial Naval Office representing the commercial chartering activity of the War Marine).

7.126 The privatization of TRANSOCEANICA is also administratively feasible. In keeping with the above, a reallocation of personnel should be carried out in the Supply and Transport Office of PETROPERU S.A. so that all the freight tenders could be managed directly.

7.127 In financial terms, privatization should imply that the new shareholders of PETROPERU TRANSOCEANICA S.A. assume the "Pavayacu" and "Isabel Barreto" debt. In early December 1989, the mature and unpaid portion of debt was 124,374,350,884 intis and the outstanding portion was 14,276,435,785 intis (the grand total of 138.6 billion Intis equivalent to some US$26.35 million).

7.128 Rescheduling this debt is feasible, bearing in mind that the tariffs to be charged for chartering ships usually consider a depreciable amount, which may be directed toward debt rescheduling.

7.129 In economic terms, privatization of TRANSOCEANICA is feasible since it is treated as a consolidated activity which generates profits.

7.130 It should be noted that one of the possible affects of privatizing TRANSOCEANICA would be a decline in PETROPERU's average charge period which last time was 204 days; this is a situation which any administration would obviously try to correct.

7.131 The book value of TRANSOCEANICA's total assets was 448.2 billion Intis at the last year end (December 31), with fixed assets of 3118.8 billion (after depreciation). In any case, an updated estimate, in terms of real market values, should be considered for the company's main assets, goods which can be accepted on the international market (tankers).

COMPAÑIA PERUANA DE GAS S.A.

7.132 Its privatization would be operatively feasible, demerging it from PETROPERU S.A. This action would not alter the current operating activities of both companies and would simply entail their relationship being the same as other trading companies competing in the distribution and commercialization of liquified petroleum gas (Lima Gas, Deita Gas, etc.).

7.133 Administratively, the privatization of CIA PERUANA DE GAS S.A. is feasible since its organization and procedure have been managed autonomously and could be developed totally independently. In financial terms, there is nothing which could affect its possible privatization. COMPAÑIA PERUANA DE GAS does not have long-term third party debts, its commercial liquidity ratio is 1.83, its acid liquidity ratio is 0.75 and its indebtedness is 0.54.

7.134 In economic terms, it should be noted that although operating activities generated a loss of 2.5 billion Intis in 1989, this was mainly recovered with financial earnings from returns on cash surpluses and installment sales of appliances.

7.135 Bearing in mind that the main income of this company comes from the sale of liquified petroleum gas and in the last few years this fuel has had the most distorted price of all, it is foreseeable that in the short term, with economic adjustments being implemented in the country, its price will be substantially higher with the logical increase in the appropriate trading margin. Even when this measure implies a sudden reduction in sales, it is estimated that the economic effect will be positive.

7.136 The book value of fixed assets at December 31, 1989, was 33.7 billion intis against total assets of 43.6 billion (both figures are stated after depreciation). An expert evaluation should be considered to obtain an updated reference in terms of market value.

7.137 It is recommended that prior to making any decision altering the relation of CIA. PERUANA DE GAS S.A. with PETROPERU, an agreement to concrete the procedure of enabling lands that both companies have planned and what is in their mutual interest to carry forward should be defined.

PETROLEOS DEL MAR (PETROMAR)

7.138 Unless PETROMAR is returned or privatized with the involvement of its old owners, its privatization in the short term will be difficult for two main reasons:

- The arrangement concerning the expropriation of assets from BELCO PETROLEUM, undertaken by the government in 1985 and giving rise to the creation of PETROMAR S.A., is still pending. Under these conditions, it would be difficult to interest private capital to participate when they are in the middle of international claims.

- The close tie with PETROPERU's operations. PETROMAR's supply of crude oil is equivalent to 37% of the crude oil processed by the Talara refinery. In addition, PETROMAR's supply of gas is more than 60% of that available in the area and it is essential to ensure operation of the Fertilizer Plant of the Malacas Electric Power Plant and other PETROPERU plants in Talara (this aspect can be overcome by defining a clear contractual agreement regarding the prices and conditions of crude oil and gas transfer). However, this is not an absolute obstacle.

PETROMAR's operating profit has been seriously impacted in the last few years by a lack of funds, which prevented an adequate supply of materials, spare parts and services for operations.

7.139 The main reasons for this economic crisis have been the decline in international crude oil prices in the foreign market coinciding with a tariff charged for the extraction of crude oil, as well as the notable distortion between the MUC exchange rate associated with the tariff, domestic inflation and the free and bank exchange rates linked to a large part of costs.

7.140 In view of the above, this subsidiary should be financially strengthened, independently from its privatization (for example, by resolving the problem that since its nationalization this company has 3000 workers more than BELCO had) so that its operating performance can be improved as soon as possible.

Servicios PETROLEROS S.A. (SERPETRO)

7.141 The state of this subsidiary is different from the others in that the operational development of this company has still not been consolidated and its organization and administration are in a process of standardization.

7.142 Provided that companies usually compete in a free market for petroleum services, a feasible alternative for this situation is considered to be a solution equivalent to leaving the petroleum services this company is proposing to develop to private initiative.

7.143 The SERPETRO operating plan for 1990 essentially displays administrative objectives and four operating projects, of which only two have advanced slightly in the first three-month period of 1990.

7.144 If redefining the State's managerial role was aimed at focussing efforts on the basic strategy areas, this would entail strengthening what is defined as PETROPERU's main activity and leaving complementary activities to private initiative, where free-market competition may produce some incentive, as in the case of petroleum services.

RECOMMENDATIONS FOR A GENERAL SUPPLY STRATEGY

7.145 The previous discussion leads to the following factors for a supply strategy:

(a) The first priority is to increase product prices to their opportunity costs, plus taxes, to moderate product demand and supply revenue for rehabilitation and expansion.

(b) A rehabilitation project for downstream activities should initially include a detailed study of the immediate maintenance needs to put the refinery and its installations in an acceptable operating condition. Current estimates indicate that about US$80 million would be required, but several substantial investments could be unnecessary. In addition to basic maintenance, adequate stocks of materials and operating and maintenance supplies need to be replaced. All the other major investments mentioned should wait for the economy to stabilize so that guidelines for the growth in demand and trends in gas and oil exploration and production may be better identified.

(c) Investments should not be undertaken in the Conchán refinery because it will most likely have to be shut down and, possibly, changed into a marine terminal and distribution deposit. The sale of this refinery to private investors could also be considered.

(d) The Talara refinery should continue operating as a fuel and petrochemical production center, but its expansion should depend on the potential of finding and developing oil and gas in the northeastern fields and on the coast. This is discussed in-depth in the upstream chapter. Other factors, such as the effect on demand of the unavoidable and substantial price increases and development of Camisea gas, should be considered.

(e) La Pampilla should probably be developed as the major refining center and in due time, should be expanded along with the growth in demand and in keeping with development of the Camisea gas, as a source of fuels and hydrogen.

(f) Peru's refineries need additional conversion capacity. In view of the scarcity of middle distillates, a hydrocracking unit using Camisea gas as a source of hydrogen should be considered for Pampilla, in the long term. Some improvements to the existing catalytic cracking units, but no new units, can be justified.

(g) A catalytic reformer should be considered in the long term. This would improve the quality of gasoline, increase LPG production and enable the levels of lead in gasoline to be reduced. This process could be introduced in one or both refineries on the coast and perhaps Iquitos. The existing small reformer in La Pampilla is uneconomical under current conditions.

(h) Privatization of the Talara Fertilizer, Carbon Black and Lubes plants should be considered, as well as the Callao lubricants plant and the rain forest refineries. These measures could improve the efficiency of both the factories and the refinery itself.

(i) The PETROPERU refineries should contract third party maintenance and similar services to reduce operating costs.

C. NATURAL GAS SUBSECTOR

7.146 Peru's energy sector shows a very large difference between the available resources and production. Petroleum, which scarcely accounts for more than 10% of proven and probable reserves, is exploited to form almost 3/4 of the country's energy production. In 1985, an average of 190,000 barrels of oil per day were extracted. Currently, production is in obvious decline as a result of the lack of reserves, of which there are only 135,000-140,000 barrels per day; while oil product consumption, encouraged by the low prices, despite the recession, borders on 130,000 barrels per day.1/

Table 1: **Commercial Energy Reserves and Production (1988)**

	Proven & Probable Reserves %	Production %
Coal	11.2	0.9
Gas & NGL	41.6	9.2
Hydropower	36.6	15.1
Oil	10.6	74.8
	100.0	100.0

Source: MEM/CONERG - National Energy Council

7.147 In view of the forecast deficit, the considerable reserves of gas and condensates (NGL)2/ discovered should urgently be put on stream. Peru's challenge in the energy field is summarized as follows; to modify its energy balance, in the next few years, thanks to the utilization of gas for the substitution of oil, to achieve considerable savings in electric power generation investments and to begin a new stage of economic growth, supported by the exportation of condensates and industrialization of these resources.

1/With the increase in price of oil derivatives, domestic consumption was much lower in September/October 1999. However, consumption will rise again and the new hydrocarbons reserves will without doubt have to be exploited.

2/NGL = Natural Gas Liquids or Condensate. These are the liquid hydrocarbons formed through condensation of the heavy fractions of natural gas due to a change in pressure and temperature, generally in treatment plants. Condensate is composed of a mixture of commercial products such as LPG, gasolines, naphthas and kero-turbo.

7.148 The country's natural gas and NGL reserves basically comprise free gas and above all, gas associated with the development of oil in the northeast, the reserves in the Aguaytia gas field and the recent discoveries of gas and condensates in the Camisea area.

7.149 The size of the gas resources in the northeast and in the Aguaytia field enable production to be developed on a regional level, while the structures discovered in Camisea, classified as "super giants", enable a national scale integral project to be outlined, with exportable surpluses.

7.150 Gas contributed to meeting 7% of the primary energy demand in the last few years. By putting the gas development projects on stream, without delay, this proven quality primary energy source could cover 20% of the energy balance in the year 2000. Moreover, in relative terms, liquid hydrocarbon consumption will have fallen from 55% to 48% and in absolute terms, adding the crude oil production from known areas of new discoveries and the condensates from Camisea, there should be a substantial exportable surplus.

Table 2: Structure of National Energy Balance (1987-2000)

	1987 %	2000 %
Coal	1	1
Oil	55	48
Gas	7	20
Hydropower	7	6
Other energy sources	30	25
	100	100

Source: CONERG - Energy Balance

GAS IN THE NORTHEAST

7.151 The proven natural gas reserves in the northeast, a production area for many years, are estimated at 0.33 x 10^{12} cubic feet (billion cubic feet) and are largely comprised of /associated gas. Roughly a third of them are distributed in onshore areas operated by PETROPERU and two thirds in offshore areas operated by PETROMAR. Net production in the area is about 98 million cubic feet per day although recently, through a lack of equipment and declining oil production, associated gas

production has fallen to a mere 30 million cubic feet per day. The reserves, in theory, would only cover 9 years of production. Consequently, on this basis, gas production will decline and consumption of current consumers will be increasingly more constrained.

7.152 PETROPERU has developed a project for associated gas development in the northeast, especially for offshore gas, which involves building new treatment plants, as well as the respective pipelines to process a greater proportion of gas from PETROMAR and onshore deposits. The project will demand investment on the order of US$35 million and will enable, on the one hand, recovery of between 1,500 and 2,000 barrels per day of LPG and natural gasoline in addition to that currently obtained from well plants, Parinas and Verdún, and on the other hand, improvement of the collection and volume of gas for the industrial complex. This project has been approved by the enterprise's board of directors, is being prioritized by the National Planning System and the basis for its international financed tender is being prepared. Its construction may possibly be undertaken in 1991-1992.

AGUAYTIA GAS

7.153 In the Ucayali basin, 80 kilometers from Pucallpa, Mobil Oil discovered a retrograde condensation gas field in the sixties. Confirmation drilling by PETROPERU, between 1985 and 1986, has enabled 0.33 x 10^{12} cubic feet of gas and 28 million barrels of condensates to be evaluated as recoverable reserves (proven and probable).

7.154 Currently, PETROPERU has a regional project, the Aguaytia Gas Field Development Project, which comprises development with a view to obtaining 2,200 barrels per day of condensates and supplying Pucallpa electric power station and the major industries located around the city with gas. The initial gas market has been estimated at 6 million cubic feet per day and should amount to double that figure around the year 2000. The project requires drilling additional wells and constructing plants and pipelines which would demand about US$50 million to be invested in two years.

7.155 The project was tendered in 1988, but due to security problems in the area and a delay in signing the financing contract, the Peruvian-Mexican consortium obtaining approval has not yet started the respective work. By improving conditions, on the basis of the offers received and/or through a new financed bidding, its implementation could be started immediately.

CAMISEA GAS

7.156 As is described in the following chapters, the Camisea gas project will be the most important energy infrastructure project which the country will begin in this decade, exploiting the most abundant and economical primary energy source available.

The Camisea reserves

7.157 Following the minimum exploration program specified in the 1981 contract for the exploration and development of Lots 38 and 42 in Peru's southern rain forest, Cia. Shell conducted a survey of about 3,000 kilometers of seismic lines and drilled 6 exploration wells. On the basis of this effort, the San Martin and Cashiriari natural gas and condensates deposits were discovered, on the banks of the Camisea River, near to its mouth in the Urubamba River, at 260 kilometers to the northwest of Cusco and 580 kilometers to the east of Lima.

7.158 Reservoir rocks are formed from highly porous and permeable sandstone with variable density argillaceous intercalations. In keeping with the characteristics of the hydrocarbons and the pressure and temperature of the reservoir, it is clear that non-associated gas deposits are being dealt with, subject to retrograde condensation.

7.159 Natural gas and natural gas liquids, coming from the San Martín and Cashiriari reservoirs, are almost completely comprised of parafinic hydrocarbons. The composition analysis carried out, starting with recombined gas and liquid samples obtained from well 1X, is shown in Table 3.

Table 3: Initial Composition of San Martin Natural Gas

Component	Molar %
Nitrogen	0.55
Carbon dioxide	0.18
Methane	80.59
Ethane	9.80
Propane	3.80
I-Butane	0.57
N-Butane	1.13
I-Pentane	0.45
N-Pentane	0.44
Hexanes	0.62
Heptanes	0.56
Octanes	0.52
Nonanes	0.29
Decanes	0.19
Undecanes	0.11
Dodecanes	0.20
TOTAL	100.0

As can be seen, the gas does not contain significant amounts of impurities (sulphur, carbon dioxide or others).

7.160 Following the international nomenclature used in industry, the fraction formed by the mixture of gaseous C_1 and C_2 hydrocarbons is considered to be dry gas and the fraction of liquid hydrocarbons formed by propane and the heaviest C_{3+} hydrocarbons as natural gas liquids (NGL). Within NGL, the C_3 and C_4 hydrocarbons are defined as liquified petroleum gas (LPG).

7.161 From the discovery of natural gas in the Camisea area, different estimates of the deposit's reserves and production performance have been carried out. The information available limits volume estimates to the volumetric method and to simulations on the basis of the most probable parameters of production performance.

7.162 Table 4 shows estimates for gas and NGL reserves for the San Martín and Cashiriari structures.

Table 4: Estimate of Gas and Condensate Reserves

	San Martin	Cashiriari	Total
IN SITU RESERVES			
Total gas (10^{12}cubic feet)	4.4	12.2	16.6
Total gas (10^{12}cubic feet)	4.0	11.4	15.4
NGL (million barrels)	335	635	970
RECOVERABLE RESERVES (*)			
Dry gas (10^{12}cubic feet)	2.8	8.0	10.8
NGL (million barrels)	250	475	725

(*) Includes proven and probable reserves. The factors used are conservative, 70% for dry gas and 75% for NGL. An aquiferous asset, a development scheme with gas recycling and efficiency of cryogenic type processing plants are considered.

7.163 Bearing in mind estimated well production and injection capacities, "in situ" gas volumes, the wealth of gas from deposits in liquid terms and potential demand for gas estimated by studying the market, the initial extraction capacity could be on the order of 1.5 billion cubic feet per day. However, as no sufficient information is available on the continuity of reservoirs, a utilization of only 80% has been considered in the financial assessment developed in this study.

7.164 In the reservoirs of gas and condensates, the separate liquid reserves of NGL depend on the exploitation scheme chosen and on the efficiency of its implementation. The performance of simulations carried out and information from similar fields enable a range of between 55% and 88% to be established for gas liquids and between 60% and 75% for gas itself. Of the total recoverable reserves, those that have a 90% or greater probability of being produced have been classified as proven reserves, and those that have a probability of between 50% and 90% as probable reserves, in keeping with internationally accepted practice.

POSSIBLE DEVELOPMENT AND PRODUCTION ESTIMATES

Appraisal program

7.165 Before starting field development, the following are required:

(a) Drilling of four (4) appraisal wells in the San Martín and Cashiriari structures to shift the majority of reserves classified as probable to the state of proven.

(b) A three dimensional seismic survey to determine the number and location of development wells exactly.

7.166 In 1989, PETROPERU's board of directors approved implementation of an evaluation program for the San Martín structure, the first to be put on stream. The company's financial constraints have not allowed investment of US$15 million, which are required to drill two wells and to test for long-term production. Bearing in mind the flow limitations of the rivers for moving drilling equipment--obliged to be implemented between November and April--it is crucial for a decision to be made as soon as possible to start this project for the 1990-1991 period. If not, another year would again be lost before starting the project.

Development drilling

7.167 The development of deposits will be facilitated by the information obtained during appraisal drilling, the 3D seismic survey and long-term production tests. A priori, it is estimated that, before starting drilling, it will subsequently be necessary to drill at least 25 wells of which 17 will be producers and 8 injectors.

Production forecast

7.168 Bearing in mind the partial utilization of the gross gas production capacity limit, estimated at 1.5 billion cubic feet per day and the gas market, as assessed in the following chapter, a production forecast has been performed for the development of Camisea.

7.169 Even if the prevailing margin of uncertainty on conclusion of the Appraisal Program is taken into account, it is estimated that the initial gas production of the San Martín wells and from some wells in Cashiriari will be less than 900 million cubic feet per day. In this case, during the first 3 or 4 years, production of liquids will start at between 50,000 and 55,000 barrels per day.

7.170 Depending on market growth, in the middle of the year 2000, additional deposits from the Cashiriari structure will be put on stream. Gross gas production, on the order of 1.2 billion cubic feet per day, would then maintain a volume of recycled gas of 700 million cubic feet per day. Thus, production of liquids will be notably increased, rising to a peak of about 72,000 barrels per day between the year 2000 and 2005.

7.171 If demand for gas continues growing, while working with the same compression capacity without putting new deposits on stream, a production of liquids will be obtained which declines to amount to 40,000 barrels per day in the twentieth year of the project (last reference date for financial assessment purposes in this study). In practice, what should happen is that new reserves must be found and the injection process should be able to operate more selectively, reducing the decline of the production curve of natural gas liquids over a much longer period of time.

GAS AND CONDENSATES MARKET

Natural Gas Market

7.172 Natural gas can be used as:

Fuel
- in industry
- in electric power generation
- in the household sector
- in the transportation sector

Feedstock-Input
- Fertilizer Production
- Iron reduction
- Petrochemicals
- Exportation

Fuel gas

a. Utilization in the Industrial Sector

7.173 Gas replaces liquid and solid fuels in the industrial sector with large technical and financial advantages. Gas allows improved temperature modulation, does not leave residues and achieves greater efficiency in consumer ovens and boilers.

7.174 Peru's industry is concentrated on the coast, particularly in the central region. Almost 40% of diesel and fuel oil, excluding marine bunkers, is sold from the Callao and La Pampilla plants. The industrial area of Lima and the central sierra, especially the CENTROMIN Smelting works in Oroya and the Cemento Andino de Tarma plant, are supplied from these plants.

7.175 In order to analyze the penetration of gas in this area of the country, the historic consumption of industrial fuels has been reviewed, determining the characteristics (equipment, processes and projects) of every single consumer. The volume of gas that every consumer could use from 1995 onwards, with economically competitive conditions, has been estimated.

7.176 From the list of industrial clients this market is seen to be highly concentrated. The top 25 consumers comprise 80% of the market. It is important, however, to analyze in some detail the cases of Cemento Lima and Fertisa, within this list. Geographic concentration and a reduced number of consumers facilitate gas penetration. It is estimated that the investment required to convert all consumers to gas will not exceed US$20 million.

7.177 It is clear that the **project obliges a redefinition of fuel prices in the domestic market.** On May 30, industrial oil (Fuel Oil 6) was sold at a free market price of about US$7 per barrel (that is, US$1.20 per million BTU) when its price in the international market was more than double. As prices are not even compatible with production costs, no project seeking energy substitution or rationalization is feasible.

7.178 Assuming an economic growth rate of about 3% per year and bearing in mind a decentralization policy obliging energy-intensive industries to move away from the capital, about 60 million cubic feet would be consumed in the central area in 1995, which could amount to between 90 and 95 million cubic feet per day in the year 2000 and 120 to 125 million cubic feet per day in the year 2010.

7.179 The advantages of gas compared to other energy sources in the industrial sector are clear. The only major industry adapted to use coal is Cementos Lima, which preferred to base its installations on coal imported from Colombia. This industry, like the rest of the heavy industrial sector, must test the use of coal in terms of useful energy, with costs of less than US$2 per million BTU to compete healthily with gas. In view of the characteristics of national coal and its handling, storage and transportation costs, this figure is very difficult to match.

7.180 Depending on interconnection of the southeast-southwest electric power system, such as is planned in the following section, it is possible to think about laying a gas pipeline toward the country's southern region. Analysis of the industrial market for gas in this region shows small results at the moment. It is feasible, however, to develop some industries that will increase gas consumption to about 12 million cubic feet per day in the year 2000, with possibilities of tripling it in the year 2010.

7.181 The following are considered among the potential gas consumers:

- Expansion of the ammonium nitrate factory in Cachimayo from 100 tons per day to 220 tons per day.
- Construction of an ammonia plant with adequate technology for the southern region, with an estimated capacity of 150 to 200 tons per day.
- The mining-metallurgical sector, first in exploitation of tailings and then production of refined copper. A cement plant.
- Additionally the domestic, subsistence level and small agricultural-industrial sector.

b. Use of natural gas in electric power generation

7.182 Implementation of the Camisea Natural Gas Integral Development Project will determine a more intensive use of gas in the electric power sector, not only supporting peak generation, but also

during the base and semi-base. The presence of gas in this sector would alleviate the use of liquid fuels in thermal power stations, being constructed to cope with the current emergency as there are no important hydropower projects being implemented, by contributing predictably substantial amounts of energy to the system during the next ten years.

7.183 Moreover, the latest projections on the situation in 1990 show a deficit in the SICN load curve which is complicated further by attacks on the large transmission lines. This obliges emergency decisions to be made.

7.184 In the case of Peru, gas has undisputed advantages compared to the other fuels for electric power generation. Comparing cost curves according to the options for electric power generation, hydropower projects, the potential investment savings achieved thanks to gas is very important. With a utilization of up to 6000 hours per year, simple- or combined-cycle gas turbines are more economical than hydropower stations which cost US$1,500 per Kw or more. By using gas on a large-scale basis, until the year 2014, savings of US$4,000 million could be obtained. The utilization of hydropower can only be envisaged after the year 2005, but only for major projects for the lower part of load curves. With respect to coal, gas presents advantages not only as a result of lower investment in generation units but also its lower operating and maintenance costs, without mentioning the environmental advantages.

7.185 In keeping with the installation program of the 1989 Master Plan, during the 1990-1994 period, the installed potential of the central-north interconnected system should be increased by 415 MW. 115 MW would be hydroelectric power from on stream projects and/or ready to be implemented projects, such as the Carhuaquero hydropower station, the improved Pato Canyon and the reinforced Yuracmayo power stations. The remainder, that is 300 MW, must be come from dual system turbogas stations, initially using industrial oil and supplying the load center of greatest demand like Lima and the northern coast as far as Trujillo. These stations will subsequently use Camisea gas.

c. Household and Transportation Sector

7.186 The electric power and industrial sectors are the markets available for the start of the Project. The household and transportation sectors will gradually be added in the medium and long term. During the first stage, it is difficult to predict a rapid introduction of natural gas in the household and residential markets, through household connections, due to the high cost of a distribution infrastructure of this type, especially in the urban part of the coast where heating is not needed. On the other hand, it would be appropriate to explore the possibility of using gas in the transportation sector, either directly as CNG (compressed natural gas), or through its conversion to methanol and/or ethanol or gasoline. The conversion technology has been developed in several countries throughout the world, among them New Zealand, Argentina, Canada and Italy, and Peru may have access to it through cooperation agreements.

Feedstock Gas

a. Fertilizer production

7.187 For the production of fertilizer, it is feasible to install a nitrogenous fertilizer plant, toward the middle of the nineties, with an internationally competitive capacity (1,000 tons per day) to cover the growing deficit observed in the national market. This plant would consume about 40 million cubic feet per day of dry gas.

7.188 The demand for nitrogenous fertilizers has grown substantially, surpassing national supply so that, despite the recession, the country is currently a net importer of fertilizers. In 1987, to cope with a demand for 167,000 tons of nitrogenous fertilizer, imports reached 91,000 tons. National supply only amounted to 76,000 tons, with the Talara plant providing 46,000 tons of nitrogenous fertilizers.

b. Iron-sponge production

7.189 HIERROPERU has a project to construct a 300,000-ton-per-year iron-sponge plant in the port of San Nicholas, near Marcona in the province of Nazca, which could still have a higher capacity. HIERROPERU's interest in this project is long term. In the absence of natural gas, the use of coal was anticipated despite its supply and infrastructure problems. Gas offers a lower-cost solution. The gas requirements of the plant being studied have been assessed at between 10 and 20 million cubic feet per day of natural gas and it would begin operation between 1995 and 2000, so that its subsequent expansion would be possible.

c. Petrochemical development possibilities

7.190 Market studies carried out by the Management of PETROPERU's Refining and Petrochemical Area show that there is already appreciable consumption of several petrochemical products in the country. Thus, in keeping with the results of these studies, the petrochemical products with the most current and future demand in the country would be the following:

Table 5: Demand Forecast of Petrochemical Products

Product	Demand (million tons per Year)		
	1987	1995	2000
Polyethylene	52	95	132
Poly Vinyl Chloride (PVC)	33	51	71
Acrylonitrile	29	40	50
Tetraphthalic acid	16	31	43
Polypropylene	15	26	37
Polystyrene	14	23	33
Dodecyl Benzene	10	13	18
SBR Rubber	5	6	7

From these demand figures it can be estimated that by the middle of this decade, demand for Polythenes, PVC and Acrylonitrile will amount to such a level as to make their production in the country feasible. Substituting imports would achieve savings above US$250 million per year.

7.191 PETROPERU has received preliminary proposals from foreign companies to study the possibility of installing ethylene and methanol plants in the country which use natural gas as a feedstock and whose production is largely geared to the export market.

7.192 In determining the yield of petrochemical projects, investment size, plant size and economies of scale criteria will generally play a decisive role.

7.193 It should be born in mind that in the last few years the technological advances, such as more resistant material and computerized control, etc., linked to the low cost of feedstock (mainly due to the discovery of large natural gas deposits in different parts of the world), are enabling the minimum economic size of petrochemical plants to be reduced, especially for basic petrochemicals. In order to stimulate the involvement of private investors, the law reserving basic petrochemicals for PETROPERU should be modified.

Natural gas exportation

7.194 In the world energy market in the next decade, gas appears to be a highly appreciated fuel in view of the growing problems of environmental protection, especially those producing large emissions of SO2 provoked by the intensive use of coal and fuel oil in certain areas. Thus, for example, Japan

imports liquified natural gas in growing amounts and a large part of this gas is destined for electric power generation.

7.195 The Pacific basin, in the case of Camisea, requires careful assessment. In Southeast Asia there are, apparently, very few economically viable liquified natural gas export projects remaining, once ongoing projects are completed. Substantial price changes would have to be expected to envisage opening new markets for natural gas liquefaction chains in, for example, Japan and Taiwan.

7.196 On the West Coast of the United States, besides the gas pipelines from Alberta, Canada or from the Alaskan liquefaction chains, the Camisea reserves are, for the moment, the closest option. Peru will have to follow the evolution of these markets and their prospects for the next century carefully.

Summary

7.197 Table 6 summarizes the projection of natural gas demand in the central region to be served with the Camisea-Combapata gas pipeline.

Table 6: Demand for Natural Gas (million cubic feet per day)

	Central Region			Northern Coastal Branch				Southern Coastal Branch				Total	INKA Region			
Year	Indus.	Elec.	Subtot.	Indus.	Elec.	Petro.	Subtot.	Ind.	Iron	Fert.	Subtot.	Central Pipeline	Indus.	Iron	South Total	Grand Total
1995	60	28	88									88				88
1996	69	31	100									100				100
1997	75	49	123									123	1	18	19	142
1998	82	35	117	26	31	1	58					175	4	20	24	199
1999	88	32	120	27	40	2	69	13	13		26	245	4	26	30	245
2000	93	51	144	36		14	93	14			48	285	9	27	36	321
2001	97	72	169	39	47	17	103	14	15	28	57	329	11	39	50	379
2002	100	102	202	40	50	19	109	15	15	32	62	373	19	39	58	431
2003	103	78	181	41	79	20	140	15	15	36	66	387	20	43	63	450
2004	106	77	183	41	84	20	145	16	15	40	71	399	22	44	66	465
2005	109	108	217	42	89	36	167	17	15	40	72	456	24	35	59	515
2006	111	146	257	43	70	38	151	18	15	40	73	482	26	37	63	544
2007	114	254	268	45	67	40	152	19	15	40	74	594	26	35	61	555
2008	117	112	229	46	75	40	161	20	15	51	86	476	26	32	58	534
2009	120	149	269	47	46	40	130	21	17	54	92	494	26	34	60	554
2010	123	165	288	49	37	40	126	22	17	57	96	510	27	39	66	576

LPG MARKET

7.198 The advantages of LPG in terms of combustion efficiency ensure that, with adequate price differentials for the public compared to its substitutes, it will be possible to finance investments enabling rapid penetration of the national market. The current quotes for middle distillates in the Gulf market, on the east coast of the United States, fluctuate around US$22.50 per barrel, from which freight of about US$1.50 per barrel has to be discounted for a FOB-Lima comparison. In the case of Propane and Butane, prices are between US$10 and US$15 per barrel, from which freight has to be discounted, in the case of large-scale exports of cooled LPG, on the order of US$3.50 to US$4.00 per barrel. Consequently, to foster a large-scale LPG penetration campaign, there is a price differential of more than US$10 per barrel.

7.199 Production from the Camisea project will exceed 20,000 barrels per day of LPG. Along with current production of almost 5,000 barrels per day, Peru will rely on making this product widely available because the present market hardly amounts to 7,000 barrels per day.

7.200 Kerosene sales currently border on 20,000 barrels per day and if provided with no substitutes, could amount to between 25,000 and 30,000 barrels per day in the year 2000. Discounting the share of Kerosene used secretly in industrial ovens and/or boilers, domestic consumption of the product itself should be 80 to 85% of the volumes sold. It is to be expected that more coherent relative pricing policies would remove this distortion.

7.201 On the basis of a moderate penetration curve, PETROPERU assumes that LPG consumption could increase to border on 9,000 barrels per day in 1995 and, by maintaining the economic conditions of penetration, surpass 15,000 barrels per day in the year 2000 and 20,000 barrels per day in the year 2005. From then on, consumption is estimated to stabilize because it will have reached the market potential figures. Henceforth, sales will increase at a more moderate rate.

7.202 The industrial market for LPG is divided into 3 sections. The first is the commercial and small industrial sector of metropolitan Lima, such as bakeries, brickworks, restaurants and other consumers requiring heat generation which currently use diesel or use kerosene illegally. The second is the group of energy-intensive industries which will not be able to rely on fuel gas for several years due to their distance from the main or secondary gas pipelines. In the second group, use of LPG could be limited by its conversion and storage costs. The third is comprised of the large-scale fuel oil users, situated away from the central region in southern and northern Peru, which have no access to any of the planned gas pipelines (HIERROPERU, Paramonga or even Southern Peru). An economic assessment of the advantages of a temporary change to LPG in each of these sections should be conducted.

7.203 Bearing in mind the additional LPG production coming from Camisea and the numerous development efforts for the domestic market, as well as the cost of the infrastructure required for LPG, it is fairly certain that the country will have significant surpluses available for export. Even discounting part of the LPG that may be consumed in petrochemical development projects, **the exportable surplus of LPG will border on 15,000 barrels per day in the first years of the project.** For financial assessment purposes, the FOB Lima-Callao price for a barrel of LPG is supposed to be conditioned by evolution of petroleum products prices as a whole, that is, in the United States Mount Belview - East Coast Gulf market and a discount for freight on the order of US$4 per barrel and US$4 per ton for the Panama Canal toll.

SOUTHERN REGION FUEL MARKET

7.204 Currently, liquid fuels arrive in the southeastern region by railway which leaves the port of Mollendo and climbs to the cities of Puno and Cusco. Prior to Mollendo, fuel arrives by tanker from the La Pampilla and Talara refineries. The presence of a fractionator and consequently, a definite supply

of fuel in Cusco, and with facilities to transport surpluses, via rail, to the Juliaca plant and even to transport them as far as the coast, would change the historic demand prospect.

7.205 LPG currently has a fairly limited use in the southeastern sierra as a result of transportation difficulties. Bearing in mind the cost of transport via rail or oil tanker to Puno or Cusco, savings on the order of US$12 to US$15 per barrel would be obtained on the basis of Camisea production. It is conservatively estimated that the initial LPG market in the entire southern region could reach 1,000 barrels per day in the year 1995 and then grow rapidly.

7.206 As for gasoline and kerosene consumption, the southeastern market will be able to absorb a considerable share of the fractionator's production. PETROPERU estimates that the fractionating plant could initially receive about 6,000 barrels per day, of which 3,500 barrels per day would be consumed in the southeastern region, sending the surplus (2,500 barrels per day) to partly meet the needs of the southwest region and partly for exportation (naphtha).

ECONOMY OF THE CAMISEA GAS PROJECT

Investments and financing scheme

7.207 In order to review the Integral Camisea project, it should be divided it into 5 major components.

a. **Field installations:**

- Production and injection wells. On the order of 30 wells would be drilled initially.
- A separation plant for which, given the initial surplus of LPG, known technology like External Cooling has been chosen. The plant would have modules of 400 million cubic feet per day, two (2) initially and then, in keeping with growth of the gas market, a third module would be added.
- Collection and injection lines between the wells and the plant.
- Compression facilities for gas recycling and to supply the gas pipeline. Compression requirements are estimated at some 700 million cubic feet per day.
- **Main pipelines** joining Camisea with Lima, both a gas pipeline and a polyduct for liquid hydrocarbons, including pumping and compression stations along the line. To satisfy market needs for gas, the pipeline would have a diameter of 26 inches and would operate at a pressure of 10 Bars. The polyduct would have a diameter of 10-12 inches and a maximum pressure of 150 Bars.

b. **The gas distribution company** on the coast, will first take charge of the distribution network in Lima and subsequently will be in charge of laying the pipelines toward the north (Trujillo) and toward the south (Marcona).

c. **The fractionating plant** to be built, next to the La Pampilla refinery, includes facilities for LPG commercialization, both for the domestic market and with a view to exportation. This plant would have a capacity of 65,000 barrels per day with storage for 10 days feedstock and 15 days product. The C5+ hydrocarbons fraction should be mixed with crude oil for processing in the distillation unit or it could be exported directly as LPG.

d. **Project development toward the south,** includes construction of pipelines from Camisea to Cusco and from the fractionating plant in this city and extensions will subsequently be built toward Tintaya and Arequipa, in keeping with market growth. For gas transportation, a 16-inch diameter pipeline will be laid and for liquid transportation a 6-

inch pipeline. The fractionator in Cusco would have an initial capacity of 7,500 barrels per day.

The investments for each situation are shown in detail in Table 7.

7.208 To be viable, the financing scheme should include involvement of a contracting company or a consortium of contracting companies who would play the role of leader in project implementation and management. PETROPERU could have a modest share in its own capital, limited by its own financing possibilities, on the basis that it will be associated with the main contractor during the different phases of the project. The remaining funds could be provided as long-term debt by the owners, partners or creditors (for example, SFI, International Development Bank).

Table 7: ***Distribution of Investments and Their Hypothetical Financing***

	CONSORTIUM* OWN CAPITAL	LOAN SUPPLIERS PARTNERS & OTHERS	TOTAL
FIELD			
Initial	384	106	490
Additional	152	38	190
PIPELINES			
Initial	120	520	640
Additional	47	203	250
FRACTIONATING			
Initial	47	113	160
COASTAL DISTRIBUTION			
Initial	11	19	30
Additional	68	242	310
SOUTHEAST REGION			
Initial	40	125	165
Additional	24	11	35
SUBTOTAL			
Initial	602	883	1485
Additional	291	494	785
TOTAL	393 (40%)	1377 (60%)	2270 (100%)

* PETROPERU or another state (or private) Peruvian agency could have a small share in this capital to ensure its presentation on the consortium board.

Source: PETROPERU

Financial Assessment

7.209 In addition to the estimated investments and possible production volumes to be undertaken, the following pricing theory has been carried out:

(a) Regarding FOB-Lima prices, it is estimated that LPG and condensate will vary in keeping with the price of a basket representing the value of oil on the international market.

(b) The price of condensate is assumed to be 20% above the price of the basket which will be reduced by freight of US$1.50 per barrel.

(c) The LPG price will only amount to 75% of the value of this basket which will be discounted by US$4 per barrel as a result of the freight. The benefits that could be derived from commercialization of LPG in the domestic or industrial markets will not be included.

(d) Regarding the price of gas, the price of fuel oil 6 will be taken as a starting point, which is assumed to be the same as 80% of the price of crude oil in the international market, discounted for freight of US$1.50 (the calorific conversion used is 1 barrel of fuel oil = 6 million BTU).

Table 8: Oil Price and Fob-lima Prices For Camisea Project Derivative Products

CRUDE OIL PRICE (US$/Bbl)	PRICE OF C5+ CONDENSATE (US$/Bbl)	LPG PRICE (US$/Bbl)	DRY GAS PRICE (US$/MMBTU)
15	16.50	7.25	1.75
20	22.50	11.00	2.42
25	28.50	14.75	3.08

7.210 The internal rate of return of the project as a whole, for the base case of US$20 per barrel, is 23% in constant values, the Net Present Value (NPV), discounted at a rate of 10%, is US$2,077 million and the investment recovery time is 5 years, after the project is put on stream. The return of the whole project falls to 16% in the event of a fall in the oil price to US$15 per barrel throughout the life of the project (20 years of production). A sensitivity analysis demonstrates that, although a return seems assured at prices above US$20 per barrel of oil, a lower price along with a delay in income for a year, or an increase in costs or a fall in income, would render the project's return marginal (or near to 15%). During this entire period, 3.1 x 10^{12} cubic feet of gas would have been produced (this is less than 30% of the recoverable proven and probable reserves) and 400 million barrels of condensates would have been produced, including LPG (this is equivalent to 55% of proven and probable recoverable reserves).

7.211 In addition, the elimination of projects toward Cusco (gas pipeline, polyduct and fractionator) enables the initial investment of US$200 million to be reduced, however, the return is only marginally improved (changing from an IRR of 22.76% to 23.28%). Since several components of the project in question appear exaggerated in view of the current and foreseeable needs of Cusco and its hinterland, it would then be possible to make substantial savings on the project, keeping the work at a more appropriate size toward (or in) Cusco without diminishing the general yield of the project. This means that the configuration of the project could and should be improved.

Risks

7.212 The main risks facing the project (besides the lack of security) would be that the predicted demand for natural gas does not materialize, or that it materializes later than anticipated, and that oil prices remain, for most of the time, below US$20 per barrel (in 1988 US$). This would place the economic and financial feasibility of certain parts of the project in danger (specifically the operation of pipelines).

VIII. ELECTRIC POWER SUBSECTOR

Introduction

8.1 Peru's electric power consumption is relatively low. Estimates for the subsector indicate that only 44% of the population has access to an electric power service. However, this aggregate value hides many regional differences since electrification of the department of Lima is 72%, while in some regions in the south of the country electrification is only 16%. In addition, the few favored with an electric power service maintain a relatively high consumption, benefitting from the low tariffs, while those that do not have access to service maintain few hopes because the financial capacity of the subsector to expand the service has also been restricted by the aforementioned low tariffs. Annual per capita electricity consumption was 630 kWh in 1989, a fairly low value in relation to the average of Latin American countries, which is 1,200 kWh per capita. Despite the severe recession the country is experiencing, there is currently considerable unmet electricity demand in many areas served by the public service utilities.

8.2 In response to the poor reliability of the public electric power service, both industrial and commercial consumers and, recently, even residential consumers have been installing a substantial generating capacity through a large variety of small, very high operating cost thermal units. During the last few years it is estimated that this capacity has increased the capacity of the Central-North Interconnected System (SICN) by about 100-150 MW. Determining factors for such a marked deterioration in the national electric power service have been the limited financial resources available for expansion and rehabilitation investments, a tariff-setting policy with drastic subsidies, low income from the unserved population, the geographic isolation of many regions and the effect of continuous terrorist attempts on the electric power infrastructure.

8.3 Peru, however, is a country rich in energy resources useful for electric power generation. The major resource identified is hydropower, whose potential is only being exploited by 4% (2,378 MW of an estimated potential of 58,000 MW). Other available energy resources are oil, natural gas and coal. There is also potential for electric power generation on the basis of biomass, geothermal energy and solar power.

8.4 During the last few years, electric power generation has not grown particularly. Total generation in the country declined from 13,785 GWh in 1987 to 13,736 GWh in 1989, that is, by 1.75% but then recovered slowly to 13,736 GWh in 1989. The aforementioned recovery was mainly due to the autogeneration sector (+17.7%), while public utilities reduced generation by 5% during the last few years, mainly in thermal generation. This reduction is as much a reflection of the fall in demand in certain cases, but is mainly due to the technical and financial deterioration of public utilities. Electric power generation during the last 10 years has evolved in the following way (in terms of annual growth rates):

	Public Service Utilities	Autogenerators	Total
1980-1983	5.3%	-4.1%	2.1%
1983-1986	7.4%	4.8%	6.6%
1986-1989	1.3%	3.8%	2.0%
1980-1989	4.6%	1.4%	3.5%

8.5 The above figures clearly demonstrate a decline in generation after a short period of rapid growth.

8.6 About 77% of electric power generation is of hydraulic origin (more than 91% between the public utilities, accounting for 69% of the total installed capacity: 4,114.1 MW). Tables 1 and 2 show the composition of Peru's electric power systems, as well as the growth during the last few decades, showing the generation of public service utilities and autogenerators.

ORGANIZATION AND LEGAL FRAMEWORK

8.7 The Ministry of Energy and Mines (MEM) is responsible for formulating subsector policy and supervising state electric utilities. During the last three decades, the electric power subsector has been regulated by three different laws: the Electric Power Industry Law of 1955 (No. 12378), the Electric Power Subsector Standard-setting Law passed in 1972 (No. 19521), and the current General Electricity Law of 1982 (No. 23406).

8.8 The Law of the Electric Power Industry established a system of private concessions which were responsible for all the technical phases of the electric power service and its commercialization. Within the context of this law, which in practice determined a strong centralizing orientation, did not enable the integration of national networks and provided unjustified gains for private capital, the Standard-setting Law of the Electric Power Subsector was passed in 1972. This new law nationalized all the electric power services and created ELECTROPERU as a state-owned company in charge of all the public service activities in the areas not served by the main existing companies (ELECTROLIMA, SEAL and others), with exclusive rights on national generation expansion. Thus, ELECTROPERU assumed total

Table 1: **Installed Electric Power Potential of the Public Service Electric Power Utilities**

REGIONAL UTILITIES	INSTALLED CAPACITY (MW)			
			TOTAL	
	HYDROPOWER	THERMAL	MW	%
ELECTROPERU S.A.	1,156.0	0.0	1,156.O	41.5
ELECTROLIMA S.A.	543.0	158.7	701.7	25.2
ELECTRO NOR-OESTE S.A.	0.0		102.1	3.7
ELECTRONORTE S.A.	1.0	63.8	64.0	2.3
ELECTRO NORTE-MEDIO S.A.	198.3	106.8	305.1	11.0
ELECTROCENTRO S.A.	12.0	72.4	84.4	3.0
ELECTRO SUR-MEDIO S.A.	1.0	6.1	7.1	0.3
SOCIEDAD ELECTRICA DEL SUR-OESTE S.A.	31.1	63.3	94.4	3.4
ELECTRO SUR-ESTE S.A.	112.2	54.0	116.2	6.0
ELECTRO-ORIENTE S.A.	0.4	62.0	62.4	2.2
ELECTRO SUR S.A.	26.0	5.0	41.0	1.5
TOTAL	2,091.1	694.1	2,795.2	100.0

Source: ELECTROPERU S.A., Electricity Master Plan, 1989.

Table 2: **Electric Power Subsector Power Generation (GWh)**

YEARS	PUBLIC SERVICE			AUTOGENERATORS		
	Hydro	Thermal	Subtotal	Hydro	Thermal	Subtotal
1960	1,010.8	162.3	1,173.1	783.4	691.4	1,474.8
1970	2,692.6	237.1	2,929.7	1,128.0	1,471.1	2,599.1
1980	748.3	640.2	6,388.5	1,264.1	2,386.1	3,650.2
1981	6,677.5	609.8	7,287.3	1,319.3	2,150.3	3,469.6
1982	6,980.5	657.3	7,637.8	1,420.3	2,292.3	3,712.6
1983	6,752.6	706.2	7,458.8	1,357.9	1,858.2	3,216.1
1984	7,240.9	834.0	8,074.9	1,330.0	2,312.1	3,642.1
1985	7,583.3	796.2	8,379.5	1,802.2	1,933.6	3,735.8
1986	8,443	791.4	9,234.4	1,437.5	2,269.4	3,706.9
1987	9,196.3	896.4	10,092.7	1,450.0	2,242.1	3,692.1
1988	9,078.0	944.8	10,022.8	1,348.2	2,173.0	3,521.2
1989	8,841.2	750.3	9,591.5	1,677.0	2,467.4	4,144.4

Source: Electricity Statistics Office, Ministry of Energy and Mines, May 1990.

responsibility for activities as diverse as implementation and operation of large power stations, planning of national electric power systems and the electric power service in hundreds of small localities.

8.9 ELECTROPERU has been unable to acceptably fulfill many of the responsibilities assigned to it. Decisions on major investment projects were imposed by the government and large projects were implemented on a turnkey contract basis without the appropriate bidding processes. In addition, a highly subsidized tariff-setting policy severely affected the financial position of the company, as well as its capacity to attract and retain highly qualified, motivated personnel. Generally, ELECTROPERU has been unable to respond efficiently to its multiple responsibilities and has largely focussed its efforts on the supply of major loads, making use of its main assets (the Mantaro hydropower station and the Central-North transmission system) through a highly centralized organization.

8.10 The 1982 law had the main objective of establishing a decentralized structure. By essentially maintaining a state system, the law establishes a decentralized system with several regional companies and ELECTROPERU acting as the main governing power utility in charge of; (i) national planning, (ii) implementing major generation projects, transmission and operating the interregional transmission system, and (iii) acting as the main shareholding central utility of the regional utilities.

8.11 Although the decentralization process has been implemented and gradually adapted to a national regionalization policy plan, the technical and financial yield of the electric power subsector continued to be weakened by excessive government intervention. During the last two years, tariffs have declined dramatically to amount to less than US$0.02 per kWh. Consequently, at the end of 1989, the subsector accumulated an overall deficit of US$848 million. Generally, subsector problems have been aggravated, making decentralization questionable and favoring financial centralization and inefficiency through mechanisms like the Generation Compensation Fund and unit tariffs.

8.12 The present organization and institutional structure of Peru's electric power subsector is defined by the 1982 LGE and the basic regionalization laws No. 24560 and No. 24792. These establish the following:

- The public electric power service will be in the charge of the State (Article 2, LGE).

- The public service utilities are:
  - ELECTROPERU
  - Regional utilities (10 in total covering the 24 departments). Originally these regional utilities were subsidiaries of ELECTROPERU but their ownership, at least for some of the utilities, is currently being transferred to regional governments.

- ELECTROPERU and its subsidiaries cannot transfer their control to the private sector.

- The Commission of Electric Power Tariffs (CTE) is the organization charged with regulating and setting tariffs on the basis of technical and accounting criteria (Article 25 and following articles, LGE).

- The plans for major projects and regional system interconnections are focused on ELECTROPERU.

- The obligatory nature of the service in the geographic area of the regional electric power utility, including the charging of contributions to the destined users of the Expansion Fund.

- Creation of different funds: for expansion, electric power development, social interest and compensation of generation tending to compensate the effects of a constant national tariff.

- Supervision is undertaken by the Ministry of Energy and Mines (MEM). This covers the "rational use of energy resources for electric power generation" to the receipt of projects, system operation, trade and company management.

SUBSECTOR ASSESSMENT

Technical Situation

8.13 Peru's public electric power service is currently suffering its severest crisis in the last three or four decades. The rationing of capacity and power, as well as a very poor supply reliability, is common in almost the entire country. As a result of this serious situation, the private sector, that is, industrial, commercial and even residential consumers, have been increasing investment in a generating capacity comprised of a large variety of very high operating cost thermal units. During the last few years this captive capacity is estimated to have grown to about 150-200 MW.

8.14 The electric power service, however, still shows a large national variation. For example, while losses in Lima's distribution system (ELECTROLIMA) remain on the order of 11%, although with an apparent upward trend, average losses in the rest of the country are 17.6% and exceed 25% in the most critical places. These high losses are mainly due to overloading distribution systems, system obsolescence and an apparent increase in illegal connections. Although there are no clear data on the present reliability of the electric power service, there has been an obvious deterioration in the last few years. In the major electric power systems, such deterioration is due to the accumulation of four major factors. These are, an increase in terrorist attempts on the transmission infrastructure, the severe drought prevailing in a large part of the country, a lack of reserve capacity and the insufficient maintenance service in many installations. These constraining factors are explained in more detail as follows:

- The electric power subsector reports the destruction of 1,146 transmission towers from May 1980 to December 1990 by terrorist actions. An especially severe case was that of the Mantaro hydropower station, located some 300 kilometers from Lima, whose available capacity (779 MW)

under normal conditions comprises half the supply capacity of the Central-North Interconnected System (SICN). One out of three transmission lines of the aforementioned power stations is permanently out of service, while the other two are highly vulnerable to terrorist attacks. An estimate of the costs to the country caused by terrorist action on the SICN up until March 1990 are shown below:

- Repair of towers	US$31.7 million
- Fuel consumption	US$20.9 million
- Protection work	US$9.8 million
- Unsupplied power	US$553 million to US$1.106 billion
(1,106 GWh) (assuming a unit cost of US$0.5 to	US$1.0 per kWh)
- Total cost	US$615 million to US$1.168 billion

In addition, the losses to electric power companies through unsold power amounted to US$39.7 million. The wide range of values used to estimate the economic cost of unsupplied power reflects the large variation of the impact of a poor service and is in keeping with the experience of other countries. The resulting data clearly reveal the severity of the problem and suggest the large profit a program of preventative measures would have, if it were feasible.

- For the second consecutive year, large parts of the country have been suffering the effects of a severe drought which impacts the generating capacity of national hydropower stations, as well as the supply of water to the major urban centers. The generating capacity has been reduced to 40% in the power stations on the western side of the country, mainly in the power stations of Lima and Arequipa. As a result of this drought, capacity reduction during peak hours amounts to an average of 14% (202 MW) in the SICN and 17% in Lima Metropolitana. Forecasts for the remaining part of the year realistically consider the need for rationing as a result of the capacity and power deficit. This will oblige the following rationing in the SICN: 207 MW for base demand, 281 MW for semi-base demand and 162 MW for peak demand.

  There is a similar situation in the southwest where the generating capacity of hydropower stations has been reduced by more than half, forcing severe rationing throughout the region.

- The persistent financial difficulties of ELECTROPERU and the regional utilities, caused by the extremely low tariff, have not enabled these companies to comply with their contractual obligations and supplies. Consequently, the lack of materials and services have severely affected operating and maintenance activities, additionally causing significant delays in the investment programs.

- With the exception of generation projects already started a decade ago (that is, the Charcani V, Restitución, Carhuaquero and Machupicchu power stations and several transmission lines), no additional project has been built during the last six years. This has entailed a dramatic decline in potential reserves and consequent deterioration in the reliability of the service. Investments in the

electric power subsector have fallen from slightly more than 2% of GDP, at the beginning of the eighties, to less than 0.6%.

8.15 With the exception of the southeastern system (Cuzco), where there is excess capacity, all the country's electric power systems and isolated centers have been suffering the problem of capacity and power rationing. In the major electric power systems, the main constraining factor is the current drought, aggravated temporarily by the affect of terrorist attempts. In isolated centers, where thermal generation usually prevails, rationing is caused by the inability of utilities to cover fuel costs as a result of the extremely low electric power tariffs. Although the end of the drought will considerably alleviate the shortage problem of the main electric power systems, it is highly probable that the problems will continue as a result of the poor availability of many installations (through deficient maintenance) and a delay in expansion or reinforcement projects. The technical situation of the electric power subsector is clearly an emergency and, therefore, requires measures in keeping with its severity.

Financial Situation

8.16 The General Electricity Law (1982) demands an overall rate of return of 12% from state electric power utilities on the net investment tied up. This aim, however, was never achieved. During 1984 and 1985 the returns were 4.0% and 5.0% respectively, and from 1986 onward have been negative amounting to a minimum of -13.9% in 1989. The main reason for this financial deterioration has been the decline in electricity tariffs. In real terms, tariffs in 1989 were 20% of their 1985 level; in current values, from an average of US$0.042 per kWh in 1985 to US$0.014 per kWh in 1988. Presently (April 30, 1990), the average tariff is US$0.021 per kWh. This value compares to an operating cost of US$0.049 per kWh and a total production cost, including debt service, of US$0.058 per kWh.1/

8.17 The impact of this dramatic decline in tariffs on the income of utilities and their financial situation is illustrated in Figure 1, which shows how earnings covered the operating and financial costs of sector utilities for the 1984-1989 period. The long period of deficit, shown in the figure, has exerted a negative impact on the technical return of the utilities and brought about a financial standstill, shown by:

- Earnings which only covers personnel expenditure and benefit payments.
- Rationing of fuel consumption at the cost of a decline in the quality of the electricity service.
- Declining maintenance and repair programs during the last four years reducing the availability and reliability of the electric power supply installations.

1/On August 16, 1990, there was a national tariff increase as part of the economic stabilization program. This measure increased the average tariff to US$0.045 per kWh (using an exchange rate of 450,000 intis per US$), that is, a real increase of about 115%, however, the tariff structure did not suffer major modifications inasmuch as a large subsidy remains in the tariff for household consumers.

- Lack of funds to implement and in some cases to complete essential rehabilitation projects of immediate benefit to the system.

8.18 Since 1986 sector utilities have had to resort to capital contributions from the government to cover their operating and investment deficits. One form of support has been through reduction of the utilities' debt service obligations. The most important initiative of this kind has been the 1987 Economic-Financial Recovery Plan of the Electric Power Subsector (DS O6J-87EF), which was tied to the conditions of a IDB loan. Through the Recovery Plan the government assumed responsibility for a total amount of US$1.832 billion corresponding to service delays and amortizations pending on that date. This plan also formulated the implementation of marginal cost tariffs and established financial aims for the 1987-1990 period. Unfortunately, continued government intervention did not enable the program to be fulfilled, the tariff subsidy was aggravated even more and the electric power utilities had to resort to major government support.

8.19 Likewise, the electric power utilities have been increasing their earnings, slightly reducing their decline in real terms, through collections stemming from various taxes on the sale of electricity. These collections have gradually been gaining importance and currently comprise between 25% and 30% of total earnings. These taxes are:

- D.L.163 (1982) for Electric Power Boundary Expansion. Considers 10% on consumption up to 150 kWh per month and 25% for greater consumption.

- D.L.532 (1989) to provide funds for the repair of damage caused by terrorist attempts. Consisting of 10% on consumption greater than 150 kWh per month.

- Selective consumption tax. 30% on consumption less than 150 kWh per month, and 60% on consumption greater than this figure. ELECTROPERU receives 20% of collections.

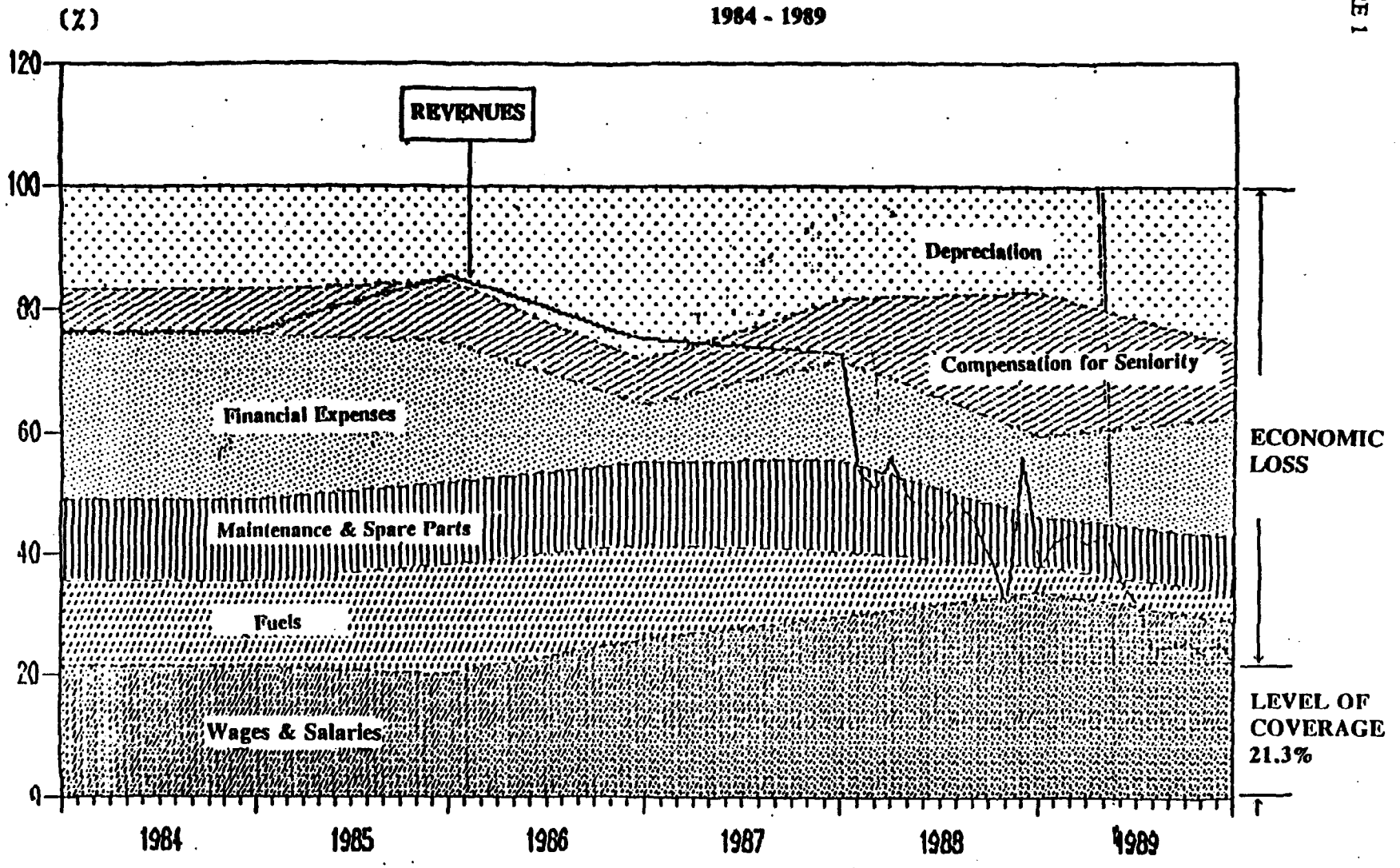
8.20 It should be noted that electricity bills also include other taxes and charges, such as municipal excise taxes (which include public lighting) and sanitary landfill, as well as taxes directed to the fire service and a university development fund. All these taxes and charges create confusion for the consumer who does not realize the real electric power tariffs being paid. It is to be expected that this practice is corrected on returning to a tariff-setting system based on economic cost criteria.

8.21 It should also be mentioned that the serious problems originating from current tariff-setting policy does not only refer to the level of tariffs but also to their structure. The present structure does not coincide with supply costs but rather opposes them. Thus domestic tariffs, whose supply cost is about 25% higher than the cost of commercial supply and almost 100% higher than the cost of industrial supply, remained at an average US$0.003 per kWh during the 1988-1990 period while the average tariffs for commercial and industrial consumers were US$0.046 per kWh and US$0.024 per kWh respectively. This marked distortion has without doubt been causing the excessive and inefficient electricity consumption by the household consumer.

FIGURE 1

STRUCTURE AND COVERAGE OF COSTS

1984 - 1989



8.22 By continuing the current tariff-setting policy, the deterioration of utilities will continue being aggravated. Table 3 shows the subsector's profit and loss account both for the past and forecast for 1990. This shows an alarming result for the 1990 fiscal year of -US$211.4 million. This forecast, based on a constant average tariff of US$0.021 per kWh, clearly reveals the urgent need to adopt a rational electric power tariff-setting policy, as soon as possible, to increase tariffs to such a level and structure to enable both survival of sector utilities and reasonable economic efficiency in electricity consumption and supply decisions.

Institutional Aspects

8.23 Since public administration of the electric power subsector was established in 1972, its organization has been modified several times. None of these reorganizations, however, had any success in improving the subsector's technical, administrative and financial return. ELECTROPERU, a company formed on the basis of four markedly weak public entities, could never manage to satisfy its managerial objectives and with few exceptions (perhaps ELECTROLIMA and SEAL) all the subsector's public utilities are very weak. The central government's view of the electric power subsector was usually that of a strategic public operation, frequently used as an economic policy instrument to implement subsidies and/or control inflation, instead of a commercial operation. This conceptual focus is born in the State's confusion between its standard-setting role and its managerial role, confusion which enabled excessive and disorderly government intervention in the management of electric power utilities, determining their poor institutional yield. Some obvious institutional problems are: (i) over-regulation and lack of autonomy in utilities which has inhibited company dynamism, (ii) government intervention along with financial constraints which has created uncompetitive working conditions, (iii) a lack of continuity in the managerial levels, (iv) an oversized workforce imposed by the government in favor of job creation (the subsector's total workforce amounted to 15,000 workers), and (v) the regionalization process which poses a serious institutional challenge since, the majority of regional utilities lack adequate personnel. This situation strongly suggests the need to seek other institutional schemes to introduce efficiency incentives in the electric power subsector.

8.24 Broadly, current subsector problems are tied to its organization and legal framework which were described at the start of this chapter. Such a notably static structure presents limitations which impact efficiency and effective decentralization, as well as the need to deconcentrate the system. Among these the following should be mentioned:

- Firm and almost exclusive state commitment in the subsector's operation and development.

- Monopolization of electric power development by only one state company (ELECTROPERU). This, along with the high subsidy implicit in nearly all electric power tariffs entails scarce or nil interest, both from the private sector and other enterprises, as well as state entities, to participate in the sector.

- Confusion, in practice, between the State's standard-setting and managerial roles. That is, a lack of clarity in the interplay between technical-financial and policy matters due to the absence of adequate channels to enable an ordered interaction, free of arbitrary acts.

Table 3: **Electric Power Subsector Profit and Loss Account (million US dollars)**

	1985	1986	1987	1988	Forecast 1990 1/
TOTAL GWH BILLED	6,528.9	7,460.0	8,172.0	8,187.1	7,840.0
TOTAL INCOME	319.0	329.5	315.7	141.0	164.6
Electric Power Sale	317.7	326.5	314.1	140.4	164.0
Other Products	1.3	3.0	1.6	0.6	0.6
AVERAGE PRICE	0.05	0.04	0.04	0.17	0.021
TOTAL COST OF SERVICES	291.1	397.8	361.8	211.8	382.7
Personnel Costs	115.2	145.0	169.6	94.0	202.4
Fuel and Lubricant	67.3	70.1	45.6	13.0	20.6
Misc. Supplies	49.8	56.2	71.2	35.3	54.4
Deprec. & Provisions	57.7	124.3	74.9	71.0	938.0
Invest. Exp. Contrib.	(4.1)		(5.2)	(2.5)	8.4
Other Admin. Exp.	5.2	2.2	5.9	1.0	3.1
DEVELOPMENT RESULT	27.9	(68.2)	(46.1)	(70.8)	(218.1)
TOTAL OTHER INC.(EXP.)	(66.7)	(24.0)	(33.1)	(62.7)	6.7
Fin. Inc. D.S. 065.87/EF			21.0	46.6	75.0
Financial Income	15.9		21.3	11.6	
(Financial Expenses)	(86.0)	(26.3)	(70.5)	(118.2)	(68.3)
Misc. Income (Exp.)	15.9		21.3	11.6	
YEAR FINANCIAL RESULT	(38.9)	(92.2)	(79.2)	(113.5)	(211.4)
Average Dollar	9.82	13.94	23.47	266.50	32.785
Average Cost	0.04	0.05	0.04	0.03	0.049
Average Cost + Fin. Exp.	0.05	0.06	0.05	0.03	0.058

1/ Forecast by ELECTROPERU (30.4.90)

- Lack of clear, stable and economically effective tariff-setting procedures. Although the Tariff Commission is an institutionally adequate organization, its little autonomy and political leverage, linked to the confusion mentioned in the previous point, have made it inoperative.

- Irrational tariff-setting and excessive government intervention in the utilities, make it impossible to value them objectively, that is, by their performance (profits). This has enabled a variety of administrative inefficiencies to remain in the utilities, such as excess personnel, a poorly used technical capacity, prevalence of short-term "survival" criteria, bureaucratization and dilution of relevant decisions. Productivity indexes are relatively low, for example the consumer per worker ratio is 90 in Peru2, while for the best Latin American enterprises it amounts to 150 to 200 and in companies in industrialized countries exceeds an average of 400 consumers per worker.

Main investment projects

8.25 During the 1979-1980 period, ELECTROPERU began constructing four hydropower projects and several transmission lines in response to the expected rapid growth in demand. This expansion was possible thanks to the easy access to foreign credit prevailing at this time. The majority of projects were contracted without going through an adequate bidding process, turnkey contracts were signed for all the projects and the financing was supplied, to a large extent, by commercial banks. A comparison between the estimated and real costs of these projects is indicated below:

COSTS OF MAIN HYDROPOWER PROJECTS
(US$ million, current)

	Installed Capacity (MW)	Estimated Cost	Real Cost	Cost Overrun (%)
Restitutión	216	148.8	328.8	121
Charcani V	125	250.9	438.3	211
Machupicchu	70	151.6	264.4	74
Carhuaquero	75	160.0	262.3	64

8.26 The average unit cost of these four projects was US$2,662 per kW, which is very high compared with world averages of US$1,500-US$1,800 per kWh, and is also high compared with previous experience in Peru. The average cost overrun was 115%, which also gave rise to considerable setbacks because on increasing the costs several projects experienced insufficient financing (in this respect, it should be mentioned that the Carhuaquero power station is still not on line). This unfortunate experience, which may well have cost the country in excess of US$300 to US$350 million, may be attributed to the following factors:

- A deficient planning process as, at that time, there was no rational and ordered process which served as a basis for making decisions.
- A very uncompetitive bidding process which led to inadequate contracts without any incentive for efficiency, where the risks were assumed almost entirely by the owner.
- Very weak project management at the executive level aggravated by the deficiency of the above-mentioned projects.
- In some cases, unforeseen technical problems during the study stage.

This unfortunate experience creates serious doubts on ELECTROPERU's capacity to manage the implementation of larger projects and suggests that new formulas should be sought to ensure efficient contracting management and project implementation.

EXPANSION PROGRAMS

8.27 In keeping with the General Law of Electricity, ELECTROPERU is in charge of conducting electric power planning on a national level. The results of this planning effort are reflected in the Electricity Master Plan, which in keeping with the law, should be updated each year. ELECTROPERU has been complying with this legal responsibility for several years, using a classic minimum cost methodology. Although the professional group assigned to this task meets the required qualifications, the methodology itself has the following limitations:

- The methodology does not enable the expansion program to be reviewed within a financial context. That is, programs are planned without taking into account real financial constraints and incur the risk of recommending unfulfillable programs.

- The methodology does not enable adequate analysis of demand-side solutions which, due to their lack of intensive capital requirements, may be an attractive alternative in Peru's electric power systems. In addition, the methodology assumes that demand is inelastic with respect to cost and price fluctuations.

- The methodology does not enable the absolute or differential risks inherent in alternative programs to be assessed. This is essentially deterministic--assuming that the future is known and proposing a minimum cost program for it--and therefore, introduces a bias in favor of the projects or programs of greater risk.

- As the generating costs for both hydropower and thermal stations appear slightly high, a revaluation is necessary.

8.28 During the last few years, ELECTROPERU's planning process would have suffered internal pressures from the company itself, which would divert its main objective, that is, the need to implement a planning objective by mandate of the Ministry of Energy. In view of the importance of this activity for sector investment decisions, as well as defining an economically rational tariff-setting policy, it is extremely important to maintain constant technical assistance geared toward continuous update and improvement of the analytical tools of electric power planning.

8.29 The serious limitations of the national electric power service, along with the sector's difficult financial situation, make a short-term emergency program necessary. This must include an appropriate balance between rehabilitation measures, maintenance improvement, load administration and tariff-setting policy programs, and high-return, short-maturity hydro strengthening projects. This type of plan is partially proposed by the Master Plan, which also includes thermal expansion up to 1995. This

program is indicated in Table 4 for the Central-North Interconnected System (SICN). In the long term, the subsector faces two markedly different developments: (i) a program based on hydropower development complemented by conventional thermal power stations, and (ii) the development of Camisea natural gas for energy purposes. ELECTROPERU's studies examine both alternatives (which are included in Tables 5 and 6), without defining a clear preference between them. This is mainly due to the current uncertainty over the Camisea gas project since, for its implementation, the different political, legal and financial problems should be resolved. In any case, total sector investment planned by the 1989 Master Plan for the 1990-1999 period is on the order of US$3.6 billion. This investment includes both generation, transmission and distribution expansion, as well as rehabilitation and expansion programs for the electricity network. Table 7 includes sector investments planned by the 1989 Master Plan. It should be noted that such data could be slightly conservative because the expansion plan is based on national electric power market growth of 4.1% per year until the end of the decade.

8.30 In the early eighties, the electric power subsector, influenced by world energy conditions and with the support of the World Bank and other development agencies, launched a substantial hydropower project pre-investment effort. More than fifteen projects were studied on feasibility or even more advanced levels, and several of them are now technically ready to be implemented. Although this information has been highly useful for improving the planning process, it is not clear at present whether an intensive hydropower program is the country's best option. Moreover, three factors deserve attention: (i) ELECTROPERU's recent experience in implementing the last four hydropower projects creates doubts on the subsector's capacity to manage these type of projects, (ii) hydropower development is highly capital intensive which makes its financing seriously difficult, and (iii) the giant Camisea natural gas deposit is a real alternative for development of the SICN. ELECTROPERU's most recent studies show that electric power expansion on the basis of natural gas would involve a lower cost on the order of US$330 million (present value) compared with conventional hydrothermal development.

Table 4: Central-north Interconnected System Installation Program
1991-1995

YEAR	POWER STATION	INSTALLED CAPACITY (MW)	AVAILABLE CAPACITY (MW)	ORGANIZATION
1991	CARHUAQUERO	75	75	IMPLEMENTATION
1992	C.PATO IMPROVEMENT	–	12	DEFINITE
1993	1 X GT 100 LIMA	100	100	PROJECT
1994	1 X GT 100 LIMA	100	100	PROJECT
	1 X GT 25 LIMA	25	25	PROJECT
1995	YURACMAYO REINFOR.	–	26	IMPLEMENTATION
	1 X GT 25 TRUJILLO	25	25	PROJECT
	1 X ST LIMA	100	100	PROJECT

Note: - Schedule of planned integration:

1991 - Cajamarca
1994 - Pacasmayo (only public service)
1993 - Piura (second semester)

8.31 The potential development of Camisea natural gas has given rise to visible public debate and political controversy. Several development schemes have been proposed in response to diverse political interests, frequently, without major technical and economic support. The proposals, however, largely agree in planning large-scale use of this resource in electric power generation. PETROPERU's initial project considers constructing a gas pipeline to the coast and developing a 400 MW thermal power plant close to the main load centers at a total cost of US$1.85 billion. ELECTROPERU's most recent studies (Master Plan) contemplate gradual development, between 1996 and 2003, which would lead to a final thermal capacity of 1,200 MW on the basis of 300 MW combined cycle units. Other schemes consider more limited regional development or development in stages; however, the initial polyduct investment (the project also includes some 50,000 barrels of condensates per day for export) would always amount to a minimum US$900 million.

Table 5: Central-north Interconnected System Hydrothermal Installation Program
1996-2015

YEAR	POWER STATION	AVAILABLE (1) CAPACITY (MW)
1996	GALLITO CIEGO	6
	4 X GT 50 N.G. QUILLABAMBA	200
1998	2 X GT 50 N.G. QUILLABAMBA	100
	(PONDAJE + EXPANSION) C.PATO	115
1999	2 X GT 50 N.G. QUILLABAMBA	100
	MAYUSH	88
2000	JICAMARCA	104
2001	PLATANAL	140
2002	YUNCAN	126
	YAUPI REINFORCEMENT	28
2003	OLMOS 11	200
	1 X GT 100	100
2004	OLMOS 12	100
2005	CHAGLIA	440
2008	OLMOS 21	216
2009	OLMOS 22	108
2010	HUAURA	150
2011	CUMBA I (MARANON)	275
2012	CUMBA II (MARANON)	275
2013	CUMBA III (MARANON)	275
2015	PAQUITZAPANGO I (JAN)	394

Note: (1) The available capacity is in the third three-month period of a minimum run-off year.

In view of the potential impact of an investment of this type on the national economy, it is essential that any decision is made on the basis of strong technical and economic criteria in order to ensure the greatest benefit for the country and that the chosen development corresponds to the electric power sector minimum-cost program.

Table 6: **Central-north Interconnected System Medium- and Long-term Installment Program 1996-2015**
CAMISEA GAS DEVELOPMENT

YEAR	POWER STATION	AVAILABLE CAPACITY
1996	2 X GT 100 N.G. LIMA	200
1997	--------	—
1998	1 X ST 100 N.G. LIMA	100
	2 X GT 100 N.G. LIMA	200
1999	2 X GT 50 NORTE	100
2000	1 X GT 100 N.G. LIMA	100
	1 X ST 100 N.G. LIMA	100
2001	1 X ST 100 N.G. LIMA	100
2003	2 X GT 100 N.G. LIMA	200
	1 X ST 100 N.G. LIMA	100
2004	OLMOS 11	200
2005	OLMOS 12	100
2006	CHAGLIA	440
2007	----------	—
2008	OLMOS 21	216
2009	OLMOS 22	100
2011	CUMBA STAGE 1	375
2012	CUMBA STAGE 2	375
2013	CUMBA STAGE 3	
2015	PAQUITZAPANGO 1	394

Table 7: Electric Power Subsector Investment Program
(January 1989 US$ million)

Year	Investment in major Projects	Electricity Border Expansion	Rehabilitation	Total
1989	100.9	21.2	23.4	145.4
1990	167.0	23.3	18.5	208.8
1991	233.1	23.3	10.3	266.7
1992	264.2	23.3	11.6	299.1
1993	338.9	23.3	7.8	370.0
1994	280.3	23.3	7.8	311.4
1995	314.5	23.3	7.8	345.6
1996	381.1	23.3	7.8	412.2
1997	449.0	23.3	7.8	480.1
1998	435.5	23.3	7.8	66.6
1999	415.7	23.3	7.8	446.8

Source: ELECTROPERU S.A., Electricity Master Plan, 1989.

SHORT- AND MEDIUM-TERM STRATEGY FOR THE ELECTRIC POWER SECTOR

8.32 The sectoral strategy to be proposed in this paragraph responds to the aforementioned serious financial, technical and institutional problems. The severity of these problems and the urgent need to resolve them justifies a strategy with short- and medium-term actions. Consequently, the objectives of this strategy must be geared toward the following: (i) resolving the sector's urgent problems, that is, the financial crisis of the electric power utilities and the service's technical constraints, and (ii) proposing conditions that promote economically efficient electric power sector operation and development in the future. The first point deals with the short-term actions proposing application of a marginal cost tariff-setting policy and implementing an emergency program for electric power supply recovery, including both supply rehabilitation and strengthening measures and demand-side management measures. The second point deals with medium-term measures, including how future investment decisions and planning for a new institutional framework should be dealt with.

SHORT-TERM MEASURES

Tariff-setting policy

8.33 This must be completed as soon as possible, in view of the financial irrationality and economic inefficiency of the current tariff-setting policy. The average SICN electric power tariff must be increased to US$0.075 per kWh, that is, triple the level in June 1990, and a marginal cost structure should be adopted. This measure, which must be complemented by adjusting the remaining energy prices to economic levels, will enable the following:

- Elimination of the electric power subsector deficit and consequent reduction of inflationary pressures. An economically rational tariff-setting policy would also allow subsector utilities to be assessed objectively.

- Normal operation of electric power utilities without entailing serious neglect in operating and maintenance aspects.

- The electric power market will be provided with the correct signs for an efficient allocation of resources both on the supply side and demand side. Real prices are the best mechanism to guarantee an economical dispatch of power as well as the rational expansion of electric power systems.

  In addition, the application of marginal costs is the only way to guarantee rational use of energy by the users and to make any load management and/or energy conservation program effective.

8.34 In this respect, it should be noted that the application of a marginal tariff policy by systems would enable the Generation Compensation Fund to be abolished. This fund, in practice, has had negative effects on being converted into a mechanism which rewarded or concealed inefficiencies.

8.35 This is a propitious moment for the immediate application of marginal tariffs in the SICN because it coincides exactly with the need to apply an economic stabilization program in the country. In addition, a large share of the analytical work has already been completed as part of the "New Electric Power Tariffs" study, which was conducted by sector agencies with IDB support. Although these studies must still be conducted in the country's other electric power systems, application of marginal cost criteria to SICN tariffs will be a first and very important step forward3/. Criteria for dealing with electric

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3/The new electric power tariffs, valid from August 1990 onwards, are without doubt the first step toward a rational tariff-setting policy. The national average of the new tariffs is US$0.045 per kWh and US$0.056 per kWh (for an exchange rate of 450,000 intis per US$) bearing in mind the taxes returning to the subsector. However, the following problems still exist: (i) although the average tariff would enable current generation costs to be covered, this is less than the long-run marginal costs which are estimated at US$0.075 per kWh for the Central-North Interconnected System; (ii) the tariff structure still maintains distortions which are mainly observed in the form of a large subsidy in the domestic tariff which is currently US$0.039 per kWh, including

power tariffs in minor localities or between utilities will be stated after a new institutional scheme for the subsector is discussed.

Electric power sector rehabilitation program

8.36 The rehabilitation program is composed of a series of low-cost priority measures shown in greater detail in Table 8.

Table 8: Electric Power Sector Rehabilitation and Strengthening Program

COMPONENT	COST (million US$)	BENEFIT (MW)	IMPLEMENTATION PLAN
Priority Measures			
Hydropower Station Rehabilitation 1/	1.22	76	months
Thermal Power Station Rehabilitation 2/	25.52	157	1 to 2 years
Hydro Strengthening 3/	11.65	131	1 to 2 years
Reduction of Distribution Losses	20.00	4/	3 years
Load Management 5/	19.60	110	1 to 5 years
Second Priority			
Repair of Transmission Lines	73.35	6/	1 to 2 years
Rural Electrification 7/		53	

1/ Restitución, Charcani IV and Machupicchu power stations.
2/ Santa Rosa, Chimbote, Chiclayo and HIERROPERU (in the SICN) power stations; Chilina in Arequipa and US$15 million to recover 60 MW in isolated centers.
3/ Strengthening for the Cañón del Pato and Charcani V (Puente Cincel dam).
4/ National distribution loss reduction in order to reduce distribution losses to about 11%. Average current losses, excluding Lima (10.3%) are 17.6%.
5/ Load management and conservation program for Lima, preparing for the implementation of marginal tariffs.
6/ Credit for planning, at a total cost of US$208 million.
7/ Completion of 31 ongoing projects (some at standstill), US$36.5 million for small hydropower stations and US$16.5 million for electric power systems.

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taxes reverting to the sector; (iii) bills still include a series of taxes and charges which create confusion for the consumer, who perceives a higher than real cost and rejects the new tariffs; and (iv) public resistance to the new tariffs, to a certain extent stemming from apparent billing errors, has recently lead to direct government interference in tariff management. This type of interference is concerning because it tends to reduce the autonomy and credibility of sector agencies. It is expected, however, that after a brief transition period, the Tariff Commission will recover the necessary technical autonomy. It is generally expected that these economic, financial and institutional deficiencies will be corrected as soon as possible.

8.37 Such measures include, besides the generation and distribution rehabilitation projects themselves, hydro-strengthening projects, maintenance improvement and a load management program in the metropolitan Lima area or perhaps as a better alternative, the introduction of a hourly tariff (with a higher premium for peak hours). The program, in its entirety, has the potential of increasing supply capacity by about 360 MW in the short term, at a cost of about US$38 million, by hydropower and thermal station rehabilitation, and hydric-strengthening projects. The Lima thermal project, including the installation program for the 1991-1995 period (Table No.3; two 100 MW gas turbines and a 100 MW steam turbine are to be installed during the 1993-1995 period) and the Piura thermal power station (25 MW turbogas), should also be added to this program. It should be emphasized that all these short-term decisions, including the marginal tariff program, do not involve major risks. It may be stated that all these programs or sub-projects are, without exception, the sector's only option to reduce current supply constraints. That is, in this case there would be no place for errors in terms of selecting solutions. Moreover, all the rehabilitation or strengthening projects are highly profitable. Therefore, any variation in external economic conditions (for example, relative energy product prices) would not tend to affect their economic feasibility. It should also be mentioned that not all the components of this program are independent, the most obvious case being the load management program which is totally conditioned by implementation of marginal cost electric power tariffs in the SICN. The greater risk decisions, dealing with large investments (except Lima's thermal power station), cannot nor should not be taken before the latter half or end of 1991. There remains, therefore, sufficient time to study these options more and reduce current uncertainties, especially regarding the availability of Camisea gas.

8.38 In view of the emergency situation, it is essential to implement the rehabilitation program in the most efficient way possible, without long delays or excessive costs. In addition, bearing in mind that many of these programs or sub-projects belong to different subsector electric power utilities, it is easy to think that, by not opting for a dynamic and efficient centralized solution, the program may experience term and coordination problems. This situation points to the advisability of creating a special temporary agency which, located away from the utilities, will take care of the following:

- To summon the bidding, negotiation and contracting of all the components of the rehabilitation program.

- Depending on each case, this agency may delegate project supervision to the utilities or place foreign specialized groups in charge of this activity. This varied treatment is justified by the large variety of projects included in the overall program. Many of the strengthening projects (for example Parón or Cullicocha) may be implemented by local contractors under direct supervision of the utilities. Moreover, more technically complex projects like the Puente Cincel dam will probably require the involvement of foreign groups.

8.39 This **Contract Unit** should consist of a small, high technical capacity work force of probably no more than five professionals. It is proposed to be separated from the utilities and directly answerable to the Ministry of Energy. Its efficiency would be guaranteed by its own autonomy, technical

capacity and a budget enabling it to contract a large part of its services abroad, including the bidding processes. There are currently attractive possibilities of obtaining these services from international development agencies. Concluding its duties, the **Contract Unit** may be dissolved or be integrated with the subsector's regulatory agency, such as is explained below in the proposal for a new institutional framework.

MEDIUM-TERM MEASURES

Investment projects

8.40 The potential development of Camisea gas for electricity generation will be, in the short term, the main decisive problem in the subsector. It is to be expected that although, due to its size and technical complexity, the implementation of such a project may not be finished before 1995, the legal and political uncertainties currently surrounding it will be resolved by the latter half or end of 1991. That is, by this time, it will be known whether the availability of gas for electric power generation from the beginning of 1996 is feasible. Toward the end of 1991 the SICN electric power development plans should be reexamined in order to decide, definitively, in favor of one of the alternative expansion plans, which are:

- An expansion program based on the intensive use of Camisea gas for electric power generation during a period of about 10 years, continuing with the most appropriate hydro or thermal projects thereafter.

- A hydrothermal program including conventional thermal power stations. In this case, the first base-load thermal or major hydropower station must not be commissioned before 1999. This means that, in the event it is a hydropower station, its implementation should not be before 1994.

8.41 In order to proceed with an appropriate comparative analysis the following aspects should be reexamined:

- The adjustment of costs and technical features of the thermal power stations in keeping with the most recent technology.

- The definition of an optimal development program for the energy exploitation of Camisea gas, bearing in mind a realistic assessment of the costs and terms of implementation.

- The reassessment of the hydrothermal program, readjusting costs and including both national and imported combined cycle and coal-fired steam power stations among the alternative thermal stations to be reviewed.

- The comparative analysis must explicitly assess the risks of each program, that is, risk minimization must be included along with the traditional objective of minimum cost. This may be conducted on the basis of well designed scenario analysis.

Institutional framework

8.42 An energy strategy must aim at achieving the maximum well-being of the community by establishing conditions of economic efficiency for the subsector's operation and development, within a framework defined by the State. In this context, the concept of economic efficiency involves the following aspects:

- The decentralized decisions of energy users and producers must be economically efficient in national terms. This implies that prices of different energy products must reflect their real economic value, so that consumption, investment, and substitution decisions are taken to obtain the lowest cost for the country.

- The production cost of each type of energy must tend to be the lowest possible. This means that technology used in the country to generate, transform and distribute power must be adequate for the current and predicted relative costs, and must also perform in keeping with state-of-the-art technology.

- Energy supply availability and security must be adequate. This implies that it is not acceptable to have unsatisfied demand or supply uncertainties under circumstances where consumers are ready to pay the costs that their supply entails.

8.43 Besides the design and acceptance of a strategy and/or rational policy, an adequate institutional framework should be relied upon to implement it. The main guidelines for sector organization are presented as follows which, bearing in mind current problems, enable its efficient development and operation. In Annex 3, support and a more detailed explanation of this proposal for institutional reorganization is presented.

ELEMENTS FOR SUBSECTOR ORGANIZATION

8.44 For the reasons expressed in the section "sector assessment-institutional aspects" and in view of the background available, the first point is the need to provide the sector with a clear organization which does not allow confusion between the State's standard-setting role and its managerial function. Current conditions point to the need to rely on a high-ranking political agency, with direct involvement of the Ministers of State most relevant to the problem (Economy and Finance, Energy, and Industry). A small but highly qualified Technical Secretariat would depend on this agency, thus bringing together high-ranking politicians with the adequate independent technical support. An organization with this political leverage and composition would enable the interests of the main political sectors involved to be directed, thus avoiding arbitrary pressures and distortions which have been seen in the past. An Energy

Commission with the above-mentioned structure could be created on the basis of the current Tariff Commission. This regulatory organism would be in charge of:

- Fixing electric power tariffs and regulating operation of the market for other energy products, initially including implementation of the new marginal tariff scheme.

- Advising and approving the Electricity Master Plan.

- Supervising the bidding and contracting processes of sector expansion projects, and authorizing implementation of larger projects.

- Overseeing smooth sector operation and especially, coordinating the orderly transition from the current to the desired situation, both for regionalization and restoration of the generator sector linked with interconnected systems.

8.45 Regionalization and the new electricity law are decentralizing electric power distribution and part of local generation. Separation of generating and transmission activities from distribution in a strict sense now seems advisable because these activities are distinct, with marked differences in operation, investment and regulation. The problem of distribution tariffs is simpler because these enterprises should only add a distribution margin to the generation tariff which would allowing them to operate reasonably. This point is crucial, as from now on, regional distribution companies will be able to organize their activities optimally without having to wait for a total rationalization of current tariffs to be implemented.

8.46 Bearing in mind the characteristics of generation in this country, it would be advisable to separate generation in the following way:

- Small isolated systems.
- Large isolated systems.
- Small power stations in interconnected systems.
- Large power stations in interconnected systems.

8.47 In general, the following aspects should be considered:

- Small, isolated systems tariff-setting should be left to the regional utility which organizes the sector and establishes tariffs by reaching agreement with common entities and allocating budgets along the social and economic development lines adopted by the region (locally agreed tariffs).

- For large isolated systems, the price of power and capacity should be established in keeping with marginal criteria, regulating the distribution tariffs. Regarding the latter,

it appears more advisable to regulate them on the basis of a "model company" along purely accountable lines.

- A marginal cost tariff system should be implemented in interconnected systems, where power purchase and sale decisions, as well as expansion decisions, would be guided by this signal, promoting economic rationality in the sector.

8.48 Two or three generation companies are planned in the main interconnected system, which could be ELECTROPERU, ELECTROLIMA and HIDRANDINA. Generation sector deconcentration, although implying changes in current legislation, has the following advantages:

- Deconcentration, even when the State is the sole owner, introduces a certain degree of competition both in the projects and their implementation, and in the development of engineering capacity and electric power services.

- Deconcentration is necessary for effective decentralization of the regions, which should be capable of gradually dealing with their supply problems. In this process, and in view of the potential for developing public or private regional projects, it is absolutely necessary to deregulate oil prices in order to avoid distortions in operation and expansion decisions.

INVESTMENT PLANNING AND COORDINATION

8.49 With respect to investment planning and coordination, the distribution of high voltage generation and transmission should be reviewed separately. Distribution is an activity, in keeping with the Law, focussed in the regional utilities. As it is a totally decentralized activity, the investment decisions for each utility should be made in keeping with the technical, social and economic conditions in each region. In view of the natural monopoly character of electric power distribution, aspects related to the obligatory nature of the service, tariffs (distribution margins) and the quality of service should be clearly regulated within the distribution concession areas. Finally, with respect to new developments and rural electrification, and in view of the implementation of marginal cost tariffs, current financial mechanisms (such as DL 163) may be abolished and replaced by regional budgets precisely specified for these activities.

8.50 For generation and transmission, the generation linked to an interconnected system should be separated from those supplying an isolated system. In interconnected systems, generation developments are centered on a few large-scale projects, intensive in their use of capital, and whose economic attraction depends on the system's current and future condition. All this points to the advisability of relying on adequate planning and coordination which enables the total cost to be minimized. This justifies the development of periodic Master Plans. In the coordination of major power station developments, the State plays a central role for several reasons:

- Its dominant share in the ownership of the electric power system.
- The need to rely on adequate and updated information on the evolution of demand and supply in the major electric power systems.
- The relationship between tariffs and optimum development of electric power supply.

8.51 However, as not only ELECTROPERU, but also other regional utilities and other state or private enterprises have ongoing projects, it seems advisable that the Master Plan be controlled and approved by an independent agency such as the proposed **Energy Commission.**

8.52 Strict coordination is not required in minor projects because they do not significantly affect the optimal state of the system. Therefore, decentralized investment decisions may be made by the regional utilities, autogenerators or private investors. To achieve this, the Law is required to provide most facilities so that these developments are implemented taking precautions against the technical aspects of security and environmental protection. In this respect, it appears recommendable to make the legal regulations regarding the use of renewable energy resources more flexible, to facilitate their development by local utilities for their own use or for public service. The present LGE is very restrictive in this sense.

OPERATION COORDINATION

8.53 The creation of an **Economical Load Dispatch Center** (Centro de Despacho Económico de Carga - CDEC) is crucial to ensure the deconcentration and competitiveness of electric power generation for each interconnected system. This would ensure the necessary coordination of the secure and efficient operation of interconnected power stations and transmission systems. Implementation of a new marginal tariff in the Peruvian electric power system provides great potential for its initiation. CDEC would be essential to promote the presence of multiple, independent generating companies operating economically and efficiently in an interconnected system. CDEC would establish:

- System operation criteria
- Criteria to value the transfer of electric power capacity between generating companies.
- Criteria for payment for the shared use of the transmission system.
- Coordination of maintenance programs in the generating units.

8.54 CDEC would be an agency with representation of the major generating companies, responsible for short-term planning of system operation, but not for its operation in real time. CDEC's essential operating criteria must be service security and minimization of overall cost.

FINAL REMARKS

8.55 Peru is in the process of decentralizing the electric power activity both for generation and transmission as well as distribution. If this process is channeled through a scheme such as the one hereby presented, including the short-term emergency measures, marginal tariff-setting policy and new institutional framework, an increase in the sector's efficiency and productivity should be expected. As the State is the main owner, the performance of this greater efficiency should first be reflected in a reduction in direct state contributions and thereafter, in net revenue generation for the Treasury. In view of the separation of the State's standard-setting and managerial roles which the proposed strategy involves, it is perfectly legitimate for the State to decide to begin to reduce its managerial presence.

8.56 The dilution of ownership, with the involvement of institutions and persons responsibly assuming the consequences of their own decisions, is an efficient way of consolidating the initiated decentralization process, increasing efficiency and attracting more capital to the sector. But without doubt, the clarity and stability of government sector policies is crucial for a process of this type to evolve in the correct direction, especially those policies concerning its own involvement, tariff-setting, competitive use of transmission systems and access to sources of financing and savings. A gradual increase in private sector involvement may be achieved in several ways; emphasizing direct investment, the creation of mixed public/private companies, the transfer of the ownership of regional utilities to the local community and the large-scale sale of shares of the major generating companies.

8.57 Although institutional order and the establishment of a sector strategy are two complementary actions, it is possible to start the process outlined here by making use of the current institutional framework with some important modifications. Thus the Tariff Commission may increase its political leverage, as a maximum regulatory agency, if the Ministers of Economy, Mining and probably, Industry are involved in it. This ensures the political leverage and technical and economic coherence with the recommendations elaborated by the executive secretary of the aforementioned agency.

8.58 As for technical matters, there is already a concrete proposal to implement a new electric power tariffs scheme, which should gradually be implemented with the technical support of the Tariff Commission. The tariff adjustment applied halfway through August 1990 is a step forward. A major finishing touch to the average tariff still remains to be implemented to correct current distortions in the tariff structure and abolish the taxes and charges which prevent the electric power tariff working as a real signal for the efficient use of energy. The Master Plan may easily be developed with the help of ELECTROPERU, ELECTROLIMA and other generating companies. Finally, load dispatch can gradually be implemented starting with a nucleus of professionals from the most important generating companies linked with the SICN; this may be carried out on the basis of the present Operations Committee. As for legal matters, the revision and agreement of the General Electricity Law is a task which may be implemented at the same time, under coordination of the Tariff Commission.

IX. WOODY FUELS AND RENEWABLE ENERGY SUBSECTOR

WOODY FUELS

Situation

9.1 The production and use of fuelwood and charcoal in the residential and commercial sectors may lead to the danger of deforestation in areas of major consumption (sierra) and scarce fuelwood resources. There are, however, other activities or factors that exert a more negative impact on the forest cover, particularly, expansion of the agricultural border, livestock farming, forestry exploitation and drought. Therefore, the impact of woody fuel production and consumption on the various causes of general degradation of the forest resource and the environment should be identified and quantified. Once the damaging activities and the areas in danger are identified, solutions which combine all the elements of the problem, in addition to the forestry ones, such as energy conservation and substitution, rural development and environmental protection policies should be proposed.

9.2 Woody fuels have special importance in Peru; in 1988 they accounted for 28% of total primary energy production and 31% of final energy consumption, with an almost stable share in the last decade. Their transactions concern financially important, although poorly known volumes. Fuelwood, for example, could account for annual sales on the order of US$10 million, assuming that 20% is marketed. As a matter of fact, its economic substitution value for kerosene is about US$500 million per year (kerosene at US$215 per TOE CIF). Finally, the forest has an important linkage with the environment and generates non-quantifiable economic benefits, particularly soil and water conservation. However, knowledge of this subsector is inadequate, such as quantitative data on the use and production of woody fuels. In addition, subsector investments are low compared to the other three energy subsectors.

Main issues

9.3 The main problems of the woody fuels subsector are indicated below:

(a) Lack of both quantitative and qualitative information (fuelwood origin; consumption, especially for charcoal and residues; production and distribution chain; prices and margins and environmental impact).

(b) A fuelwood deficit (unsustainable demand) in certain areas, which may be irreversible if additional actions are not undertaken (substitution, production improvement and conservation).

(c) Multiplicity of institutions and lack of coordination between them, with a certain bureaucratization of reforestation and lack of exploitation of the capacity of regional agencies.

(d) Low value of the standing tree, which does not reflect its economic replacement cost, especially in areas showing a deficit.

(f) Insufficient control over fuelwood movements and low levels of tax collection.

(g) Low woody fuel production and utilization efficiency.

(h) The lack of interest of campesino communities in planting trees is due to several reasons, among which, their short-term rationale, ignorance of technical solutions, the little time for matching agricultural cycles, etc.

(i) Security problems in the sierra make forestry and agricultural expansion work difficult.

Demand

9.4 Almost all the rural population utilize fuelwood, mainly for food preparation and very occasionally for household or water heating. Fuelwood is generally collected, but in certain areas (Trapecio Andino) and at certain times (rainy season) the percentage of families purchasing fuelwood may amount to 30%. Cooking equipment (three-stone or semi-closed hearths, 'biscarras') is energetically deficient. These hearths are generally found inside the house, especially in high-altitude areas, and usually lack a chimney, with the consequent impact on the health of the women who cook exposed to the smoke.

9.5 Charcoal and fuelwood are sold for use in certain productive establishments such as ironworks, chicha (fermented grain beverage) factories, bakeries, brickworks and poulterers which are generally found in urban areas (including Lima). Moreover, in medium-sized sierra cities, a significant part of the population, amounting to 20% or 30%, cook with "purchased fuelwood". This consumption, combined with that of the small enterprises, comprises a relatively important market.

9.6 In addition, there are discrepancies between the different sources available regarding total fuelwood consumption, which varies between 7 million cubic meters (DGFF, 1986, but without urban consumption) and 14.4 million cubic meters (CONERG, 1988, equivalent to 3,120 TOE), shifting to 11 million cubic meters (PNAF, 1987). Moreover, DGFF estimates average consumption according to ecological area (the coast, 0.5 cubic meters per inhabitant per year; the sierra, 1 cubic meters per

inhabitant per year and rain forest, 1.5 cubic meters per inhabitant per year). These levels are comparable with other countries which have similar conditions, among them, Bolivia and Ecuador.1/

9.7 In weakened areas subregional balances have more value and use than an overall balance. Detection and quantification of the use of different fuels may reveal a trend either toward modern substitution fuels (higher income and improved accessibility), or toward lower quality fuels such as dung and 'Yareta' (irreversible resource degradation and lack of collecting time, etc.)

Supply

9.8 On the coast, there are some degraded Vetch plantations (Prosopis Chilensis) remaining. The north has a large forestry potential and the main activity is shepherding. The sierra virtually lacks natural forests, but has Eucalyptus plantations. This sierra region has the largest expanse of land classified as appropriate for forestry plantation. In addition, it lacks cultivable land. This region is known for its irrigation and dry agriculture and shepherding, the latter even above an altitude of 3,500 meters, where Eucalyptus no longer grows. In the high areas of the sierra native species, especially bushes and bushy plants (Yareta) grow. The rain forest is largely covered with thick damp forests and its scarce population is mainly dedicated to shifting agriculture.

9.9 An estimate of forestry resources stocks (natural woods and plantations) is indicated in Table 1 which also details the rate of deforestation. Natural woods include those free access woods (34.9 million hectares), protected woods (27.9 million hectares), Protection Units (5.5 million hectares) and state woods (5.3 million hectares). The accumulated area of plantations in the sierra probably amounts to no more than 200,000 hectares. Deforestation in the rain forest and on the coast basically stems from expansion of the agricultural border. In addition, the DGFF indicates that in 1989 the quantity of controlled sawn wood was about 500,000 cubic meters, the remainder (some 700,000 cubic meters per year) is exploited without control. Fuelwood consumption is noted to be about 10 times more than sawn wood production.

1/For exact estimation of total consumption, consumption surveys are needed with certain features, such as, representativity, sample stratification, assessment of seasonal variations and the use of different fuels, and consumption measurement in sub-samples, etc. In any case, an overall consumption figure has limited value, which is even more pronounced when there are additional uncertainties on quantitative aspects of supply.

Table 1: Forestry Resources and Production

	Coast	Sierra	Rain forest
Woods	3,700,000 ha	almost nil	73,700,000 ha
Plantations	1,100 ha	200,000 ha	1,200 ha
Volume	40 m^3/ha	-	10-150 m^3/ha
Commercial volume	-	-	30- 50 m^3/ha
Commercial wood	-	-	1,200,000 m^3/year
Reforestation	<500 ha	15,000 ha	<500 ha/year
Deforestation	20,000 ha	-	250,000 ha/year
	----------11,000,000 m3----------		

Source: PNAF, 1987

Coast

9.10 On the northern coast, natural woods in the Departments of Tumbes, Piura and Lambayeque are the main source of fuelwood for charcoal and are in danger. Since 1970, the felling of trees in this region has been prohibited, as a result of the rapid decline of this resource. However, felling has continued, partly illegally but also under certain legal conditions as it stems from the expansion of the agricultural border. This indicates that control is inadequate, and also that there are, in the Ministry of Agriculture itself, conflicts stemming from disagreement on objectives for the purpose of land use.

Sierra

9.11 The sierra is the region with the largest area of plantations (mainly Eucalyptus Globulus), with an annual average increase (AAI) estimated, on the basis of trials, between 6 and 10 cubic meters per hectare per year, according to the site. In some places the AAI amounts to 15 cubic meters per hectare per year for ten years. Most plantations are found on cultivated forestry lands, which are owned by the campesino community. In the case of reforestation with state support, the campesino community decides on the land to be planted. The State pays the cost of planting, including the production of seedlings and labor. The community becomes, in theory, the owner of the plantation once the State is paid the equivalent of up to US$450 per hectare with the plantation's gradual production earnings. Despite this amount only covering a share of the State's expenses, which amounts to between US$1,500 and US$3,000 per hectare according to the land, there are few cases where the communities pay the required amount.

9.12 In the sierra, high fuelwood consumption (estimated at some 5.5 million cubic meters per year) and the apparent shortage of biomass resources promotes the search for other possible sources of

fuelwood supply. The area of the plantations is estimated at 200,000 hectares, but there are possibly only about 100,000 hectares. There are almost no natural forests. Most of the production of Eucalyptus plantations is used for wood. Only 30% of the branches are used as fuelwood, which is beginning to form a byproduct of wood production. Thus, with an average production of 8 cubic meters per hectare per year, 100,000 hectares would only produce some 240,000 cubic meters of fuelwood per year. Nor is it probable that the fuelwood will be transported over large distances from areas not in the sierra; in fact, most of the population do not purchase fuelwood, but collect it. Therefore, fuelwood production is only explained on the basis of woody vegetation found outside the areas classified as forests: living fences, isolated trees and windbreak screens, which are mainly found in agricultural areas, as well as bushes and tree pruning, etc.

9.13 A study on Peru's forestry resources (FAO, 1981) indicated that the number of trees planted in boundary lines amounted to 40-50 per intensively-used agricultural hectare in the valleys of the sierra. Starting from this figure, 2,280,000 hectares of (dry and low irrigation) agricultural lands in the sierra (Ministry of Agriculture, 1987) are estimated to produce some 4.5 million cubic meters per year, comprising therefore, the major share of the sierra's estimated consumption (5.5 million m^3 per year), the remainder coming from the other above-mentioned woody resources.

9.14 Thus, the policies that may influence the supply of fuelwood are more concerned with the use and management of agricultural land than with forestry plantations. The latter has its main economic justification in industrial production (sawn wood, posts and charcoal) and in the protection of hydrographical basins, with fuelwood as a byproduct. In addition, the experience of reforesting for fuelwood have not been very positive up to now due to the classic problems of insufficient human and financial resources, lack of training of the beneficiaries, transport difficulties, and also centralization of the forestry apparatus. To conclude, the forestry expansionist has to stop being a planter of trees and change to being a rural forestry facilitator who, along with the campesino, identifies, analyzes and tests the many functions of the woody vegetation in the countryside and expands its productive capacity. This conclusion is also valid for fuelwood production on the coast where, bearing in mind the excessive tree felling in this ecologically delicate area, the need for
intervention is even more urgent.

Rain forest

9.15 The utilization of surplus rain forest biomass (sawdust residues, residues from agricultural border expansion and annual increase in natural formation), does not appear economically feasible. The production of charcoal from fuelwood for export to the cities of the sierra or Lima would not be financially profitable as a result of the high cost of transportation. In the case of biomass gasification electric power stations there are technical problems and high maintenance costs.

Institutional Aspects

9.16 Three public institutions are responsible for forestry energy matters: the General Forestry and Fauna Directorate (Dirección General Forestal y Fauna - DGFF) of the Ministry of Agriculture regarding forestry production and a certain form of monitoring; the Forestry Police, agency of the National Police of the Ministry of the Interior for implementing monitoring of the application for legal provisions, and the Ministry of Energy and Mines regarding energy statistics, including biomass.

9.17 The DGFF establishes standards and coordinates forestry programs. In keeping with the DGFF chart (Annex 1), it is noted that despite the importance of fuelwood, there is no specific division responsible for forestry energy. The Directorate closest to forestry energy (Forestry Management and Reforestation) still considers the production of fuelwood as an exclusively forestry matter.

9.18 Within the DGFF there is the National Forestry Action Program (Programa Nacional de Acción Forestal - PNAF), whose activities are based on the "National Forestry Action Program 1988-2000" Document (PNAF, 1987). The total investment required (national and international) for the proposed projects is US$254 million (Annex 3). It contains 5 programs, among which figures Program 2: Support for the production and conservation of energy and biomass, needing an investment of US$26.5 million. This program assumes a fuelwood deficit of 4 million cubic meters per year in the year 2000 and proposes a series of actions, which are not sustained with data which forecast the possible quantitative impact regarding deficit reduction. On comparing the PNAF programs with the structure of the DGFF, the absence of an agency specifically in charge of defining policy and woody fuel standards is again noted. The absence of this agency, as well as research programs on this theme in other institutions, contribute to explain the aforementioned lack of reliable and consistent data, since the matter is not strictly part of the responsibility of any agency.

Legal Framework

9.19 There are a large number of laws, supreme decrees, ministerial directives and regulations affecting the use and repopulation of forests for energy purposes. The most important law is the Forestry and Forestry Fauna Law. Important laws are: (a) the Legislation of the Campesino Communities, defining that these entities are autonomous in their use of land, as well as in economic and administrative aspects; (b) the "Law of Protection, Preservation and Reforestation of natural pastures and trees, in the República territory", of environmental scope, to be applied by the regional governments, campesino communities, enterprises and other agencies.

9.20 The major problem remaining is the lack of application of the laws, which leads to indiscriminate felling of trees and forests throughout the country. This deficiency stems from the lack of sufficient financial resources and trained personnel as well as an adequate structure for efficient control.

9.21 The different legal provisions only concern natural forests and define felling restrictions, royalties for forestry products, the reforestation levies and transport guidelines. These provisions, however, are mainly applied to the production of wood (in the rain forest), since in the sierra, fuelwood production is undertaken starting from plantations owned by the communities or starting from the aforementioned sources (isolated trees). In addition, public earnings from these activities are very low and only a small share is dedicated to reforestation activities.

9.22 Taking the case of the northern area dry forest as an example, fuelwood production would provide the State (through Agrarian Units) with an amount of 39 intis per Kg (of which, 13% is for the price of fuelwood, 77% for the reforestation levy and 10% for formats and guides), compared with the market price of 6,000 intis per Kg (Lima). The cost of reforesting and protecting this area is on the order of US$1,500 per hectare, while the state's earnings would not exceed US$20 per deforested hectare (considering a total volume of standing Vetch of 80 cubic meters per hectare) if they were all collected. This means a drastic increase in the reforestation levy and its periodic adjustment are required, as well as more efficient collection by the Forestry Units in the different regions. As they have recently been authorized by Supreme Decree, these Units should set the different taxes, permits and other regulatory elements, in keeping with the nature and condition of the woody resource. This regionalization of the process is highly justified and should also promote development and integration of the rural forest within the agricultural area.

Monitoring and supervision

9.23 Monitoring the standards defined by the DGFF is the responsibility of the Forestry Police of the Ministry of the Interior, whose budget is funded by the Ministry of Agriculture. The insufficiency of this budget almost caused standstill of monitoring activities in 1988 and 1989. Peru is divided into five forestry commands, which presently have 86 fixed posts for traffic monitoring on the main roads and 561 policemen, that is, an somewhat high average of 6 policemen per post. Besides the lack of training of the police in forestry matters, there are security problems which have lead to the removal of some posts. Monitoring efficiency is very limited. In the case of charcoal, in 1986, about 18,000 tons were monitored (97% coming from the northern area) when the total charcoal consumption was estimated by CONERG to be about 200,000 tons on a national level.

Supply and demand actions of woody resources

9.24 Despite the lack of quantitative data, the above shows that fuelwood extraction and even more so charcoal production, probably tend to provoke gradual, perhaps irreversible, degradation of the forestry resource in certain areas (Trapecio Andino and the northern area) or under certain conditions (areas with a high density of rural population, unbalancing the agrarian system, especially in dry or high altitude areas above 3,500 meters, and fuelwood and charcoal extraction areas for consumption in the cities of the sierra). Where this situation of irreversible degradation is observed, it is necessary to act swiftly to reduce consumption and increase production.

9.25 Consumption reduction may be achieved through the substitution of fuelwood for modern fuels (insofar as the earnings of residents allow them to purchase modern fuels) or through the use of improved cooking stoves (in the cities of the sierra and the northern coast). The increase in fuelwood production implies having to resort to management of current woody resources and to agroforestry and community reforestation actions; this will be done with native species (particularly in high areas) and rapid growth species like Eucalyptus.2/

9.26 In 1983, the FAO/Netherlands/DGFF project initiated the installation of improved bar-type cooking stoves (Lorena type), as a complement to their reforestation activities in the sierra. Despite efforts of the expansionists and the initial positive consumer reaction, the program has not had much success and the cooking stoves built have gradually gone out of use. This is attributed to the non-adaption of the cooking stoves to consumer expectations (requirement for many functions from a cooking stove) but above all, to the cost and maintenance frequency of the improved cooking stoves, in addition to the very small increase in efficiency. Another option would be the introduction of improved ceramic cooking stoves (light and low cost) in the areas where there are already traditional cooking stoves of this kind, which could be traded through current private distribution systems. The option of substituting fuelwood with kerosene is only feasible where the fuelwood is commercialized, which strongly limits this option. There are few rural areas where fuelwood is purchased all year round and in the cities most of the population already use kerosene. The cost of cooking equipment and the regular supply of kerosene are other obstacles.

9.27 Several projects (FAO-Netherlands/DGFF, Arbol Andino and CARE/AID) have experience with agroforestry systems, either with native (including bushes) or exotic species. Representative quantitative data are still lacking on growth, optimum integration methods for agricultural lands, effect on the yield of cultivations and livestock rearing, and the best fuelwood production techniques. Fuelwood production from trees on agricultural lands could be increased with improved management of current resources and a greater integration of trees and bushes in agricultural lands, whose potential could thus amount to 9 million cubic meters of fuelwood per year. The qualitative benefits of having isolated trees and windbreak screens on agricultural lands are well known; increased agricultural production, soil conservation.

9.28 Of special importance is the promotion of native bush and tree planting in high altitude areas where households use animal dung for fuel. This usage seriously damages the fertility of agricultural soils, where herds graze for part of the year. A study has shown that the opportunity cost of dung is equivalent to substituting with chemical fertilizers in the amount of US$8 per ton. In other countries, it has been verified that a ton of animal dung added to the soil increases cereal production by about 50 Kg per hectare. The use of animal dung estimated for 1984 (1.7 million tons) would, therefore, account for a maximum loss of 85,000 tons of cereal per year (supposing that all the animal dung would fall on cultivation land).

2/In Peru, several valuable experiences have been obtained on these options, especially in the sierra.

9.29 The establishment of dense energy plantations in the sierra by the DGFF faces the following severe problems:

(a) High cost, often greater than US$1,500 per hectare,

(b) Low survival rate (50% maximum);

(c) Difficulty and efficiency to monitor and protect the plantations and flow of wood products.

9.30 In fact, the cost of producing fuelwood from plantations, including the plantation, extraction, and transport costs, and eventually the cost of the land (although dedicated forestry lands are almost always reforested), is much higher than the cost of fuelwood to the public. This is a result of fuelwood merchants considering fuelwood to be a wood byproduct (only cost increases affect fuelwood, since all the costs affect the main product, that is, wood). In additions, they have informal and competitive distribution chains which pay a price for the standing tree, which is less than its replacement cost by energy plantation.

9.31 The DGFF should focus on basin protection plantations and, possibly, industrial purpose plantations (wood and posts, with fuelwood and charcoal as byproducts). It has been observed, however, that the cost of plantations fall considerably, about US$500 per hectare, in the FAO/Netherlands/DGFF project, on obtaining expansion support from campesino communities in the form of labor.

Recommendations

9.32 Definition and implementation of specific projects to improve the fuelwood supply situation in the sierra, and also on the coast, has to follow the creation of an adequate institutional infrastructure, particularly in the DGFF, which may coordinate these type of activities and remedy the lack of data and information. The following actions are therefore recommended:

(a) Establishment of a rural and woody fuels Forestry Unit within the General Forestry and Fauna Directorate. This unit will develop a system to collect, process, store and disseminate the relevant subsector data, in the form of a data base and close coordination with CONERG. Training of Unit personnel, as well as field staff will be planned.

(b) Implementation of specific detailed studies in selected areas on the following points: Marketing and autoconsumption of wood products; production systems, measurement of the consumption of each energy source.

(c) Increasing the amount of taxes on fuelwood and charcoal production in natural forests and eventually on their transportation (at the control posts at the entrance to medium-

sized sierra cities) to improve earnings dedicated to reforestation (so that they at least cover the management costs for natural forests).

(d) Preparation of a management plan for the dry forest in the northern region and imposing a closed season on the production of fuelwood and charcoal in this region, at the same time as establishing stricter control on the flows of fuelwood and charcoal at strategic points.

(e) Revision of forestry energy components of the PNAF: regrouping projects to avoid duplication; classification and prioritization of projects to facilitate their financing; limiting the number of agencies in charge of project implementation.

(f) According to the results of the short-term actions, especially the aforementioned Unit activities, the objectives and modalities of reforestation and a strategy for the supply of short-term forestry energy will be defined, integrating energy, forestry and agricultural matters. An emphasis on communal reforestation programs with trees of multiple use on agricultural lands and with native species in high areas is anticipated.

NEW AND RENEWABLE ENERGY SOURCES

Experiences and problems

9.33 During the seventies and the first half of 1980, Peru saw intense activity in the field of renewable energy sources which, however, has been falling as a result of the trend (low prices of conventional energy products and lack of capital) but above all, the discouraging results of many projects carried out. Under the promotion of ITINTEC, national manufacture of several technologies was developed (solar water heaters and dryers, windmills, turbines and regulators for micro-hydropower station and biodigesters,) and a large number of projects were implemented, mainly in the rural environment, with emphasis on equipment operation and maintenance by the users themselves, assisted by agencies or decentralized enterprises.

9.34 There are many justifications for these efforts: As a result of its generally widespread character, renewable energy sources are available near the users, which is interesting in Peru in view of the size of the country, as well as deficiencies in the supply of conventional energy. On generating employment and adding value in the place it is used, renewable energy products may contribute to curtail rural migration because the supply of energy plays a wider role in integrated rural development. Generally, the substitution of exportable oil products is also achieved and finally, the impact of renewable energy sources on the environment is usually much less than the impact of conventional fuels.

9.35 The discouraging results of the application of renewable energy sources in Peru are due to a series of technical, economic and social factors. For the technical aspect, the inappropriateness of the environment, design deficiencies, high maintenance frequency and insufficient quality of national

products are the main problems that face many of the technologies. In general there has also been a lack of complete analysis on energy demand and consumer motivations, including socio-cultural matters.

9.36 The lack of consideration given to economic and financial aspects was more serious: On several occasions applications were promoted which were not minimum economic cost, placing unquantifiable doubts in the balance of benefits. Generally, due to low demand and the absence of a productive sector, the rural energy supply units were not financially profitable.

Mini-hydropower stations

9.37 ELECTROPERU has developed an important mini- and micro-hydropower station program, either isolated or integrated into decentralized mini-networks (Small Electric Power Systems, PSE). Of some 120 installed power stations, it is estimated that a third are in a deficient operating condition or are at standstill. Here the major problems have been maintenance and often, deficient design. In addition, the costs per installed KW are high, between US$2,000 and US$3,000 for capacities between 300 and 1,000 KW (USAID and ELECTROPERU project). For smaller capacities, the utilization of national technology (Mitchel-Banki turbines for example) and involvement of the beneficent community by way of labor should enable costs of about US$1,000 and US$1,500 per KW to be achieved. In most sites of implementation, very low load factors have negatively influenced the profitability of the mini-stations compared to diesel units. In addition, in several sites the opportunity cost of water is not zero, as a result of irrigation requirements.

Solar power

9.38 The solar resource is excellent (4 to 5 kWh per square meter per day, with few seasonal variations) in a large part of the Peruvian territory, except in the east and on the central coast. There are five enterprises manufacturing solar water heaters and it is estimated that more than 3,000 square meters of collectors have been installed. With the increase in electric power tariffs, the use of solar water heaters will be profitable and will also contribute to reducing the demand for electricity during peak hours, advantages which, nevertheless, will be constrained by the low number of households with heaters and by their seasonal use. The solar grain dryers, of rustic and cheap design (UNI/GTZ and ITINTEC projects), have been well accepted for the drying of certain products in the sierra (corn, oregano and chili) owing to an important reduction in wastage more than the quality of the product (which has little influence on the product's price). In the region of Puno, 50 photovoltaic systems were installed within the framework of the Special Energy Program (GTZ) for lighting, radio and television at a unit cost of US$250 for a capacity of 40 W. In some of the households in this region, conventional energy expenditure (candles, kerosene, batteries and car batteries) will be higher than the amortized cost of the photovoltaic system and, therefore, there is a market for these systems provided that credit facilities are available.

Wind power

9.39 Wind power potential is high and relatively constant along the length of the coast, while in the sierra it is localized and fluctuates (with the risk of equipment being destroyed by suddenly strong winds). More than 3,000 windmills were installed in the Departments of Piura and Arequipa. After the floods in Piura, GTZ implemented a successful windmill (rustic wood construction) rehabilitation program. Motivated by the research of ITINTEC, six companies are manufacturing multi-sailed windmills, with the dominant model in Arequipa. Some have inadequate designs and for all of them, very low volume production is a serious obstacle. A GTZ study showed that with wind speeds of more than an average 4 m/s per day, windmills are the best option for pumping water for irrigation, while in the case of potable water requirements or for livestock (almost nonexistent demand in the sierra) windmills are uncompetitive compared to manual pumps.

Geothermal energy

9.40 Between 1982 and 1985 ELECTROPERU implemented reconnaissance studies for geothermal potential in 90% of the country, followed by a prefeasibility study which produced negative results in one of the four identified areas of interest. Even if studies in the remaining regions (suspended up until now) reveal a favorable deposit, examples in other countries (on average, a cost of US$2,500 to US$3,000 per kW and 5.5 to 6.5 US cents per kWh) show that the geothermal option probably has a limited future compared to current alternatives for electric power generation (especially with implementation of Camisea gas).

Biomass and biogas

9.41 A charcoal gasifier was installed in Iberia (rain forest), as the first stage of a biomass valorization program. Despite a cost per kW three times greater than the cost of a diesel power station, the gasifier would have enabled a cost of US$0.1 per kWh compared to an estimated cost of US$0.14 per kWh for the diesel power station. However, it was discovered that the gasification technology has serious technical problems regarding its reliability of operation and maintenance frequency. With the promotion of ITINTEC, almost a hundred, mainly Chinese model, biodigesters have been installed, particularly in the Arequipa region (with the Gloria milk company). Apart from technical problems (temperature, for example), the major obstacle has been the high initial investment. This technology does not have much of a future in Peru, except if the economic benefits from producing byproducts like fertilizers and improvement of environmental health can be accounted for.

Recommendations

9.42 Despite the problems identified, some renewable fuels may represent a minimum cost solution for certain energy demands in the rural environment. With the additional purpose of valorizing the important efforts implemented during the last two decades, it is important to assess the conditions in

which these technologies can be used. Therefore, bearing in mind the fuel price adjustments, the following actions are recommended:

- Conducting a complete assessment of renewable energy sources in Peru, in technical, economic and socio-cultural terms, in order to determine the mature technologies corresponding to identified demands and which have market prospects.

- Starting from the assessment results, specific programs could be designed for selected technologies, which take into account the following aspects:

- Minimum cost study and assessment of the project's financial return (payment capacity of the consumers).

- Standards and quality control during manufacture and equipment installation.

- Major involvement of the decentralized rural promoters (ONG, CORDES, Rural Development Projects, etc.)

- Promotion of small local utilities to install and maintain equipment.

- Major institutional coordination in order to avoid duplication of efforts and so as not to research proven and appropriate technologies for Peru or technology which has already been rejected as unusable.

X. COAL SUBSECTOR

10.1 According to present knowledge of the contents of Peruvian coal, the latter could appear to be a possible alternative for some specific uses. In the medium term, coal does not appear to be an important alternative among the other energy sources. Its proven reserves are low (70 million tons or 264 million tons including probable reserves) and the extraction costs for an economic volume would be high because deep mines are being dealt with. In the current state of the mining activity, production and also volume are subsistence level (average production is 5,000-8,000 tons per year per mine at a cost which varies from US$10 to US$15 per ton at the mine mouth).

10.2 It is not known what the costs would be for the mechanized or semi-mechanized extraction of a large volume (in Peruvian terms) that is, 500,000 to 1 million tons per year. This does not mean, however, that coal does not have a specific role it could play, for example, in thermal uses in small or subsistence industries (brickworks, etc.), especially in the immediate area of the coal region. Present coal consumption in Peru is on the order of 400,000 tons per year, of which 200,000 tons are imported (coking coal).

10.3 Given the low prices of liquid fuels, coal has not been competitive compared to subsidized oil products. Most probably, even with fuel oil at international levels (US$90 to US$100 per ton) national coal would not be competitive in Lima, but could possibly be on the northern coast (Chiclayo, Trujillo and Chimbote) where the transport costs for coal would be lower. In small quantities for thermal uses, national coal could compete with imports (that is, with the techniques and volumes of present production, domestic Peruvian coal could compete with Venezuelan and/or Colombian imports but with greater volumes and more costly techniques this is not certain).

10.4 In theoretically comparative terms, national coal at US$50 per ton (ROM containing about 4,100 Kcal per Kg) would not compete with natural gas at about US$2 per million BTU (or even US$2 per million cubic feet), which is 45% cheaper.

10.5 For use in the home, coal briquettes seem to be competitive with kerosene on the northern coast, but not in Lima. Clearly, economic competitiveness is a necessary but insufficient reason for acceptance of these briquettes by the population. Anyway, total coal requirements would be lower and would not justify substantial investment in mining. However, some more detailed conclusions and recommendations are presented as follows.

RECOMMENDATIONS

10.6 The majority of important industrial activities are concentrated in the Lima-Callao region and along the coast, from north to south. 85% of fuel consumption is concentrated in these areas (with 65% in the Lima-Callao district). Many of the industrial plants, such as the cement, metallurgical, paper, sugar and fishing industries burn fuel oil 6. A gradual substitution of this type of fuel, with national coals, seems possible in those industrial areas situated near the source of coal, such as Ancash and La Libertad, where about 196,000 cubic meters per year of fuel oil 6 could be substituted by 336,000 tons of coal per year.

10.7 The use of coal briquettes for the domestic market could be an alternative to kerosene. Briquettes could compete with kerosene (at economic prices) in the aforementioned departments in the same way as in the industrial area of Oroya due to their proximity to the Jatunhuasi mines.1/ Within this area, the potential market for coal briquettes could amount to some 250,000 tons per year, using anthracite and/or local bituminous coals.

10.8 With a little care, the local bituminous coals, (after adequate preparation) could be used in the CENTROMIN metallurgical plants, substituting some 50,000 tons of imports per year.

10.9 Due to the high price of imported coal, compared with the cost of Peruvian coal, it can not really compete (at current market levels) for thermal uses. The only coal that has to be imported is coke, which is mainly used by SIDERPERU for metallurgical processes. In this case, the incidence of transport costs for the bituminous coking coals of Oyon and Jatunhuasi would be too high and would not enable national coal to compete with coke, except maybe in the areas of Oroya or the northern coast.

10.10 So that Peru can produce and use 500,000-1 million tons of local coal per year in place of other greater value energy sources, the following considerations should be taken into account:

- That oil prices (especially fuel oil 6) reflect their economic costs.
- Gradual substitution or transformation of heat (steam) generating equipment, generally used in the fishing, paper, sugar, heat processing and metallurgical industries, to equipment suitable for burning national coal. 30% of boilers are small with a 6 MW capacity and are not suitable for conversion to coal. Larger boilers can be transformed conveniently. This operation could be undertaken only in the industrial areas where coal is found at competitive prices.
- Development of appropriate equipment for burning coal is recommended, which burns anthracite with a low proportion of volatile matter and bituminous coals with a low fixed

1/In contrast, this recommendation is not considered for the Lima/Callao area due to the high transport costs.

carbon content more efficiently. These technologies are found in use in other countries with similar coals.

- Some cement plants have already made investments enabling them to use coal, but continue to burn fuel oil because of its low price. To maintain competitive coal prices (for example, the same as or less than US$54 per ton of pulverized coal), coal crushing plants should be operated directly by the cement companies (coal crushing is presently a monopoly in Peru).

- In keeping with the high consumption of kerosene in the domestic market, a briquette program could mainly be conducted in the densely populated and low-income areas near to the mines, such as La Libertad, Ancash and Junín. These markets could absorb about 250,000 tons of coal, replacing other fuels in some 160,000 households, restaurants and small enterprises.

- Modern coal-mining methods, as well as the washing process, will generate a greater quantity of fines. The briquetting process should, therefore, be studied with particular attention, not only for the domestic market but also for industrial uses. The substitution of 50,000 tons per year of imported coking coal by national bituminous coal from Jatunhuasi should be considered, which when washed and partially briquetted could be used in the CENTROMIN smelting works.

10.11 So that the mining industry can meet possible national demand of about 500,000-1 million tons per year generated by substituting fuel oil and kerosene in industry and the domestic market, the following recommendations are suggested:

- Implementation of an additional exploration program (in the areas being mined) to determine the effective coal reserves in areas of better access for good quality thermal and coking coals and determining their geological, mining and capacity characteristics to meet industrial requirements.

- Conducting limited studies of coal washing to see if the characteristics required by the market, such as ash, volatile material, sulphur content, heat and cokability are obtained. Alternatively, the coal with the best characteristics could be concentrated on.

- Organization and development of present mining activities which are generally small, occasional and subsistence level, to transform them into more developed, mechanized or semi-mechanized mines, capable of providing a determined yield for the whole year. The currently few experiences should be monitored and any useful experience should be extended to the most important private mines.

- In order to reduce the strong influence of transport costs on the price of coal, mining efforts should be concentrated in the regions that already have transport infrastructure, including road connections, loading capacity and rail links.

PERU'S COAL DEPOSITS: COAL AND RESERVE QUALITY

10.12 Coalfields may tentatively be grouped into four regions, from north to south: the northern, central, southern and eastern. The Santa and Alto Chicama basins, and those of the Oyon and Goyllarisquizga-Jatunhuasi basins in particular, have deposits with the best prospects, either as a result of their size or the quality of coal they contain.

Alto Chicama basin

10.13 The coal field is found in a strip in the northwest direction, with an area of about 750 square kilometers.

10.14 Within the productive level of the Chimú formation, it has been possible to identify ten coal seams of varying capacity, with an average thickness of 1.6 meters. Of the total ten seams identified, only five or six may be considered of economic importance. Because of the tectonic events experienced by the Andes formation was deformed and impacted. The numerous faults, which led seams to occupy structurally varied positions, have begun to adopt steeply inclined, even vertical dips, in some areas of the coal field.

Santa Basin

10.15 The coal-bearing outcrops in this basin extend in an area of about 300 square kilometers. The seams have potentials varying from 0.6 to 3.0 meters, with 20 to 75 degree dips.

10.16 There are considered to be at least six potential and economically exploitable seams within the productive formation. The region's rocks, as a result of the deformation processes, are highly folded and fractured into numerous blocks, limited by faults splitting them in several directions.

Oyon Basin

10.17 Structurally, the area is complex. The Andean mountain building movement lifted and folded the area's sediments giving rise to complex structures, such as upturned folds and inverted faults which harrow on run-off and which are crossed, in turn, by normal, sharp-angle faults.

10.18 Within the coal seams there are potentials from one to two meters, with dips of 40 to 50 degrees.

Goyllarisquizga Basin

10.19 The dimensions of the deposit are about six kilometers in length by four kilometers in width. The basin's most important structural feature is a wide syncline whose axis is submerged to the southeast where the coal, despite being fragile, has been conserved in acceptable conditions.

10.20 Within the coal-bearing formation, two horizontals separated by a packet of quartz-bearing sandstone with a potential of 30 to 90 meters, can be differentiated. The upper horizontal has 4 coal seams with an average potential of 0.90 to 3.60 meters. The lower coal-bearing horizontal has only one layer of 0.9 meters potential.

Jatunhuasi Basin

10.21 The dimensions of the coal-bearing basin are 35 kilometers in length by 5 kilometers in width. The most important structural feature is a wide syncline, on whose eastern side lies a coal deposit. Within the productive unit, it has been possible to differentiate six coal seams of which only two may be considered economically profitable, with variable potentials of 0.30 to 1.5 meters and 0.5 to 0.8 meters, respectively. The average dip of the seams is 30 degrees. In general, the structure is regular.

Quality and range of coals

10.22 Coal quality is somewhat varied, both within the same basin and within the same coalfield. These variations mainly refer to the physical characteristics of hardness and size. The Alto Chicama and Santa basin coals are anthracitic and their characteristics have been defined as good quality. In each one of the regions a variation has been noted from north to south. In the case of the Oyon basin, there is a variation which in some cases may be explained by the different tectonics, such as the regions between the Chacras River (anthracite) and Pampahuay (sub-bituminous). The Guyllarisquizga and Jatunhuasi basin is sub-bituminous and the Tumbes deposit is lignite.

10.23 The type of coals in the entire Alto Chicama and Santa basins are anthracite, with an acceptable quality for industrial use, although their size distribution is not very favorable. As a result of high pressure conditions and frequent or intense tectonic movements, Peruvian anthracite has a high tendency to crack and break, which is caused by the substantial amount of vitrinite in the maceral groups. Consequently, the size distribution of ROM coal unfortunately tends to be fine (20% greater than 5 cm; 40% greater than 1 cm and 60% less than 1 cm, which are common average values), the content of volatile material is generally 2-3% less than the normal standard of 8% and the fixed carbon content is generally less than 92%.

10.24 Several enrichment by washing tests have been undertaken. The tests with anthracite demonstrate the great difficulty of washing anthracite, which is mainly a result of two factors; (i) its specific high weight and (ii) its highly fragile texture. Although bituminous coals, such as those in Oyon, Jatunhuasi and Goyllarisquizga, may be used as coking coals in the metallurgical processes of

SIDERPERU or CENTROMIN, they are similarly inconvenient, with large amounts of fines, more than 59% ash, between 22% and 38% volatile material, and more than 6% sulphur. For the metallurgical industry to use local coke instead of imported coal, the local coals should be washed, thus reducing the ash and sulphur content and, consequently, increasing the volatile material, fixed carbon and calorific content.

10.25 In most laboratory tests, conducted by the Corporación Cerro de Pasco, it was concluded that these coals could be used to prepare coke, by mixing them with other imported coals to produce a better quality coke. Like thermal coals, they do not present major problems nor extraordinary benefits.

Table 1: Analysis of Peruvian Coal

	ROM Coal	Washed Coal
Fixed carbon	32%	57%
Volatile material	20%	36%
Ash	49%	7%
Sulphur	14%	1.99%
Calorific Value	4100 kcal/kg	7400 kcal/kg

PERU'S COAL RESERVES

10.26 Coalfield exploration and prospecting is not systematically carried out in the country, as a result of cost and due to a depression in the mining industry which, as demonstrated by production volumes, currently does not have a market.

10.27 Peru has proven and probable reserves on the order of 264 million tons and of these reserves, 70 million tons are proven and available in the short term. Potential reserves are 1.666 billion tons.

Table 2: Coal Reserves in Peru

Region	Type	Reserves		
		Proven	Probable (million tons)	Possible
Northern				
Tumbes	Lignite	-	-	100.0
	Bituminous	-	-	25.0
Tuco & Piñipata				
Alto Chicama	Anthracite	38.0	82.0	560.0
Central				
Santa	Anthracite	28.0	72.0	516.0
Oyon	Anthracite/ bituminous	4.0	24.0	298.0
Goyllarisquizga	Sub-bituminous	-	2.0	6.0
Jatunhuasi	Sub-bituminous	-	14.0	60.0
Others				
Cuspinique	Anthracite	-	-	24.0
Yanacancha	Anthracite	-	-	74.0
Carumas	Semi-anthracite		-	3.0
		70.0	194.0	1666.0

COAL MINING ACTIVITIES IN PERU

Coal production

10.28 During the last 20 years, the Peruvian coal industry has been operating at very low levels. Production remained at about 150,000 tons per year between 1970 and 1986, increasing in 1989 to some 200,000 tons per year. Currently, the Peruvian Government is tending to increase the involvement of coal in the energy sector, which in total only amounts to 0.6%, by opening up new markets for this product. The prospect of other energy products being sold, in the future, at their economic prices could provide a substantial incentive to produce coal for thermal uses.

Table 3: Peru: Coal Production

Field Production	Type Production	1986 (ton/year)	1989 (ton/year)	*Potential Production (ton/year)
Alta Chicama	Anthracite	28,000	38,000	750,000
Santa	Anthracite	59,500	43,500	450,000
Oyon	Anthracite Semi-bituminous	12,500	18,000	200,000
Jatunhuasi	Sub-bituminous	-	-	200,000
Goyllarisquizga	Sub-bituminous	66,000	-	-
		165,800	200,00	1,600,000

Source: PROCARBON, several studies and Study Group Estimates.

* Potential production means what could be produced, if there were a market, with some additional investment in mechanization and mine development.

Analysis of active coal mines

10.29 There are 19 coal-bearing basins in Peru but only the anthracite from Alto Chicama and Santa, and the bituminous from Oyon, Goyllarisquizga and Jatunhuasi are of economic importance. The total incidence of coal with coking characteristics in these last three fields is 30% of their total reserves, while 80% of Peruvian coal reserves are anthracite, generally with a lower content of volatile material.

10.30 There are 32 well-known coal mines, in the above-mentioned areas, of which only 19 have been officially registered but, in addition to these, there are many small private mines operating on certain occasions. Only 3 of them are opencast mines: Rio Negro and Galgada, in the Santa coal field and Surasaca in the Oyon field. The rest are deep mining type. There distribution is indicated in the following table.

10.31 Many of the mines are privately owned, with the exception of Callacuyan, operated by MINEROPERU; Checras, Gazuna and Pampahuay, operated by SIDERPERU; and Jatunhuasi and Goyllarisquizga, by concession to CENTROMIN.

10.32 On analysis of the data, it is noted that the mines produce a very low quantity of coal. Production of 5,000-8,000 tons per year reflects an average value for a deep mine, while opencast mine production amounts to a capacity of 30,000 tons per year. These low and costly production levels stem from extremely difficult market conditions.

Table 4: NUMBER OF MINES, STATE OF ACTIVITY, PRODUCTION AND POTENTIAL

Basin	Goyllarisquizga	Alto Chicama	Santa	Oyon	Jatunhuasi
Opencast	-	2	-	1	Standstill
Deep	-	2	14		Standstill
On line	8			7	Standstill
Development	3		-	1	Standstill
No information	3	5	1	-	Standstill
Average 1986 (production (ton/year)	5,000	8,000	6,000	-	66
Potential production (ton/year)	30,000	30,000	50,000	100,000	-

Public-owned mines

10.33 At the same time as Siderperu is developing a mine in Pampahuay, MINEROPERU is implementing a three year program, with its own exploration and mining development, in order to increase its mining capacity to more than 360,000 tons per year in the Callacuyan mine in the Alto Chicama area. CENTROMIN forecasts other developments in the Jatunhuasi basin, where the productivity of its mining concession is planned to be increased to more than 100,000 tons per year, through the application of hydraulic mining methods. Neither the economic justification for these activities nor the markets in which these substantial production increases are going to be sold are known. As there are prospects to privatize large-scale mining, these coal mines would easily be to sold to private operators especially as oil is now being sold at prices reflecting its economic costs.

Mining Methods

10.34 The most commonly used mining method used in subsistence level deep mines comprises entering the coal seem, aiming for a small dip in the fissure without supports, working upwards and downwards within a seam without knowing its geology and extension, and without using any safety measures or ventilation. Generally, coal seems are inclined within a range of 35-70 degrees. Therefore, even in mines where opencast methods are applied, a too thick overburden layer will rapidly be encountered and the mine will either have to be closed or deep exploitation methods will have to be developed.

10.35 Normally functioning with simple natural ventilation, the depth of the mines rarely exceed a maximum of 700 meters. This may be acceptable as there are very few volatile elements and work is usually carried out above the level of the surrounding ground.

10.36 Research shows that as a result of the lack of beneficiary coal plants, all mines currently distribute untreated coal (ROM). The way to reduce the amount of ash in the product, which already has a reasonably low ash content, is by visual inspection and manual selection, thus removing the largest visible impurities. The considerable number of occasional laborers, who work sporadically when there is a market would, therefore, have to be increased.

10.37 Coal production per miner is currently 0.5-1.0 tons per day, with the miner carrying out his work in difficult conditions and receiving a salary of about US$100 per month (often paid per job).

Legal Aspects

10.38 Currently, there is no specific coal legislation. Legislative Decree No. 109 of the General Mining Law protects mining activities such as reconnaissance, prospecting and exploitation, etc., as well as the prerogatives and obligations of the miners rights and the system of taxes.

10.39 Prospecting is free throughout the national territory, except in areas where the mining rights have already been acquired or tied up in urban areas, archaeological sites and areas with special state rights, etc.

10.40 Exploration is in the charge of MINEROPERU, using sector companies. If a contract is held with private individuals, it stipulates that they have the right to exploration and development concessions over a total area of no more than 20% of the original exploration area.

10.41 By virtue of the conceded rights, mining concessions are classified according to exploration, development, etc. Exploration and development concessions authorize the holders to exploit the minerals within the perimeter of the concession, including ownership of the extracted substances. Mining concessions may be obtained by written request to the respective Regional Mining Office. Exploration concessions are granted for periods of up to 5 years, while development concessions are granted for an indefinite period. The State is the only entity authorized to implement, without exception, all mining industry activities and these special rights are assigned to the Empresa Minera de Perú (MINEROPERU).

10.42 Non-exportable mineral products, whose prices are determined by the local supplier and demand, will be sold on the domestic market under the system used for this kind of transaction. The Ministry of Energy and Mines may be obliged to intervene, if public interest requires, by organizing the relevant mechanisms to regulate its trading. (3rd heading, Chapter I, article 37).

10.43 Regarding development concessions, when requesting a concession for exploitation, the solicitant must pay 0.025% of a UIT per hectare, and 4% of a UIT as the total tariff for registration in the Public Mining Register.

10.44 Exploitation concessions may be kept indefinitely if a minimum production is maintained (relative to the minimum proved probable reserves and with an additional investment to replace the extracted reserve). The obligatory minimum production per year may be reduced or abolished if there is no market. Under normal market conditions, exploration concessions and concession rights (for exploitation) may be abolished (or lost) merely by fine or abandon, that is, production standstill for 2 consecutive years without authorization, nullity, renunciation of rights or cancelation.

THE PERUVIAN COAL MARKET

Current use of coal in the Peruvian market

10.45 Coal is used in small quantities by national industries, up to a total of some 400,000 tons per year, and is mainly consumed in the reduction process of metallurgical industries, for thermal uses in small application industries, like brickworks and for domestic use in areas near to mining sites. The bituminous coals of Oyon, Jatunhuasi and Goyllarisquizga, which may be used as coking coal in the metallurgical processes of SIDERPERU or CENTROMIN, have the inconvenience of the aforementioned fine sizing. Other problems may also arise as a result of the high sulphur content of unwashed coal. Current national production of 200,000 tons per year, 90% accounted for by anthracite, is absorbed by industry and the domestic market. SIDERPERU uses anthracite (60,000 tons per year) for iron sponge reduction and production (60,000 tons per year) and (40,000 tons per year) for the elaboration of process gas. A sizeable amount is used in brickworks and for domestic uses (cooking), especially in the sierra, near the mining regions.

10.46 Imported coking coal (200,000 tons per year) is used by SIDERPERU (150,000 tons per year) and CENTROMIN (50,000 tons per year) in the metallurgical plants of Chimbote and La Oroya.

Table 5: MAIN USES FOR COAL IN PERU

Coal Consumption User	Locality	Coal Type	Utiliz.	Consumption	
				National (t/year)	Imported (t/year)
Siderperu	Chimbote	Anthracite	Steel	100,00	--
Siderperu	Cimbote	Bituminous	Coke for met. use	--	150,000
Procarbon	Cimbote	Anthracite fines	Briqauettes	8,000	--
Procarbon	Huaraz	Anthracite	Nroqaiettes	2,000	--
Centromin	La Oroya	Bituminous	Coke for met. use	--	50,000
Brick, Ind. & domestic market		Anthracite fines	Thermal		

10.47 To introduce briquettes on the domestic market, PROCARBON maintains a small production plant in Chimbote, using part of the fines available in the plant. The plant's theoretical capacity is 50,000 tons per year but it is estimated that total effective production is less than 8,000 tons per year. There is also a second pilot plant in Huaraz (2,000 tons per year), which produces a different size briquette.

Table 6: COAL PRODUCTION AND IMPORT

	1980 t/year	1982 t/year	1985 t/year	1989 t/year
Production				
Anthracite	41,000	70,000	122,000	200,000
Coking coal	30,000	32,000	27,000	-
Total Prod.	71,000	102,000	149,000	200,000
Import				
Anthracite	36,000	24,000	44,000	-
Coking coal	150,000	126,000	97,000	200,000
Total Imp.	188,000	150,000	141,000	200,000
Total Prod. & Imp.	259,000	252,000	290,000	400,000

COAL PRODUCTION COSTS AND MARKET PRICES

Production cost of ROM coal and price in the mine

10.48 The coal production cost is calculated at US$15 per ton, therefore, the average sale price of coal at the mine mouth is US$22 per ton, with small variations as a result of the quality of the coal. The same price is applied both for anthracite and bituminous coal. These costs are based on estimates in semi-mechanized mines such as Callacuyan and Pampahuay. In mines, using simple subsistence mining techniques (with labor paid per job and low wages), the production costs could be about US$10 per ton.

Transportation Costs

10.49 The coal price in the locality of the user is severely affected by transport costs, which may increase the fuel price by 50-60%. Real transport costs have been estimated at about US$0.13 per ton per kilometer in the mountainous regions and by US$0.04 per ton on the asphalted roads of the coast. Adequate maintenance of the road infrastructure and improvement of the transport systems could materially reduce these costs. There is also a central railway, which could be used in the Jatunhuasi area of the central sierra to serve Huancayo and/or Lima. The (subsidized) coal tariff would be US$0.03 per ton per kilometer.

Coal price in the locality of the user

10.50 Selected coal sale supply prices, in certain localities, are shown in the following table. The offers made by mechanized mines may be considered as representative of conditions in the Peruvian industrial markets. However, it is not known whether there were transactions at these prices or at what prices the transactions took place.

Table 7: NATIONAL COAL SUPPLY PRICES IN SEVERAL REGIONS

	Origin	Price (US$/ton)
	Santa	35
Trujillo	Alto Chicama	37
Lima/Callao	Oyon	47
Paramonga	Oyon	45
La Oroya	Jatunhuasi	39
Moquegua	Oyon	58

Prices of imported coal

10.51 The price of imported coking coal, which is used in the metallurgical processes of CENTROMIN or SIDERPERU is US$53 per ton FOB Colombia. The sea freight, customs and port expenses increase the CIF price of coal in Callao by US$20.0 per ton (that is, Callao CIF value of US$73 per ton). Other types of coal have not been imported recently (for example, thermal).

10.52 In previous years, FOB prices for imported thermal coals, with a calorific content of 6,000/7,000 kcal per kg, which could be used in the Peruvian market, have varied between US$38 per ton for coal from Venezuela and US$59 per ton for those from North America (origin FOB). Moreover, real import prices (Callao CIF) have been about US$55 per ton for coal from South Korea; US$65.5 per ton for Japanese coal; US$60.8 per ton for Vietnamese coal and US$65 per ton for Australian coal. However, these prices are not representative for small quantities.

POTENTIAL USE OF NATIONAL COAL IN PERUVIAN INDUSTRIES AND DOMESTIC MARKETS

Coal substitution for generation, reduction or direct heat in industry

10.53 Currently, the fuel most commonly used in Peruvian industry is Fuel oil 6. Evidence of its importance for total consumption in industrial districts, near coalfields such as Lambayeque, La Libertad and Ancash, where fuel substitution could be considered, is presented below.

Table 8: USE OF FUEL OIL IN AREAS NEAR TO COAL SOURCES AND POSSIBLE SUBSTITUTION BY COAL

Place	FO6 Consumption (m^3)	Coal Equivalent (tons)
Lambayeque	17,960	30,000
La Libertad	206,310	360,000
Ancash	126,390	220,000
Lima	579,940	1,000,000
Ica	86,580	150,000

10.54 Steam generating equipment is used in the fishing, sugar, metallurgical and paper industries, where a total of 210 boilers are employed in 43 production plants. Boilers with a steam capacity of 8-10 tons per hour, equivalent to 6 MW, appear to be the most common size, accounting for 30% of the effective national boilers. Only 6% of the total production has been generated by boilers with a capacity of more than 100 tons per hour.

10.55 Feasibility studies conducted by GTZ tried to define the production costs of steam, generated in new boilers, using fuel oil 6 or coal, as well as comparing the generating costs with fuel oil 6 in existing boilers and with boilers transformed to use coal. The results are presented in the following table:

Table 9: COMPARISON: USE OF FUEL OIL AND COAL IN NEW AND OLD TRANSFORMED BOILERS

Unit	New FO6 boiler (Fuel oil)	New boiler (coal)	Old F06 boiler (fuel oil)	Old transf. boiler (coal)
Annual investment cost	18,049	45,723	-	27,927
	81,136	91,136	81,136	91,136
	94.5	47	94.5	47
Annual fuel costs	257,512	220,101	257,512	220,101
Total costs	356,697	356,960	338,648	339,164
Steam production t/year	37,440	37,440	37,440	37,440
Costs per tonof steam	9,527	9,534	9,045	9,059

10.56 It appears that on considering international prices for fuel oil 6, compared to prices for national coal, substitution of fuel oil 6 by coal would not be reasonable in the industrialized areas of Peru, such as Lima/Callao, Ica or those districts in the south. In these areas substitution by gas should be considered.

10.57 In the past, the cement industry showed particular interest in substituting fuel oil 6 with coal. The major manufacturers, such as Cementos Lima, Cemento Andino and Cemento Pacasmayo, undertook investments to be able to substitute, but continued using fuel oil as a result of its low price. The efficiency of this conversion was verified by working for a while with bituminous coal imported from Colombia. Normal conditions for use are a blend of coal/fuel oil in a ratio of 70/30. This condition should be maintained in the future by the characteristics of bituminous coal from Oyon and Jatunhuasi.

10.58 Analyzing the situation of Cementos Lima, the substitution of fuel oil 6 for coal may only implemented if the coal is finely pulverized and so would end up costing US$77 per ton, against the international price of US$94.5 per cubic meter for fuel oil 6. The coal is not pulverized by the cement plant but by Carbón LAR, directly in the cement plant. Consequently, the following annual figures would be obtained if coal were used at this plant.

Table 10: TOTAL ENERGY COSTS IN CEMENTOS LIMA COMPARING THE USE OF COAL AND FUEL OIL

Fuel oil cost US$/year	Coal cost US$/year	Difference US$/year
6,248,340	8,778,000	-2,529,660

10.59 It can be deduced from this table that the use of coal would be economical, (compared to international prices of fuel oil 6), only if the pulverized coal in the cement plant costs less than US$54.8 per ton for both national and imported coal.

Fuel substitution on the domestic market

10.60 Kerosene is the fuel most often used on the domestic market and in small activities, like restaurants, in the populated areas around industrial centers such as Trujillo, Chimbote, La Oroya and Lima. Almost 14% of national energy consumption is kerosene and fuelwood. The partial substitution of kerosene by coal briquettes appears to be a possibility. Coal briquettes could find a potential market among low-income households, which comprise a large part of the aforementioned areas.

Table 11: COMPARISON OF THE COST OF COAL BRIQUETTES IN LIMA AND TRUJILLO

	Lima US$/ton	Trujillo US$/ton
Direct costs:		
Feedstock	33.3	24.7
Labor	0.7	0.7
Services	0.8	0.8
Depreciation	0.7	0.7
Subtotal	35.5	26.9
Indirect costs:		
Labor	0.6	0.6
Miscellaneous	1.0	1.0
Tax	1.3	1.0
Subtotal	2.9	2.6
Profit (5%)	2.0	1.5
Factory gate cost per ton of briquettes	40.4	31.0
Transport (15 km)	1.2	1.2
Gross margin	2.0	1.6
Final distribution margin (12%)	4.8	3.8
Subtotal	8.0	6.6
Cost per ton of briquettes at point of distribution/ consumption	48.4	37.6

10.61 Low sulphur content coal is normally used but, if this exceeds 1%, an ingredient like $CaCo_3$ (calcium carbonate) should be added to fix the sulphur (preventing its release to the atmosphere as SO_2).

10.62 A comparison of the costs to produce heat for cooking, using either kerosene or coal briquettes, shows that coal is more expensive (US$18.22 per GJ) than kerosene (US$16.97 per GJ) in stoves with a 30% efficiency, in Lima. In other potential markets such as Huaraz, La Oroya, Trujillo and Chimbote, briquettes may be competitive, since the transport costs are much lower (so the cost per GJ would be much lower, at about US$14).

ANNEX 1

GROSS DOMESTIC PRODUCT FORECASTS AND SIMULATIONS ON THE EFFECT OF VARIATIONS ON THE SUPPLY AND COST OF ENERGY PRODUCTS

GROSS DOMESTIC PRODUCT FORECASTS AND ITS MAIN COMPONENTS

It is difficult, in present circumstances, to forecast the performance of the main macroeconomic aggregates in view of the current distortions in the hyperinflationary process and the lack of clarity regarding the economic policy performance of the new Government. In this document two scenarios (I and II) have been treated, having as a central theme, common to both, the application of a stabilization program in the second half of 1990. This program will enable economic recovery at a growth rate below the rate of population growth during the first three years (1990-1992). Beginning in 1993, scenario I is conservative in the dynamic the Peruvian economy will have, postulating average GDP growth rates on the order of 3.8% beginning in the second half of the decade. Scenario II is less conservative, more optimistic and incorporates the assumption that the economy may grow at an average rate of 5.3% starting in the second half of the decade.

Signs of the serious economic imbalance that the country was experiencing in early 1990 were multiple and closely linked. Among the more significant ones, the following should be noted: high and unstable inflation; severe distortions in relative prices; recession, unemployment and falling real salaries; falling taxation earnings and a persisting fiscal deficit; financial disintermediation and loss of international reserves. This serious economic crisis was accompanied, in addition, by an increase in social violence and by a weakening of the State's institutional apparatus.

Based on the assessment of the present economic situation, economic policy objectives were planned which considered the achievement of positive and sustained per-capita gross domestic product growth rates, significant reduction of inflation, removal of fiscal imbalances and the generation of work posts, in the domestic sphere. In the foreign sphere, reinsertion into the international financial system and articulation with the international market in more efficient conditions were considered.

In the forecasts, a macroeconomic consistency model inspired by a simplified version of the World Bank Revised Standard Model (RMSM) was used. This framework allows medium- and long-term forecasts to be conducted on the performance of the main aggregates and the macroeconomic imbalances, and calculation of the financial gap which should be covered with foreign resources.

The results obtained for each scenario in the 1990-2000 period are illustrated in Tables 1 and 2 and are summarized as follows:

Scenario I (Conservative)

- Average GDP growth of 3.3% and an adequate average employment level of 37.5%. The relative participation of private consumption remains almost constant, at an average level of 63% of GDP, and public consumption (13% of GDP) is increased with respect to the levels observed in the eighties (10%), making possible an increase in social expenditure. Total investment remains constant during the first few years of the period (21% of GDP) and then is increased to 24% in the last few years. Finally, net exports, which within this scheme result from the difference, experience average levels of 1.1% and reflect the positive transfer of external resources.

- Tax pressure at 18%, starting in the fifth year, above the average of the past decade. Public company sales earnings show an important recovery, amounting to 24.6% of gross domestic product for the year 2000. These greater resources result from the readjustment of energy prices and taxation administration reforms. This allows the negative trend in savings in the public sector current account to be reversed, amounting to an average of 8.4% of GDP.

- Imports are consistent with the assumptions on domestic growth and investment, and are obtained by the difference, based on the spending pattern. Traditional exports amount to an average of 12% of GDP and untraditional ones of 5%. The trade balance stabilizes during the period, at an average slightly greater than 2% of gross domestic product. The balance of financial services amounts to 3.5% of GDP, assuming a 50% reduction in the total debt, as well as the interest payment starting from the second year. This shows a moderate accumulation of international reserves which, on average, was around US$125 million per year for the last five years.

- Domestic savings amount to an average 28% of GDP during the period. In the first few years, private sector savings are fairly substantial but then decrease their relative share in favor of public sector savings, which are sustained at positive levels amounting to the current account saving of this sector. External savings show the external financing required to sustain levels of growth and the pattern of spending. On average, these savings increase from -2% of GDP during the first five years to almost -2.6% for the rest of the period.

TABLE 1
SCENARIO I
GROSS DOMESTIC PRODUCT AND MAIN MACROECONOMIC FLOWS FORECAST
1990-2000

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Crecimiento PIB (Porcentaje)	-0.3	-10.4	0.0	2.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0
Estructura porcentual por sectores económicos													
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agropecuario	11.00	13.00	13.00	13.32	13.12	12.93	12.74	12.56	12.38	12.14	11.90	11.66	11.43
Minería	11.07	10.51	10.94	0.80	0.70	0.60	0.51	0.42	0.33	0.25	0.20	0.40	0.33
Manufactura	20.00	21.00	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.04
Construcción	5.42	5.30	5.40	5.40	5.37	5.34	5.32	5.30	5.27	5.20	5.32	5.34	5.37
Servicios	48.30	49.47	49.22	49.75	50.16	50.60	51.01	51.41	51.80	52.00	52.37	52.64	52.91
Estructura porcentual por tipo de gasto													
Total			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Consumo Privado			64.00	64.00	64.00	64.00	64.00	64.00	64.00	62.00	62.00	62.00	62.00
Consumo Público			13.70	13.00	13.34	13.30	13.34	13.30	13.30	13.30	13.30	13.30	13.30
Inversión			20.00	20.30	21.00	21.30	21.30	21.30	21.30	24.00	24.00	24.00	24.00
Exportaciones Netas			1.00	1.00	1.00	1.10	1.14	1.30	1.30	0.00	0.00	0.00	0.00
PEA ocupada, empleada (Miles de personas)			2013	2032	2060	2102	2138	2166	2013	2190	2204	4130	4204
PEA ocupada, empleada / PEA total (Porcentaje)			25.00	25.40	25.67	26.20	26.76	27.10	27.60	28.10	28.70	29.30	30.05
PIB per cápita (US dólares)			600	606	621	634	648	666	715	731	746	765	783
Exportaciones FOB			2127	2200	2323	2363	2461	2527	4066	4227	4354	4500	5100
Importaciones FOB (Millones US dólares)			2074	2200	2777	2927	2977	3100	3342	3700	3900	4322	4654
Crecimiento real de las exportaciones			-14.3	-0.4	1.4	1.5	1.5	1.5	1.5	3.5	3.5	3.5	3.5
Crecimiento real de las importaciones (Porcentaje)			16.0	-0.7	4.5	2.1	2.0	0.0	1.0	7.5	4.0	4.0	4.0
Balance en Cuenta Corriente (Porcentaje del PIB)			-1.2	-1.0	-1.2	-1.3	-2.4	-2.2	-2.2	-2.7	-2.7	-2.7	-2.7
Balance de Capitales (Porcentaje del PIB)			-2.6	3.0	4.2	4.3	2.0	2.7	2.7	3.2	3.2	3.2	3.2
Variación de RIN (Millones US dólares)			-720	465	410	430	111	114	117	122	127	132	137

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Operaciones del Gobierno Central											
Ingreso Tributario (Porcentaje del PIB)	10.0	12.0	13.0	14.0	17.0	16.0	16.0	16.0	16.0	16.0	16.0
Ahorro en Cuenta Corriente (Porcentaje del PIB)	-0.7	-1.4	2.3	3.1	4.0	3.4	3.4	3.4	3.4	3.4	3.4
Superávit o Déficit No Financiero (Porcentaje del PIB)	-1.7	-2.4	0.6	1.1	1.2	1.0	1.4	1.2	0.0	0.0	0.0
Operaciones de Empresas Públicas No Financieras											
Ingresos por Ventas (Porcentaje del PIB)	14.3	16.2	19.0	21.7	22.0	22.3	22.6	23.0	23.3	24.0	24.6
Ahorro en Cuenta Corriente (Porcentaje del PIB)	-3.0	0.3	1.0	3.0	4.1	4.4	4.8	5.3	5.0	6.4	7.0
Superávit o Déficit No Financiero (Porcentaje del PIB)	-0.4	-0.7	-0.3	0.4	0.4	0.2	0.2	0.2	0.3	0.3	0.4
Operaciones del Resto del Sector Público											
Ahorro en Cuenta Corriente (Porcentaje del PIB)	0.0	0.3	0.7	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Superávit o Déficit No Financiero (Porcentaje del PIB)	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Operaciones del Sector Público No Financiero Total											
Ahorro en Cuenta Corriente (Porcentaje del PIB)	-4.6	-0.4	4.8	7.7	9.1	10.6	11.2	11.7	12.2	12.6	13.4
Superávit o Déficit No Financiero (Porcentaje del PIB)	-7.5	-3.6	0.0	1.0	1.1	1.0	1.1	0.0	0.7	0.7	0.0
Internacional											
Ingresos por Venta de Combustibles	7.0	11.3	11.3	11.0	11.7	12.0	12.2	12.6	13.0	13.4	13.0
Gobierno Central	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Petroperú	5.0	7.1	7.4	7.0	7.0	8.0	8.3	8.7	9.0	9.5	9.0
(Porcentaje del PIB)											
Ingresos por Venta Gasoducto (Porcentaje del PIB)	0.0	1.0	1.0	2.1	2.1	2.2	2.3	2.4	2.5	2.0	2.7

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Ahorro Interno	22.1	20.2	27.3	27.4	28.0	27.7	27.7	28.7	28.7	28.7	28.7
Privado	20.7	20.6	22.4	19.8	19.0	16.0	16.5	16.0	16.5	17.0	17.3
Público (Porcentaje del PIB)	-4.6	-0.4	4.8	7.7	9.1	10.6	11.2	11.7	12.2	12.0	13.4
Ahorro Externo (Porcentaje del PIB)	-1.2	-1.0	-2.2	-2.3	-2.4	-2.2	-2.2	-2.7	-2.7	-2.7	-2.7
Inversión Interna	20.0	20.0	21.0	21.0	21.0	21.0	21.0	24.0	24.0	24.0	24.0
Privada	16.0	16.3	16.0	13.0	12.0	11.3	10.4	12.3	11.3	10.0	10.4
Pública (Porcentaje del PIB)	3.7	4.2	5.0	7.0	9.0	10.3	11.1	11.7	12.0	13.1	13.6
Inversión Externa (Porcentaje del PIB)	0.4	2.0	3.0	3.0	3.2	4.0	4.0	4.0	4.0	4.0	4.0

TABLE 2
SCENARIO II
GROSS DOMESTIC PRODUCT AND MAIN MACROECONOMIC FLOWS FORECAST
1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Crecimiento real del PB (Porcentaje)	0.0	2.5	3.0	4.0	4.5	4.5	4.5	5.5	5.0	5.5	5.0
Estructura porcentual por sectores económicos											
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agricultura	13.32	13.32	13.12	12.91	12.44	12.00	11.74	11.38	10.97	10.61	10.28
Minería	10.34	9.80	9.70	9.47	9.38	8.96	8.73	8.47	8.22	7.98	7.75
Manufactura	21.62	21.62	21.62	21.62	21.72	21.83	21.93	22.03	22.14	22.24	22.35
Construcción	5.46	5.40	5.37	5.32	5.27	5.22	5.17	5.12	5.08	5.07	5.06
Servicios	49.22	49.76	50.16	50.78	51.37	51.91	52.44	53.03	53.57	54.10	54.60
Estructura porcentual por tipo de gasto											
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Consumo Privado	84.00	84.00	84.00	83.00	82.00	81.00	81.00	80.00	80.00	80.00	80.00
Consumo Público	13.70	13.00	13.24	13.32	13.34	13.38	13.38	13.38	13.38	13.38	13.38
Inversión	10.50	10.00	20.00	23.00	23.00	28.00	28.00	28.00	28.00	28.00	28.00
Exportaciones Netas	2.00	2.00	2.76	1.00	-0.36	0.00	0.00	-0.38	-0.38	-0.38	-0.38
PEA ocupada, empleada (Miles de personas)	2913	2935	2946	2980	3006	3010	3005	3005	4128	4288	4004
PEA ocupada, empleada / PEA total (Porcentaje)	35.00	35.33	35.70	36.27	37.00	37.73	38.47	39.40	40.40	41.40	42.54
PB per cápita (US dolares)	885	886	891	905	924	944	966	994	1025	1052	1080
Exportaciones FOB	3127	3200	3383	3770	4042	4335	4640	5000	5326	5631	6002
Importaciones FOB (Miles US dolares)	2374	2376	2443	2600	2704	2760	4079	4720	5170	5463	6163
Crecimiento real de las exportaciones	-14.3	-0.4	1.4	9.4	3.0	4.1	4.1	5.0	5.0	5.0	6.0
Crecimiento real de las importaciones (Porcentaje)	7.0	-2.0	0.6	21.7	10.0	-2.0	4.0	12.0	6.1	6.2	6.2
Balance en Cuenta Corriente (Porcentaje del PB)	-0.2	-0.0	-0.7	-1.0	-3.0	-3.7	-3.7	-3.7	-3.7	-3.7	-3.7
Balance de Capitales (Porcentaje del PB)	-3.6	1.0	1.7	2.3	4.4	3.2	3.2	4.2	4.2	4.2	4.2
Variación de RIN (Miles US dolares)	-750	203	209	100	113	110	124	131	138	146	153
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Operaciones del Gobierno Central											
Ingresos Tributarios (Porcentaje del PB)	10.0	12.0	15.0	16.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0
Ahorro en Cuenta Corriente (Porcentaje del PB)	-0.7	-1.4	2.3	3.1	4.0	3.4	3.4	3.4	3.4	3.4	3.4
Superávit o Déficit No Financiero (Porcentaje del PB)	-1.7	-3.4	0.6	1.1	1.2	1.0	1.4	1.2	0.0	0.0	0.0
Operaciones de Empresas Públicas No Financieras											
Ingresos por Ventas (Porcentaje del PB)	14.3	16.2	19.0	21.0	22.2	23.0	23.3	24.0	24.7	25.4	26.3
Ahorro en Cuenta Corriente (Porcentaje del PB)	-3.6	0.5	1.8	3.0	4.4	5.0	5.6	6.3	7.1	7.0	8.0
Superávit o Déficit No Financiero (Porcentaje del PB)	-0.4	-0.7	-0.3	0.4	0.5	0.2	0.3	0.3	0.4	0.5	0.5
Operaciones del Resto del Sector Público											
Ahorro en Cuenta Corriente (Porcentaje del PB)	0.0	0.5	0.7	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Superávit o Déficit No Financiero (Porcentaje del PB)	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Operaciones del Sector Público No Financiero Total											
Ahorro en Cuenta Corriente (Porcentaje del PB)	-4.6	-0.4	4.5	7.0	9.4	11.4	12.6	12.7	13.5	14.3	15.2
Superávit o Déficit No Financiero (Porcentaje del PB)	-7.0	-3.6	0.0	1.0	1.2	1.0	1.2	1.0	0.0	0.0	0.0
Desagregación											
Ingresos por Venta de Combustibles	7.0	11.1	11.3	11.0	12.0	12.4	12.0	13.3	13.0	14.0	15.1
Gobierno Central	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Petroperú	5.0	7.1	7.4	7.7	8.0	8.4	8.0	8.4	10.0	10.0	11.2
(Porcentaje del PB)											
Ingresos por Ventas Derivados (Porcentaje del PB)	0.0	1.0	1.5	2.1	2.2	2.3	2.4	2.6	2.7	2.0	3.1
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Ahorro Interno	16.1	21.2	21.0	20.4	20.0	21.7	21.7	20.7	20.7	20.7	20.7
Privado	22.7	21.0	16.0	16.7	23.1	20.3	19.7	22.0	22.2	21.4	20.0
Público	-6.6	-0.4	4.0	7.0	9.4	11.4	12.0	12.7	13.5	14.3	15.2
(Porcentaje del PB)											
Ahorro Externo (Porcentaje del PB)	-0.2	-0.0	-0.7	-1.0	-3.0	-3.7	-3.7	-3.7	-3.7	-3.7	-3.7
Inversión Interna	16.3	16.6	20.0	23.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Privado	16.0	15.3	14.1	15.0	15.7	14.2	13.2	15.3	14.3	13.5	12.7
Público	2.7	4.2	5.0	6.0	6.3	10.0	11.0	12.7	13.7	14.5	15.3
(Porcentaje del PB)											
Inversión Externa (Porcentaje del PB)	-0.0	0.0	1.0	1.0	3.7	4.0	4.0	4.0	4.0	4.0	4.0

Scenario II (Optimistic)

- Average GDP growth of 4.5% and average adequate employment of 38.2%. The relative share of private consumption (61% of GDP on average) falls slightly with respect to that seen in Scenario I, to maintain the level of net exports compatible with required investment levels. As for public consumption, this remains constant (13% of GDP) but is always greater than the levels seen in the eighties. Total investment records higher levels than those seen in Scenario I. From almost 24%, during the first few years of the period, it increases to 28% of GDP in the last few years.

- The tax pressure amounts to the same levels and generates the results mentioned for Scenario I. As in Scenario I, public company sales earnings experience a considerable recovery but amounts to higher levels (26.3% of GDP in the year 2000). Public sector current account savings amounted to an average of 9% of the GDP, more than that achieved in Scenario I. The public sector current account surplus is slightly more than that seen in Scenario I.

- In the same way as in Scenario I, imports are consistent with assumptions on domestic growth and investment, and are obtained by the difference based on the spending pattern. Traditional exports amount to an average 18.5% of the GDP and untraditional to 5.5%. The trade balance, differing from the stability seen in Scenario I, shows a falling trend in the last few years of the period. 1.3% of GDP is reached in the year 2000. The levels of the balance of financial services are the same as those in Scenario I.

- The current account balance is more negative (2.6% of GDP) than in Scenario I. The overall performance of the balance of payments shows a moderate accumulation of international reserves, similar to that observed in Scenario I.

- Domestic savings amount to an average 30% of GDP during the period. Both private and public sector savings increase in the last few years to slightly higher levels than those seen in Scenario I but their performance is the same. External savings increase from -1.7% of GDP during the last five years to almost -3.5% for the remainder of the period, that is, higher than that seen in Scenario I.

SIMULATION OF THE EFFECT OF FINAL DEMAND ON PRODUCTION COSTS AND PRICE LEVELS

The simulation was conducted on the basis of an input-output matrix, calculated for the Peruvian economy in 1979. This decision is based on the fact that the values of energy product intermediate consumption coefficients were related to international costs, a fact that is not verified in the update of the matrix for 1987,

which is affected by distortions in the domestic pricing policy of energy products. For operative purposes, the original data were reduced to a square matrix of 37 by 37 sections used in the forecasts. The 1979 matrix coefficients are shown in Annex 1.

For the simulations, variations in energy product costs were considered, based on the determination of their economic costs. Direct costs result from the participation of energy product purchases in the gross production value of the corresponding activity. Total costs are defined as the sum of direct and indirect costs.

Domestic fuel prices, implied in the 1979 input-output matrix, are about the same as international prices, especially gasoline and to a lesser extent diesel and fuel oil. The exception was domestic kerosene. For this reason, in the simulation process of fuel price adjustment, the 1979 matrix coefficient was considered to be a good approximation to economic cost criteria.

Table 3

IMPLIED FUEL PRICES AT START OF THE SIMULATION (US$)

	(1) Original 1979 Matrix Prices	(2) Consumption Pattern %	(3) 1979 International Prices
Gasoline 84	0.87	0.25	0.91
Diesel	0.43	0.28	0.94
Fuel oil	0.30	0.33	0.45
Kerosene	0.11	0.15	0.69
Total 1/	0.45	1.00	

(1) Implied prices in the 1979 Input-Output Matrix.
(2) Share of fuels in final consumption.
1/ Average weighting for national consumption pattern.

In the case of electricity, the implied prices in the 1979 matrix amounted to US$0.04, which is acceptable for an approximation using marginal cost criteria.

To determine the effect of implied energy product prices, first the original situation involving the 1979 matrix coefficients and, second, a situation corresponding to a 100% increase in fuel prices, electricity at US$0.08 per Kwh for industrial activity and US$0.10 for other activities (tariffs weighted for the electricity consumption pattern meaning an increase of 84% over the original

tariff) were considered.

SIMULATION RESULTS

Effects on production costs

The results of the impacts for the two situations mentioned in the previous paragraph are illustrated in table 4. In the first situation, the energy products influence production costs by 3.8%, fuels being 64% responsible for this incidence. On disaggregation of these costs into direct and indirect, the former represent 53% of the total.

It should be added that the incidence on costs is not uniform throughout the sectors and neither are the relative share of costs of each energy product. In sectors like fish extraction and elaboration, basic chemical products, mining, iron and steel, and sugar[1] transport and elaboration, an incidence level above 7% was recorded. Besides, in fish extraction and elaboration,and transportation, fuel costs are the most significant: 83% and 95% of the cost of energy products. In sectors like mining and iron and steel, electricity is responsible for a substantial share of the energy costs, although in a lower proportion than fuels: 60% and 56%, respectively. For the other sectors, the share of costs for both energy products are almost the same.

An increase in fuel prices of 100% and in electricity of 84% over the prices implied in the first situation considered (1979 Matrix), results in an incidence on production costs of 6.3% and, in the same way as in the previous case, direct costs and fuel costs are the most significant.

Effects on public finances

The impact on public finances of changes in energy product prices considers the assumptions of GDP growth and evolution of the main macroeconomic flows which are included in Scenarios I and II.

Energy price increases impact central government tax earnings and the per sale earnings of the public enterprises (PETROPERU and ELECTROPERU). The effects are seen in current account savings and in the non-financial public sector surplus or deficit, where the results reflect an improvement in both balances. This information appears in Table 5. Thus, an increase in fuel prices of 100% and in electricity prices of 84% produces a non-financial public sector surplus of 7% of GDP in the year 2000 and, under the assumptions of Scenario I, in contrast to the level obtained when based on the

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[1]The following paragraphs include remarks on the incidence of energy costs in those sectors recording the highest relative costs.

initial situation (1979 Matrix), 0.7% of GDP for scenario I in the same year.

TABLE 4
INCIDENCE OF FUEL AND ELECTRICITY PRICE CHANGES ON COSTS

1979 MATRIX

	Combustibles		Electricidad		Incidencia Total	
	Directos	Totales	Directos	Totales	Directos	Totales
1 FARMING, FORESTRY & HUNTING PROD.	0.00316	0.00793	0.00008	0.00399	0.00324	0.01192
2 FISHING	0.08215	0.08327	0.00025	0.00333	0.08240	0.09160
3 OIL EXTRACTION	0.00136	0.00882	0.00115	0.00197	0.00251	0.01078
4 MINING	0.02061	0.03045	0.03888	0.04356	0.05949	0.07400
5 MILK PROD. MANUFACTURE	0.00912	0.02510	0.00448	0.01506	0.01360	0.04016
6 FISH ELABORATION & PRESERVATION	0.02291	0.05586	0.00781	0.01423	0.03072	0.07009
7 FISHMEAL AND OIL MANU.	0.03554	0.07109	0.01950	0.02376	0.05504	0.09485
8 MILLING AND BAKING	0.00452	0.01661	0.00440	0.01232	0.00892	0.02893
9 SUGAR REFINING & ELABORATION	0.05291	0.06788	0.07353	0.07947	0.12643	0.14734
10 OTHER FOOD PRODUCTS	0.00727	0.02347	0.00495	0.01381	0.01223	0.03729
11 BEVARAGES & TOBACCO	0.01786	0.03428	0.02107	0.03385	0.03892	0.06813
12 TEXTILES	0.01264	0.02926	0.01079	0.02441	0.02343	0.05367
13 CLOTHING MANUFACTURE	0.00064	0.01803	0.00135	0.01574	0.00199	0.03377
14 LEATHER & FOOTWEAR	0.00192	0.01634	0.00781	0.01948	0.00972	0.03583
15 FURNITURE	0.00842	0.02175	0.00442	0.01297	0.01284	0.03472
16 PAPER, PRINTING & PUBLICATION	0.00956	0.02289	0.01467	0.02625	0.02424	0.04915
17 CHEMICAL BASE PROD. AND FERTILIZER MANUFACTURE	0.02197	0.03792	0.05146	0.06413	0.07343	0.10205
18 PHARMACEUTICAL AND MEDICAL PROD. MANUFACTURE	0.00487	0.01586	0.00331	0.01367	0.00817	0.02953
19 MANUFACTURE OF OTHER CHEMICALS	0.00736	0.02253	0.00377	0.01900	0.01113	0.04153
20 OIL REFINING	0.00003	0.01274	0.00527	0.00786	0.00530	0.02060
21 RUBBER ANDPLASTIC PRODUCTION	0.00662	0.01955	0.01419	0.02725	0.02081	0.04680
22 NON-FERROUS METALS	0.03603	0.05225	0.03523	0.05177	0.07131	0.10403
23 NON-METALLIC MINERAL PRODUCTION	0.04747	0.06062	0.01662	0.02485	0.06409	0.08547
24 IRON & STEEL	0.01402	0.03382	0.02402	0.04304	0.03804	0.07686
25 VARIOUS METAL PRODUCTS MANUFACTURE	0.00688	0.02358	0.00673	0.02314	0.01361	0.04671
26 NON-ELECTRIC MACHINERY	0.00490	0.01680	0.00511	0.01474	0.01001	0.03154
27 ELECTRIC MACHINERY	0.00208	0.01962	0.00524	0.02004	0.00732	0.03966
28 TRANSPORT MACHINERY	0.00412	0.01731	0.00665	0.01686	0.01077	0.03416
29 PRODUCTION OF OTHER DIFFERENT MANUFACTURED	0.00262	0.02045	0.00519	0.02259	0.00781	0.04305
30 ELECTRICIDAD	0.06339	0.06670	0.00191	0.00402	0.06530	0.07073
31 AGUA	0.02378	0.03472	0.07372	0.07818	0.09750	0.11290
32 CONSTRUCTION	0.01333	0.02759	0.00028	0.01034	0.01361	0.03793
33 COMMERCE	0.00416	0.02128	0.00357	0.00592	0.00772	0.02721
34 TRANSPORT & COMMUNICATIONS	0.07194	0.08093	0.00117	0.00533	0.07311	0.08626
35 FINANCIAL SERVICES	0.00118	0.00567	0.00514	0.00780	0.00631	0.01348
36 INSURANCE	0.00032	0.00679	0.00442	0.01040	0.00474	0.01719
37 OTHER SERVICES	0.00516	0.01132	0.00672	0.01109	0.01188	0.02241
TOTAL	0.01314	0.02429	0.00697	0.01366	0.02011	0.03795

Input-output Matrix coefficients elaborated by INE for 1979

TABLE 4
INCIDENCE OF FUEL AND ELECTRICITY PRICE CHANGES ON COSTS

	Combustibles 100% - Electricidad 84%					
	Combustibles		Electricidad		Incidencia Total	
	Directos	Totales	Directos	Totales	Directos	Totales
1 FARMING, FORESTRY & HUNTING PROD.	0.00630	0.01602	0.00024	0.00411	0.00645	0.02012
2 FISHING	0.16430	0.17251	0.00025	0.00404	0.16455	0.17285
3 OIL EXTRACTION	0.00272	0.01786	0.00115	0.00204	0.00387	0.01990
4 MINING	0.04121	0.06168	0.03888	0.04380	0.08009	0.10548
5 MILK PROD. MANUFACTURE	0.01524	0.05064	0.00448	0.01527	0.02272	0.06611
6 FISH ELABORATION & PRESERVATION	0.04583	0.11317	0.00781	0.01467	0.05364	0.12784
7 FISHMEAL AND OIL MANU.	0.07107	0.14402	0.01950	0.02432	0.09058	0.16833
8 MILLING AND BAKING	0.00904	0.03363	0.00440	0.01247	0.01344	0.04610
9 SUGAR REFINING & ELABORATION	0.10581	0.13748	0.07353	0.08003	0.17934	0.21751
10 OTHER FOOD PRODUCTS	0.01455	0.04753	0.00495	0.01403	0.01950	0.06156
11 BEVARAGES & TOBACCO	0.03571	0.06945	0.02107	0.03413	0.05678	0.10357
12 TEXTILES	0.02527	0.05927	0.01079	0.02466	0.03607	0.08393
13 CLOTHING MANUFACTURE	0.00128	0.03652	0.00135	0.01589	0.00263	0.05241
14 LEATHER & FOOTWEAR	0.00383	0.03310	0.00781	0.01962	0.01164	0.05272
15 FURNITURE	0.01684	0.04405	0.00442	0.01315	0.02126	0.05720
16 PAPER, PRINTING & PUBLICATION	0.01913	0.04637	0.01467	0.02644	0.03380	0.07281
17 CHEMICAL BASE PROD. AND FERTILIZER MANUFACTURE	0.04394	0.07682	0.05146	0.06443	0.09540	0.14125
18 PHARMACEUTICAL AND MEDICAL PROD. MANUFACTURE	0.00973	0.03213	0.00331	0.01380	0.01304	0.04593
19 MANUFACTURE OF OTHER CHEMICALS	0.01472	0.04564	0.00377	0.01918	0.01849	0.06482
20 OIL REFINING	0.00006	0.02582	0.00527	0.00796	0.00534	0.03378
21 RUBBER ANDPLASTIC PRODUCTION	0.01323	0.03961	0.01419	0.02740	0.02743	0.06701
22 NON-FERROUS METALS	0.07216	0.10586	0.03523	0.05219	0.10739	0.15805
23 NON-METALLIC MINERAL PRODUCTION	0.09493	0.12281	0.01662	0.02533	0.11155	0.14813
24 IRON & STEEL	0.03304	0.06551	0.02402	0.04331	0.05706	0.11132
25 VARIOUS METAL PRODUCTS MANUFACTURE	0.01377	0.04776	0.00673	0.02332	0.02049	0.07108
26 NON-ELECTRIC MACHINERY	0.00981	0.03403	0.00511	0.01488	0.01492	0.04891
27 ELECTRIC MACHINERY	0.00415	0.03574	0.00524	0.02020	0.00939	0.05594
28 TRANSPORT MACHINERY	0.00823	0.03506	0.00665	0.01699	0.01488	0.05205
29 PRODUCTION OF OTHER DIFFERENT MANUFACTURED	0.00524	0.04144	0.00519	0.02276	0.01043	0.06420
30 ELECTRICIDAD	0.12678	0.13513	0.00191	0.00455	0.12869	0.13968
31 AGUA	0.04756	0.07034	0.07372	0.07845	0.12128	0.14879
32 CONSTRUCTION	0.02666	0.05590	0.00028	0.01056	0.02694	0.06645
33 COMMERCE	0.00831	0.04312	0.00357	0.00609	0.01188	0.04921
34 TRANSPORT & COMMUNICATIONS	0.14387	0.16395	0.00117	0.00578	0.14505	0.16972
35 FINANCIAL SERVICES	0.00235	0.01147	0.00514	0.00765	0.00749	0.01934
36 INSURANCE	0.00063	0.01375	0.00442	0.01045	0.00505	0.02420
37 OTHER SERVICES	0.01033	0.02293	0.00672	0.01118	0.01705	0.03412
TOTAL	0.02628	0.04920	0.00697	0.01356	0.03325	0.06307

Input-output Matrix coefficiencts elaborated by INE for 1979

TABLE 5
IMPACT ON PUBLIC FINANCES OF CHANGES IN ENERGY PRODUCT PRICES

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SCENARIO I											
On the Basis of 1979 Matrix Coefficients											
Total Non-Financial Public Sector Operations											
Current Account Savings (Percentage of GDP)	-4.6	-0.4	4.8	7.7	9.1	10.8	11.2	11.7	12.2	12.8	13.4
Non-Financial Surplus or Deficit (Percentage of GDP)	-7.6	-3.6	0.0	1.01	1.1	1.6	1.1	0.9	0.7	0.7	0.8
Fuels 100% - Electricity 84%											
Total Non-Financial Public Sector Operations											
Current Account Savings (Percentage of GDP)	2.4	6.2	11.6	14.7	16.3	18.2	18.8	19.7	20.6	21.5	22.5
Non-Financial Surplus or Deficit (Percentage of GDP)	-1.4	2.4	6.0	7.0	7.2	7.6	7.2	7.1	6.9	7.0	7.0
SCENARIO II											
On the Basis of 1979 Matrix Coefficients											
Total Non-Financial Public Sector Operations											
Current Account Savings (Percentage of GDP)	-4.6	-0.4	4.8	7.8	9.4	11.4	12.0	12.7	13.5	14.3	15.2
Non-Financial Surplus or Deficit (Percentage of GDP)	-7.6	-3.6	0.0	1.0	1.2	1.6	1.2	1.0	0.8	0.9	0.9
Fuels 100% - Electricity											
Total Non-Financial Public Sector Operations											
Current Account Savings (Percentage of GDP)	2.4	6.2	11.	14.8	16.8	19.1	20.1	21.3	22.6	24.0	23.3
Non-Financial Surplus or Deficit (Percentage of GDP)	-1.4	2.4	6.0	7.1	7.2	7.7	7.3	7.2	7.1	7.2	7.3

Refers to increments over the initial situation (Matrix 1979)

Effects on final consumption

The impact on the energy products contained within final consumption was assessed on the basis of the weightings of the 1989 Consumption Basket used by the National Institute of Statistics to elaborate the Consumer Price Index (CPI) for metropolitan Lima. With this objective, the direct and indirect impact of changes in energy product prices were considered in Table 6. The direct impact includes fuel and electricity expenditure, while the indirect impact considers an increase in the energy costs of other components of the consumption basket.

The total impact of the incidence is 4.68%, 2.52% corresponding to direct impact and 2.16% to indirect impact. Of this total, only 9% corresponds to electricity and its share is more prominent through direct impact.

Fuel and electricity consumption forecasts

The consumption forecasts for fuel and electricity for the 1990-2000 period are presented in Table 7. The assumptions on the growth of Scenarios I and II and the total energy requirements resulting from varying one percentage point in GDP growth were considered in the calculation. These requirements were produced from manipulation of the 1979 input-output matrix.

In Scenario I, from a consumption of almost 46 million barrels in 1991 (125,000 barrels per day), nearly 59 million barrels are consumed in 1995 and 87 million in the year 2000 (238,000 barrels per day). Regarding Electricity, from a consumption of 14,000 Gwh, nearly 18,000 Gwh are consumed in 1995 and 25,000 Gwh in the year 2000. In Scenario II the previous figures are higher due to the assumption of greater GDP growth.

Energy component of imports

In order to determine the energy component of imports, the vector of imported inputs was multiplied by the total energy product requirements resulting from input-output calculations. Likewise, it was determined that the energy component is almost 0.3% of the Gross Production Value.

TABLE 6
CALCULATION OF THE IMPACT OF ENERGY PRODUCT PRICE CHANGES ON THE CONSUMPTION BASKET

	WEIGHTINGS	DIRECT IMPACT	INDIRECT IMPACT	TOTAL IMPACT
1 PROD.AGROPECUARIA,SIVICULTURA Y CAZA	20.233		0.150	0.150
2 PESCA	1.405		0.124	0.124
3 EXTRACCION DE PETROLEO	0.290	0.290	0.003	0.293
4 MINERIA			0.000	0.000
5 FABRIC. DE PRODUCTOS LACTEOS	3.675		0.092	0.092
6 ELAB.Y PRESERVACION DE PESCADO			0.000	0.000
7 ELABORACION DE HA. Y AC.DE PESCADO	0.417		0.030	0.030
8 MOLINERIA Y PANADERIA	11.420		0.190	0.190
9 ELABORACION Y REFINAC. DE AZUCAR	1.662		0.126	0.126
10 OTROS PRODUCTOS ALIMENTICIOS	3.067		0.072	0.072
11 BEBIDAS Y TABACO	2.535		0.087	0.087
12 TEXTILES	2.070		0.061	0.061
13 FABRICACION DE PRENDAS DE VESTIR	4.304		0.078	0.078
14 CUEROS Y CALZADO	2.813		0.046	0.046
15 MUEBLES	1.328		0.029	0.029
16 PAPEL,IMPRESION Y EDICION	0.931		0.022	0.022
17 FAB. PROD. QUIM. BAS. Y ABONOS			0.000	0.000
18 FAB. PROD. FARMACEUT. Y MEDICAM.	0.965		0.015	0.015
19 FABRICACION DE OTROS QUIMICOS			0.000	0.000
20 REFINACION DE PETROLEO	1.822	1.822	0.023	1.845
21 PROD. DE CAUCHO Y PLASTICOS			0.000	0.000
22 METALICOS NO FERROSOS			0.000	0.000
23 PROD. MIN. NO METALIC.			0.000	0.000
24 SIDERURGIA			0.000	0.000
25 FAB.DE PROD. METALICOS DIVERSOS	0.310		0.007	0.007
26 MAQ. NO ELECT.	0.070		0.001	0.001
27 MAQ. ELECTRICA	2.740		0.054	0.054
28 MATERIAL DE TRANSPORTE	0.079		0.001	0.001
29 FABR. OTROS PROD.MAN. DIVERSOS	2.919		0.060	0.060
30 ELECTRICIDAD	0.410	0.410	0.027	0.437
31 AGUA	0.525		0.018	0.018
32 CONSTRUCCION			0.000	0.000
33 COMERCIO			0.000	0.000
34 TRANSPORTE Y COMUNICACIONES	6.427		0.520	0.520
35 SERVIC. FINANCIEROS			0.000	0.000
36 SEGUROS	0.135		0.001	0.001
37 OTROS SERVICIOS	27.192		0.308	0.308
TOTAL	100.000	2.522	2.156	4.678

* Corresponde a las ponderaciones de la canasta de consumo familiar 1969

TABLE 7
FUEL AND ELECTRICITY CONSUMPTION FORECASTS 1990-2000

Scenario I	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuel Consumption (thousand barrels)	43515	45854	48812	51960	55311	58879	62677	68067	73920	80278	87182
Growth rate	0.00	5.38	6.45	6.45	6.45	6.45	6.45	8.60	8.60	8.60	8.60
Electricity consumption (Gwh)	13836	14469	15263	16101	16985	17918	18901	20285	21770	23363	25074
Growth rate	0	4.575	5.49	5.49	5.49	5.49	5.49	7.32	7.32	7.32	7.32

Scenario II											
Fuel Consumption (thousand barrels)	43515	45854	48812	53009	58138	63763	69932	78201	87449	97789	109353
Growth rate	0.00	5.38	6.45	8.60	9.68	9.68	9.68	11.83	11.83	11.83	11.83
Electricity consumption (Gwh)	13836	14469	15263	16520	17881	19353	20947	23055	25376	27930	30741
Growth rate	0	4.575	5.49	8.235	8.235	8.235	8.235	10.065	10.065	10 065	10.065

SECTORAL ENERGY CONSUMPTION AND COSTS

An attempt is made to specify energy consumption and costs for those sectors recording high coefficients in the input-output matrix used in this report.

The first section considered is fishing, comprising the extraction and elaboration of fishmeal and oil. The national fishing fleet has an average age of 15-20 years and currently the majority of these boats cannot operate efficiently on a permanent basis. This situation has given rise to high maintenance and fuel costs. On average, fuels comprise 20% of the operating cost of embarkation.

In the elaboration of fishmeal and oil, fuel oil is used most (59%), followed by diesel (33%). Electric power only represents 10% and is largely supplied by the public network.

The amount of fuel oil for fishmeal production is 57.3 gallons per metric ton when the present values for this industry are 45-48 gallons per metric ton.

Cement and glass are considered in the non-metallic mineral products sector. Cement manufacture consumes 91% of the sector's energy, with fuel oil (85%) dominating its energy pattern, followed by electric power (13%). On average, specific consumption is 939 Kcal per Kg and 0.138 KWh per Kg, which are similar to those recorded in other countries (example, in Italy they are 900 Kcal per Kg and 0.127 KWh per Kg).

Fuel oil shares 40%-50% in the direct production cost while electric power participates 15%-25%.

In glass production, in the same way as cement, the most important energy product is fuel oil (65%), followed by diesel (20%). Electric power barely represents 5%. The specific consumption of fuel oil is 60-100 gallons per metric ton, amounting to 140 in certain cases. These levels are extremely high as the international level is 30-35 gallons per metric ton.

For the basic metal industry sector, iron and steel are considered for consuming 94% of the sector's energy, with special mention of the iron and steel complex of SIDERPERU. In this complex the most used energy products are coke (52%), fuel oil (24%) and electric power (12%).

Regarding the specific energy consumption for steel production, an average of about 5,600 Kcal per Kg is used on average, which is high if compared with that recorded in other countries (3,900-4,700).

In the agricultural industry, the most significant sector for

energy consumption is the sugar industry (99% of the sector's total). The main energy products used in the process are bagasse (51%), fuel oil (25%), diesel (11%) and electric power (8%). Sugar production demanded 5,900 Kcal per Kg, above average international levels (3,500-4,700 kcal per Kg).

The mining-metallurgical sector is comprised of large-scale, medium-scale and small-scale mining enterprises. The first group of companies is responsible for 67% of the energy sector total.

In view of the heterogeneity of the companies and the different processes, some important companies have been selected to characterize the sector's energy situation.

a. Southern Peru Copper Corporation

This is one of the largest copper producing companies in Peru and consumes the highest percentage of energy in the sector (34%). The main energy products consumed are fuel oil (72%) and electricity (25%). In terms of specific consumption, blister production demands 7,200 Kcal per Kg and 2,900 KWh per metric ton, higher than that seen in modern plants (5,000-6,000 Kcal/Kg). The share of energy in direct production costs is about 40%.

b. CENTROMIN PERU

Major metal production comprises copper, lead and zinc. Its energy consumption represents 24% of the mining-metallurgical sector. Overall, in its energy consumption, electric power (41%), fuel oil (33%) and diesel (17%) are dominant. In terms of cost, energy represents 18% of the direct production costs.

c. MINEROPERU

This company operates the following productive units: the Ilo copper refinery, the Cerro Verde production unit, the Cajamarquilla zinc refinery and the Bayobar unit. Overall, the composition of the energy consumption pattern is as follows: electric power (58%), diesel (32%) and fuel oil (7%). On the level of each production unit, the consumption pattern is fairly differentiated, mainly in the case of the zinc refinery and Cerro Verde, as a result of their relatively high intensity in their use of electricity (92% and 63% of total energy consumption).

The incidence of energy in direct production costs varies according to the type of production unit. By means of illustration, the case of the Cajamarquilla refinery is presented.

The main product of this company is zinc refined in bars and, in addition, sulphuric acid and residues. Its specific consumption is

278 Kcal per Kg and 4,200 KWh per metric ton, which are acceptable levels for this type of production. The incidence of energy in direct production costs is 48%.

ANNEX 1

1979 INPUT-OUTPUT MATRIX COEFFICIENTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 FARMING, FORESTRY & HUN. ING PROD.	0.04751	0.00740	0.00000	0.00220	0.25052	0.00238	0.00000	0.22952	0.45436	0.38273	0.02733	0.15506	0.00090	0.00150	0.09105	0.00031	0.00092	0.01134	0.00437
2 FISHING	0.00000	0.00715	0.00000	0.00000	0.00000	0.23082	0.31667	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3 OIL EXTRACTION	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00250	0.00000	0.00186
4 MINING	0.00176	0.00000	0.00028	0.00055	0.00000	0.00000	0.00000	0.00000	0.00008	0.00168	0.00003	0.00000	0.00000	0.00000	0.00000	0.00009	0.00633	0.00020	0.00068
5 MILK PROD. MANUFACTURE	0.00000	0.00140	0.00000	0.00029	0.01783	0.00007	0.00000	0.00086	0.00000	0.00041	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00085	0.00025
6 FISH ELABORATION & PRESERVATION	0.00000	0.00006	0.00000	0.00002	0.00000	0.00000	0.00031	0.00000	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7 FISHMEAL AND OIL MANU.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.04849	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8 MILLING AND BAKING	0.00359	0.00727	0.00000	0.00058	0.00747	0.00011	0.00000	0.21347	0.00000	0.01213	0.01248	0.00043	0.00000	0.00000	0.00065	0.00000	0.00000	0.00037	0.00069
9 SUGAR ELABORATION & REFINING	0.00142	0.00059	0.00000	0.00030	0.03596	0.00044	0.00000	0.00765	0.00576	0.02517	0.06412	0.00000	0.00000	0.00000	0.00000	0.00945	0.00220	0.00131	0.00018
10 OTHER FOOD PRODUCTS	0.06262	0.01081	0.00000	0.00173	0.00931	0.01658	0.00000	0.02497	0.00000	0.03839	0.00692	0.00066	0.00000	0.06024	0.00091	0.00067	0.00429	0.00209	0.03587
11 BEVERAGES & TOBACCO	0.00000	0.00380	0.00000	0.00016	0.00000	0.00018	0.00000	0.00001	0.00002	0.00093	0.02940	0.00000	0.00000	0.00000	0.00000	0.00001	0.00200	0.00110	0.00212
12 TEXTILES	0.00246	0.00464	0.00000	0.00067	0.00000	0.00181	0.00006	0.01070	0.00059	0.02083	0.00000	0.31443	0.49042	0.03917	0.02761	0.00092	0.00033	0.00127	0.00046
13 CLOTHING MANUFACTURE	0.00000	0.00118	0.00004	0.00068	0.00000	0.00006	0.00274	0.00030	0.00000	0.00000	0.00000	0.00003	0.00000	0.00001	0.00004	0.00002	0.00003	0.00008	0.00005
14 LEATHER & FOOTWEAR	0.00006	0.00094	0.00000	0.00112	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00004	0.02536	0.20022	0.00647	0.00000	0.00001	0.00008	0.00020
15 FURNITURE	0.00168	0.00056	0.00000	0.00141	0.00022	0.00000	0.00000	0.00000	0.00000	0.00001	0.00149	0.00001	0.00875	0.00667	0.19680	0.00060	0.00001	0.00027	0.00555
16 PAPER, PRINTING & PUBLICATION	0.00000	0.00709	0.00030	0.00127	0.02263	0.01762	0.00195	0.00871	0.00888	0.01338	0.02317	0.00331	0.00271	0.01047	0.00239	0.29179	0.00434	0.01800	0.03237
17 CHEMICAL BASE PRODUCTS AND FERTILIZER PRODUCTION	0.02342	0.00081	0.00000	0.00575	0.00511	0.00148	0.00624	0.00151	0.00246	0.00557	0.01730	0.05599	0.01391	0.02863	0.00934	0.01420	0.08214	0.04145	0.11671
18 PHARMACEUTICAL AND MEDICAL PRODUCT MANUFACTURE	0.00360	0.00000	0.00029	0.00219	0.00003	0.00033	0.00000	0.00009	0.00004	0.00337	0.00001	0.00000	0.00000	0.00030	0.00127	0.00000	0.00009	0.07799	0.00114
19 MANUFACTURE OF OTHER CHEMICALS	0.00000	0.01330	0.00059	0.01432	0.00670	0.00602	0.00133	0.00066	0.00041	0.00187	0.00300	0.00323	0.00172	0.03175	0.02456	0.02088	0.00245	0.00136	0.02116
20 OIL REFINING	0.00316	0.08215	0.00136	0.02061	0.00912	0.02291	0.03554	0.00452	0.05291	0.00727	0.01786	0.01264	0.00064	0.00192	0.00842	0.00956	0.02197	0.00487	0.00736
21 RUBBER AND PLASTIC PRODUCTION	0.00040	0.00078	0.00010	0.00614	0.00733	0.01520	0.01617	0.00371	0.01692	0.00653	0.00661	0.00410	0.00273	0.03535	0.03026	0.00301	0.01393	0.01224	0.03699
22 NON-FERROUS METALS	0.00000	0.00034	0.00001	0.00279	0.00245	0.00118	0.00359	0.00010	0.00049	0.00140	0.01329	0.00030	0.00003	0.00003	0.00942	0.00133	0.03370	0.02630	0.01262
23 NON-METALLIC MINERAL PRODUCTION	0.00000	0.00414	0.00000	0.00568	0.00000	0.00000	0.00000	0.00000	0.00155	0.00021	0.00001	0.00014	0.00000	0.00028	0.00108	0.00009	0.00080	0.00002	0.00023
24 IRON & STEEL	0.00214	0.00252	0.00001	0.02717	0.00000	0.00659	0.00782	0.00001	0.00000	0.00025	0.00031	0.00585	0.00001	0.00046	0.01508	0.00225	0.00068	0.00000	0.00017
25 MANUFACTURE OF VARIOUS METAL PRODUCTS	0.00441	0.00209	0.00176	0.00632	0.10911	0.08401	0.00079	0.00059	0.00330	0.01056	0.03569	0.00117	0.00014	0.00648	0.02213	0.00206	0.00750	0.00910	0.01599
26 NON-ELECTRIC MACHINERY	0.00084	0.00000	0.00083	0.00344	0.00033	0.00633	0.00262	0.00185	0.00248	0.00240	0.00719	0.00511	0.00146	0.00201	0.00047	0.00647	0.00631	0.00504	0.00817
27 ELECTRIC MACHINERY	0.00001	0.00318	0.00001	0.00423	0.00228	0.00127	0.00582	0.00134	0.01661	0.00179	0.00567	0.00107	0.00010	0.00054	0.00172	0.00385	0.00178	0.00443	0.00311
28 TRANSPORT MACHINERY	0.00108	0.01604	0.00071	0.00122	0.00017	0.00009	0.00003	0.00008	0.00066	0.00005	0.00025	0.00015	0.00001	0.00010	0.00002	0.00015	0.00048	0.00005	0.00007
29 OTHER VARIOUS MANUFACTURED PRODUCTS	0.00001	0.00128	0.00014	0.00182	0.00157	0.00175	0.00014	0.00063	0.00027	0.00106	0.00255	0.00336	0.01055	0.01081	0.00300	0.00280	0.00158	0.00521	0.01231
30 ELECTRICITY	0.00008	0.00025	0.00115	0.03886	0.00448	0.00781	0.01950	0.00440	0.07353	0.00495	0.02107	0.01079	0.00135	0.00781	0.00442	0.01467	0.05146	0.00331	0.00377
31 WATER	0.00000	0.00013	0.00010	0.00021	0.00137	0.00122	0.00025	0.00058	0.00875	0.00133	0.00502	0.00012	0.00029	0.00035	0.00072	0.00051	0.01183	0.00075	0.00114
32 CONSTRUCTION	0.00000	0.00000	0.00729	0.00008	0.00028	0.00000	0.00000	0.00037	0.00079	0.00103	0.00428	0.00180	0.00040	0.00147	0.00078	0.00189	0.00188	0.00197	0.00276
33 COMMERCE	0.01742	0.02879	0.00368	0.03077	0.08499	0.04042	0.03187	0.09185	0.02158	0.07930	0.05736	0.04457	0.04948	0.15265	0.08147	0.06341	0.02311	0.04843	0.05700
34 TRANSPORT & COMMUNICATIONS	0.00639	0.02339	0.08484	0.03246	0.04554	0.07690	0.03873	0.01355	0.03516	0.02846	0.03689	0.01390	0.00262	0.01011	0.01799	0.01737	0.03140	0.01722	0.07981
35 FINANCIAL SERVICES	0.04052	0.02131	0.01175	0.06606	0.13921	0.01481	0.02625	0.22425	0.01185	0.06558	0.11920	0.04297	0.00679	0.05606	0.01511	0.05140	0.27024	0.31188	0.24230
36 INSURANCE	0.00030	0.00832	0.00046	0.00256	0.00080	0.00140	0.00271	0.00103	0.00045	0.00074	0.00221	0.00148	0.00030	0.00140	0.00100	0.00168	0.00383	0.00241	0.00287
37 OTHER SERVICES	0.02425	0.02810	0.00401	0.05491	0.01832	0.06265	0.04739	0.01377	0.04022	0.01378	0.03581	0.01140	0.00645	0.02239	0.01097	0.01802	0.01784	0.06383	0.05674
38 TOTAL INTERMEDIATE CONSUMPTION	0.24912	0.26931	0.11913	0.33859	0.78311	0.62246	0.56850	0.85778	0.76029	0.78167	0.55666	0.69409	0.62711	0.68926	0.59717	0.53945	0.68753	0.67462	0.71708
39 AGGREGATE VALUE	0.75088	0.73069	0.88087	0.66141	0.21689	0.37754	0.43150	0.14222	0.23971	0.21833	0.44334	0.30591	0.37289	0.31074	0.40283	0.46055	0.31247	0.32538	0.28292
40 V.B.P. PP	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

(Page 2)

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1 FARMING, FORESTRY & HUNTING PROD.	0.00000	0.00099	0.00027	0.00035	0.00000	0.00000	0.00000	0.00000	0.00000	0.00008	0.00000	0.00014	0.00051	0.00004	0.00000	0.00000	0.00000	0.00014
2 FISHING	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00070
3 OIL EXTRACTION	0.02693	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4 MINING	0.00000	0.00076	0.32418	0.03789	0.02906	0.00157	0.00041	0.00003	0.00022	0.05871	0.00000	0.00014	0.01973	0.00009	0.00029	0.00000	0.00000	0.00014
5 MILK PROD. MANUFACTURE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00208
6 FISH ELABORATION & PRESERVATION	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00031
7 FISHMEAL AND OIL MANU.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8 MILLING AND BAKING	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000	0.00004	0.00027	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00104	0.00000	0.00580
9 SUGAR ELABORATION & REFINING	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00194
10 OTHER FOOD PRODUCTS	0.00025	0.00000	0.00008	0.00000	0.00024	0.00049	0.00013	0.00014	0.00000	0.00262	0.00000	0.00084	0.00000	0.00000	0.00022	0.00000	0.00000	0.01323
11 BEVERAGES & TOBACCO	0.00000	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000	0.00000	0.00000	0.00000	0.00140	0.00032	0.01039
12 TEXTILES	0.00000	0.01028	0.00018	0.00490	0.00001	0.00024	0.00077	0.00091	0.01532	0.03551	0.00025	0.00000	0.00000	0.00371	0.00025	0.00000	0.00000	0.00265
13 CLOTHING MANUFACTURE	0.00007	0.00203	0.00016	0.00006	0.00000	0.00005	0.00000	0.00000	0.00054	0.00024	0.00237	0.00042	0.00000	0.00028	0.00032	0.00266	0.00158	0.00168
14 LEATHER & FOOTWEAR	0.00000	0.00008	0.00013	0.00000	0.00000	0.00030	0.00022	0.00002	0.00123	0.00088	0.00041	0.00014	0.00000	0.00000	0.00002	0.00000	0.00000	0.00052
15 FURNITURE	0.00000	0.00018	0.00030	0.00099	0.00010	0.00101	0.00135	0.02183	0.00444	0.00823	0.00030	0.00098	0.03093	0.00097	0.00064	0.00009	0.00070	0.00062
16 PAPER, PRINTING & PUBLICATION	0.00040	0.00488	0.00672	0.00612	0.00000	0.01299	0.00187	0.00751	0.00262	0.07878	0.00341	0.01081	0.00260	0.01004	0.00456	0.03611	0.00682	0.00933
17 CHEMICAL BASE PRODUCTS AND FERTILIZER PRODUCTION	0.00001	0.11452	0.00894	0.02111	0.00681	0.01973	0.00389	0.01082	0.01519	0.03787	0.00014	0.02574	0.00028	0.00000	0.00001	0.00047	0.00000	0.00106
18 PHARMACEUTICAL AND MEDICAL PRODUCT MANUFACTURE	0.00023	0.00004	0.00062	0.00000	0.00000	0.00090	0.00000	0.00000	0.00017	0.00000	0.00027	0.00056	0.00000	0.00000	0.00012	0.00076	0.00000	0.00734
19 MANUFACTURE OF OTHER CHEMICALS	0.00120	0.01662	0.00080	0.00324	0.00002	0.00883	0.01536	0.00784	0.01160	0.01003	0.00090	0.00056	0.01181	0.00044	0.00052	0.00017	0.00032	0.00220
20 OIL REFINING	0.00003	0.00682	0.03608	0.04747	0.01402	0.00688	0.00490	0.00208	0.00412	0.00262	0.06339	0.02378	0.01333	0.00416	0.07194	0.00118	0.00032	0.00516
21 RUBBER AND PLASTIC PRODUCTION	0.00012	0.01661	0.00309	0.00695	0.00052	0.00323	0.00888	0.01156	0.01627	0.01910	0.00076	0.00084	0.00500	0.00450	0.01247	0.00004	0.00000	0.00346
22 NON-FERROUS METALS	0.00000	0.00051	0.00304	0.03325	0.01022	0.06270	0.61779	0.14828	0.02593	0.11404	0.00123	0.00042	0.03873	0.00081	0.00029	0.00000	0.00013	0.00125
23 NON-METALLIC MINERAL PRODUCTION	0.00000	0.00000	0.00536	0.04119	0.00314	0.00250	0.00135	0.00036	0.00170	0.00042	0.00033	0.00056	0.04954	0.00005	0.00000	0.00000	0.00000	0.00101
24 IRON & STEEL	0.00000	0.00257	0.00125	0.00250	0.32159	0.17610	0.08033	0.02808	0.03472	0.00414	0.00049	0.00056	0.05045	0.00000	0.00006	0.00000	0.00000	0.00236
25 MANUFACTURE OF VARIOUS METAL PRODUCTS	0.00367	0.00221	0.00352	0.00211	0.01022	0.02834	0.01509	0.01375	0.03031	0.02497	0.00166	0.00196	0.01778	0.00095	0.00095	0.00090	0.00000	0.00195
26 NON-ELECTRIC MACHINERY	0.00000	0.01289	0.00187	0.00211	0.00262	0.00788	0.04050	0.01135	0.01090	0.00374	0.00415	0.00014	0.00215	0.00006	0.00064	0.00002	0.00006	0.00138
27 ELECTRIC MACHINERY	0.00068	0.00304	0.00228	0.00391	0.00212	0.00598	0.01769	0.04832	0.01339	0.00352	0.01337	0.00294	0.00598	0.00005	0.00282	0.00135	0.00177	0.00127
28 TRANSPORT MACHINERY	0.00035	0.00012	0.00057	0.00000	0.00053	0.00055	0.00316	0.00074	0.04816	0.00013	0.00161	0.00168	0.00021	0.00000	0.00497	0.00000	0.00000	0.00730
29 OTHER VARIOUS MANUFACTURED PRODUCTS	0.00006	0.00367	0.00051	0.00018	0.00063	0.00301	0.00656	0.00489	0.00266	0.02699	0.00036	0.00308	0.00162	0.00004	0.00092	0.00471	0.00227	0.00267
30 ELECTRICITY	0.00527	0.01419	0.03523	0.01662	0.02402	0.00673	0.00511	0.00524	0.00665	0.00518	0.00191	0.07372	0.00028	0.00357	0.00117	0.00514	0.00442	0.00672
31 WATER	0.00058	0.00095	0.00107	0.00135	0.00017	0.00093	0.00303	0.00094	0.00068	0.00086	0.00025	0.00056	0.00058	0.00006	0.00024	0.00040	0.00088	0.00035
32 CONSTRUCTION	0.00165	0.00131	0.00036	0.00000	0.00037	0.00185	0.00224	0.00267	0.00243	0.00189	0.00826	0.04812	0.00000	0.00000	0.00352	0.00141	0.00025	0.00509
33 COMMERCE	0.00489	0.06052	0.01755	0.04884	0.06431	0.05599	0.09507	0.09751	0.08948	0.08630	0.02548	0.01511	0.06375	0.00494	0.02883	0.00887	0.00322	0.03210
34 TRANSPORT & COMMUNICATIONS	0.05488	0.02490	0.01846	0.03594	0.02527	0.01934	0.02186	0.02186	0.03060	0.00900	0.00420	0.01469	0.02737	0.19184	0.05498	0.01975	0.01038	0.00051
35 FINANCIAL SERVICES	0.04728	0.37062	0.02080	0.06489	0.13935	0.20813	0.17157	0.18974	0.26461	0.08716	0.03767	0.03245	0.13412	0.00697	0.07214	0.00913	0.13285	0.05660
36 INSURANCE	0.00069	0.00255	0.00161	0.00131	0.00109	0.00211	0.00287	0.00287	0.00201	0.00134	0.00067	0.00028	0.00055	0.00199	0.00564	0.00194	0.00806	0.00163
37 OTHER SERVICES	0.00263	0.03321	0.01246	0.00929	0.06032	0.02921	0.04165	0.02896	0.02023	0.01991	0.03017	0.04700	0.05432	0.05450	0.15603	0.09824	0.30945	0.16116
38 TOTAL INTERMEDIATE CONSUMPTION	0.05186	0.70666	0.50749	0.39282	0.71673	0.66750	0.56350	0.66857	0.65618	0.83809	0.20432	0.32830	0.53918	0.29005	0.42445	0.19584	0.57375	0.32819
39 AGGREGATE VALUE	0.04814	0.29334	0.49251	0.60718	0.28327	0.33241	0.43650	0.33143	0.34384	0.36191	0.79568	0.67170	0.46090	0.70995	0.57555	0.80416	0.42625	0.67181
40 V.B.P. PP	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

ANNEX 2

ENERGY CONSERVATION AND SUBSTITUTION PROJECT

EXPLANATION OF MOTIVES

Description

The economic growth forecast for the next few years, and therefore the sustained increase in the population's well-being, will require greater energy consumption. This is a proven fact in other countries. In Peru, current oil production, which is the main energy source, has reached levels which are insufficient to cover present demand. Although the country has recently discovered reserves of energy, like oil and natural gas, and coal and hydropower reserves, the development of these resources would require some years to mature and considerable investments which are not easily available to the country.

In view of the current financial constraints our country is experiencing in financing investments for exploration, exploitation, transportation and oil refining programs, no new discoveries have been made in the last nine years. Rather, an accelerated exhaustion of oil reserves has taken place, beginning in 1982 and currently amounting to 450 million barrels, due to which increasing volumes of oil and oil product imports have been resorted to in the last three years to cover demand, thus losing our status as a self-reliant country.

The electric power supply, due to problems of terrorism and scarcity of financial resources, has not been able to grow and, therefore, will not be able to cover the increasing need for electric power in the next 2 or 4 years.

In general, during the period 1986-1989, primary energy production saw a recessive performance, explained by lower oil production due to the lower volume of crude oil exports, despite the growth of hydropower production.

There has been significant waste in energy consumption in the different mining-metallurgical, industrial, transportation, residential-commercial and services sectors, as well as in energy transformation and distribution systems. This is explained by a general lack of awareness of the population on the need to save energy, use of inefficient technologies and industrial processes in terms of energy, lack of maintenance and technological innovation, and the shortage of company policies for energy saving, as well as due to the lack of incentives to motivate this saving.

In view of this situation, there are two options remaining for

the country to cope with these energy needs over the short and medium term, while the effort to develop national energy resources is intensified. The first option is to import energy and the second is to reduce growth in energy demand without affecting an increase in the requirements of production and the population, through efficient production, distribution and final use of energy.

In this sense, energy conservation is a short-term, low-cost and rapidly implemented alternative, since it may increase the available energy supply by between 15% and 30%. It is worthwhile mentioning that for the country it would be more economical to save a barrel of oil than to extract it and that the negative effects of short-term energy importation (1990-1995) may be halted significantly if a clear policy and a national program for the rational use of energy and energy substitution are adopted.

Within this context, government energy policy considers the complete and rational use of energy in the different economic sectors of the country, through the most efficient use of current resources, to be top priority.

Background

The Peruvian Government formed the Energy Conservation Center (Centro de Conservación de Energía - CENERGIA), through Supreme Decree No. 005-85-EM/VM, as a non-profit institution of the energy and mines sector, in charge of implementing policies and programs for energy saving, conservation and substitution in all the country's consumption sectors. CENERGIA unites the efforts of these State and private companies and institutions.

Since its creation, CENERGIA has received technical assistance from the United Nations Development Program, having implemented the following programs within this framework: Project PER 84-006 Technical Assistance to CENERGIA and CONERG, Project PER 86-011 Technical Assistance to CENERGIA and CONERG, second phase, and is presently implementing Project PER 88-01 Technical Assistance to CENERGIA, third phase. These projects have enabled activities to be undertaken in the different consumption sectors where actions in the Industrial sector are emphasized through conduction of energy audits and demonstrations of new technologies. Work has also been carried out in the transportation sector and in the residential-commercial and services sector.

Within the framework of the "Energy Conservation and Substitution in the Metal-Mining Industry" project, since November 1988, with the support of the European Economic Community, CENERGIA is currently developing a program which includes the plants with consumptions over 800 TEP per year: five large industrial complexes which consume between 30 and 80,000 TOE per year, 8 medium-sized companies which consume between 5,000 and 10,000 TOE per year and 32 companies which consume between 800 and 5,000 TOE per year.

CENERGIA also works in the area of energy efficiency in the transformation sector of generating plants.

PROJECT JUSTIFICATION

Introduction

During the five years of its institutional life, CENERGIA has developed adequate technical capacity to perform Energy Audits and implement conservation programs, through the performance of 48 energy audits, of which 30 where performed in the industrial sector, 3 in large mining-metallurgical complexes, 5 in the transportation sector and 10 in the residential-commercial and services sector; and 6 demonstrations of new technologies in the different industrial sectors of the national production sector.

The results obtained by CENERGIA in the energy audits undertaken, have enabled the identification of a potential overall energy saving of 950 kTOE, obtainable in 4 years, which represents 16% of the total commercial energy fuels consumed. This estimate does not include improvements from changes of processing and technology due to the lack of data and the country's situation, which obliges prioritization of minimum investment savings.

In the first phase, during two years, it is estimated that 300 kTOE will be obtained, that is, 40% of the anticipated savings through investments, with a recovery time of six months. The aforementioned savings may be obtained solely through operating measures, especially metering and monitoring of fuel consumption and its combustion. This involves, among other measures, metering instrumentation facilities and monitoring of equipment, processes, etc. Of the 300 kTOE to be saved during this phase, 68.2% corresponds to the production sector, 22.4% to the transportation sector and 9.4% to the residential-commercial and services sector.

In the second phase, with a two-year duration, 650 kTOE will be saved with a recovery time of no more than 2 years, which will be destined to improve monitoring of energy production and consumption, in equipment like heat recoverers, new installations in steam and condensate networks, continuous analyzers of thermal and electric power variables, automatic monitoring of equipment and processes, high efficiency electric power motors, automatic regulation mechanisms of thermal and electric power variables, and fixed and portable plant equipment.

Of the 650 kTOE saveable during the second phase, 44.6% corresponds to the production sector, 38.5% to the transportation sector and 16.6% to the residential-commercial and services sector.

In general, the savings obtained up till now are not very significant, (200,000 barrels per year), which is explained by the lack of a realistic pricing policy for fuel and electric power, the lack of adequate incentives for the prioritization of energy

conservation projects and the lack of a promotional campaign for the efficient use of energy.

CENERGIA will have to be strengthened with international aid in order to accelerate the rate of conducting energy audits, providing support to local consultants in order to perform audits in the companies which are macroconsumers of energy in all the consumption sectors, within a time span of no more than four years, enabling optimization of the country's energy consumption.

Implementation of this project as indicated, will allow an aggressive energy auditing program to be undertaken, to set the potential energy saving, achieve real energy savings, increasing the awareness of users, disseminate new technology, consolidate CENERGIA's technical capacity in applying conservation and energy saving measures through the implementation of a field activities program in the aforementioned sectors. The project would likewise create a technical capacity in the energy producing and consuming enterprises and in the consulting firms participating in the project.

Forecast Situation at End of Project

The required technical cooperation will serve to complete the actions being undertaken by CENERGIA, thus guaranteeing the following actions:

- Assistance to solve the current energy crisis, facilitating a wider availability of supply, with the lowest alternative cost, thus contributing to a progressive adjustment of the pattern of supply and demand. Project activities will impose maximum energy efficiency objectives on the production, transformation and use of energy products. The combined effect of both will be the reduction of investments to increase supply, costs at the level of true energy consumption avoiding the additional costs coming from energy wastage as a result of poor utilization, without affecting productive development nor sacrificing welfare.

- Reinforcing the technical and operational capacity of CENERGIA to fully complete its functions, through the additional training of its personnel with intensive field work. The project has forecast the training of CENERGIA management and technical personnel, local consultants linked to the project and engineers of companies participating in the project.

- To contribution to reducing the vulnerability of the energy supply, reducing dependence on oil, tending towards diversification of supply of primary energy sources.

- To contribute to an in-depth transformation of the patterns of individual and collective performance, as well as substantial

modification of installations and equipment, to assist the optimization of energy consumption in the country.

Beneficiaries

When the recommendations of the auditors and other activities of the project are implemented and the anticipated savings are produced, the main beneficiaries of the project will be:

- The enterprises and agencies of the industrial sector, who will reduce their energy costs so that energy waste declines.

- CENERGIA and national consultancy and engineering, because they will have strengthened their technical capacity to implement the energy saving and conservation policy of the government, and

- The country, because energy imports will decline and sector energy consumption will be optimized. Also, because investments in energy development projects will be optimized and, in the case of making more oil reserves available, the exportable balance will increase. In addition, it will enable electric power supply shortage problems to be halted as soon as possible.

Project Strategy and Institutional Arrangements

In order to guarantee the project's success, the Government should prioritize the implementation of a realistic pricing policy for energy products, as well as a relative pricing structure for those products whose substitution should be promoted.

Consequently:

- The country will be the direct recipient of the project's results and activities, since it will achieve optimization of energy consumption as a result of the aggressive Energy Conservation Program to be implemented in the period from 1991 to 1994.

- The audited companies will also be direct recipients of the project's results, through the conclusions and recommendations of the energy audits, and the reduction of energy costs.

- The project will be implemented by CENERGIA personnel with the assistance of international and national consultants.

Reasons for World Bank Assistance

Due to the current energy crisis in the country and the shortage of viable alternatives to overcome them, the Government has only two options to cover short- and medium-term energy

requirements, while the effort to develop national energy resources is intensified. One option is the rehabilitation and/or recapacitation of current energy transformation centers, which need substantial investment. The other is to reduce the growth of energy demand without affecting an increase in the requirements of production and the population, through implementation of an aggressive energy conservation program, which demands lower investment and permits an efficient production, distribution and utilization of energy.

As a result of the financial restrictions threatening the country, foreign assistance from the World Bank is needed to finance the expenditure of this project, and especially the requirements that should be paid in foreign currency.

Counterpart support capacity

CENERGIA has 20 professionals and 2 national experts specialized in the different techniques for energy saving and\or substitution, as well as advice from international experts that assist CENERGIA within the context of projects implemented with United Nations and European Economic Community cooperation. Likewise, it has administrative support personnel totally dedicated to energy conservation activities in the industrial, transportation, transformation, residential-commercial and services, and mining-metallurgical sectors.

CENERGIA has trained 11 professionals abroad, through grants and field work.

CENERGIA permanently trains personnel chosen from enterprises and agencies like the Ministry of Energy and Mines, ELECTROPERU, ELECTROLIMA, PETROPERU and facilitates coordination with the agencies that play a direct role in energy sector activities.

The resources for implementing the operating budget of CENERGIA are largely generated by activities of CENERGIA itself and the contributions it receives from the member companies of CENERGIA as part of its budget.

The project foresees the training of Peruvian professional personnel in energy-saving techniques through grants abroad.

OBJECTIVE

The basic objective of the project will be to strengthen and promote an aggressive energy conservation program, capable of producing the energy savings identified as potential in the production, transportation, transformation, and residential-commercial and services sector within a four year period.

The impacts of the project will halt the serious energy

deficit problems predicted for this period, as the most viable and economical alternative.

This project will be implemented by CENERGIA, requiring intensive involvement from national energy conservation specialists, as well as advice from foreign experts and national consultants.

ACTIVITIES

Technical Aspects

Energy Efficiency Improvements

(i) Revision and evaluation of results achieved by CENERGIA

Some checks will be performed on companies audited by CENERGIA in order to verify the extent of compliance with the recommendations made in the audits.

(ii) Prioritization of actions

Activities should be prioritized to establish the energy audit program, for which it will be necessary to conduct an industrial survey in macroconsuming energy enterprises.

(iii) Continuation of the Energy Audit Program

The project should increase the rate of energy audit implementation, conducted by CENERGIA, in order to perform, within a period of four years, 160 energy audits in macroconsuming energy enterprises, especially in the production and transportation sectors. The implementation of forty audits per year is expected.

(iv) Feasibility Studies

Sixteen feasibility studies corresponding to the main investment improvements identified in the audits should be undertaken during the project, on the order of four a year.

(v) Implementation of improvements

CENERGIA should be capable of implementing and assessing the proposed improvements, for which advice will be provided to those companies requesting it.

Development Technology

(i) Consulting Company and CENERGIA personnel Training

CENERGIA, through the project, must have a training

institution with highly qualified teachers available, enabling a permanent training program to be implemented. The presentation of courses will be channelled through the Training Center, which are predicted as part of the project.

The local training program on energy efficiency, considers two types of courses: general and specialized by type of industry. The latter should be given in the first stage, by foreign experts, during the first two years.

The project also predicts a training program abroad for technical staff and CENERGIA officials.

Likewise, Consultancy Company and CENERGIA personnel are planned to be trained in the techniques of energy auditing and new technologies during the course.

(ii) Demonstration operations

The project anticipates implementing twelve demonstration projects on new technologies, at a rate of three per year.

Promotion of the Efficient Use of Energy

(i) Design of Promotion Campaigns for the different sectors

The advice of an Advertising company should be relied on to design the respective campaigns in a coordinated fashion.

(ii) Campaign Implementation

The project should anticipate sufficient funds to finance the advertising measures to guarantee their success.

(iii) Different Publications

The project anticipates elaborating leaflets, posters, triptychs, manuals and other aids concerned with the project's objectives.

Moreover, the CENERGIA bulletin is anticipated to be published every two months.

(iv) National and international events

The project anticipates holding an international seminar, every year, to disseminate state-of-the-art technology and the most noteworthy experiences on a national and international level.

Legal Aspects

Legal Framework

CENERGIA will collaborate through the project to define the legal framework, providing standards for energy conservation actions in the country and presenting the relevant proposals.

Energy Efficiency Standards

CENERGIA will collaborate with ITINTEC to specify the technical standards on energy efficiency equipment.

Modifications to the National Regulation of Constructions

CENERGIA will collaborate with the School of Engineers and Architects, Municipalities, Ministry of Housing, Universities and other entities associated with the National Regulation of Constructions in order to introduce energy design criteria as a complement to aesthetic design criteria.

Financial Aspects

Lines of Credit

The project will promote the creation of specific lines of credit, to be applied to the implementation of measures recommended in the energy audits.

Institutional Aspects

Training Center

The project, on complying with the task of training national personnel, will provide the possibility of theoretical and practical training in energy auditing techniques, within the Latin American region.

The Training Center will enable CENERGIA to finance part of its operating budget.

Information Center

The project anticipates providing, through the Information Center, a service to both users of the different sectors and consultants, and to CENERGIA, in the different variables associated with the efficient use of energy.

Aspects of Infrastructure Support

Metering and Monitoring Instruments and Equipment

In order to comply with the planned audit program, the project should anticipate the acquisition of four sets of metering equipment.

Motor Vehicles

The project should have 3 motor vehicles available to transport technical equipment and staff participating in the plant works audits, feasibility studies and demonstration projects implemented by CENERGIA.

Photocopiers

Industrial photocopiers should be obtained in order to reproduce the audits, feasibility studies, demonstration projects, training course material, and other material.

Microcomputers

The increase in the rate of work of CENERGIA demands a larger number of work posts (terminals) in the currently operating NOVELL network. Moreover, the need for a laser printer to print the audits should be met and to gain time in the plant, especially in field works outside Lima, two laptop microcomputers should be used.

Software

The project will solve the software needs for the different project activities.

Others

1991-1994 PROJECT BUDGET

Implementation of the Project will require about US$4,402,000, the main items of which are indicated below:

1.	Foreign Advice	1,248,000
2.	National Staff	816,000
3.	Official Trips	288,000
4.	Training	600,000
5.	Equipment	530,000
6.	Promotion & Infrastructure Support Campaign	400,000
7.	Miscellaneous	520,000
	Total	4,402,000

Table 1

1991-1994 BUDGET OF THE ENERGY CONSERVATION PROGRAM

	TOTAL		1991		1992		1993		1994	
	N/a	US$	N/a	US$	N/a	US$	N/a	US$	N/a	US$
I. Asesoramiento Tecnico										
1 Asesor permanente	48	576,000	12	144,000	12	144,000	12	144,000	12	144,000
1 Asesor Sector Transportes	24	288,000	6	72,000	6	72,000	6	72,000	6	72,000
1 Asesor Sector Residencial	24	288,000	6	72,000	6	72,000	6	72,000	6	72,000
4 Asesores Capacitacion	8	96,000	2	24,000	2	24,000	2	24,000	2	24,000
Sub-Total	104	1,248,000	26	312,000	26	312,000	26	312,000	26	312,000
II Personal Nacional										
10 Profesionales especialistas conservacion energia	480	720,000	120	180,000	120	180,000	120	180,000	120	180,000
2 Especialistas microcomputo	96	96,000	24	24,000	24	24,000	24	24,000	24	24,000
Sub-Total	576	816,000	144	204,000	144	204,000	144	204,000	144	204,000
III Viajes Oficiales		288,000		72,000		72,000		72,000		72,000
Sub-Total		288,000		72,000		72,000		72,000		72,000
IV Capacitacion										
- Becas		320,000		80,000		80,000		80,000		80,000
- Estadias Investigacion		200,000		50,000		50,000		50,000		50,000
- Simposio Internacional		80,000		20,000		20,000		20,000		20,000
Sub-Total		600,000		150,000		150,000		150,000		150,000
V Equipamiento										
- 6 sets instrumentos medic.		200,000		150,000				50,000		
- Fondo apoyo compra equipos Consultoras privadas		250,000		150,000		50,000		50,000		
- Equipos de computo		40,000		30,000		5,000				5,000
- Compra software especializado		40,000		10,000		10,000		10,000		10,000
Sub-Total		530,000		340,000		65,000		60,000		15,000
VI Campaña de Promocion e Infraestructura apoyo		400,000		200,000		200,000				
Sub-Total		400,000		200,000		200,000				
VII Miscelaneos										
- Operacion mantenimiento eq		80,000		20,000		20,000		20,000		20,000
- Informes		40,000		10,000		10,000		10,000		10,000
- Varios		400,000		100,000		100,000		100,000		100,000
Sub-Total		520,000		130,000		130,000		130,000		130,000
T O T A L		4,402,000		1,408,000		1,133,000		928,000		883,000

Table 2

POTENTIAL ENERGY SAVINGS
ANNUAL OBJECTIVES

	1991	1992	1993	1994	Potential		Overall
					Phase I	Phase II	Total
Productive							
Fuel KTOE	100	200	100	100	200	300	500
Electric Power	14	14	21	22	28	43	71
Transport							
Fuel	20	80	120	100	70	250	320
RC And S							
Fuel KTOE	10	40	40	40	30	100	130
Electric Power	8	9	12	13	17	25	42
Total Fuel	130	320	260	240	300	650	950
Total Electric Power	22	23	33	35	45	68	113

ANNEX 3

INSTITUTIONAL ORGANIZATION OF THE ELECTRIC POWER SUBSECTOR

An electricity policy, in keeping with a general energy strategy, should be structured with a clear objective and a tactic defined to achieve the aforementioned aim. Likewise, legal and technical tools should be provided to enable the effective implementation of the chosen strategy.

In broad outline, the current organization of the sector and institutional structure in Peru (essentially derived from the General Electricity Law (LGE) No. 23406 (1982) and basic regionalization laws No. 24560 and 24792) establishes that:

- The public electricity service will be in the charge of the State (Second Article LGE).
- The public service companies are basically the following:
- ELECTROPERU.
- Regional Companies (10 in total, covering the 24 departments). Originally these regional companies were subsidiaries of ELECTROPERU but currently their ownership, or at least part of it, is being transferred to the regional governments.
- ELECTROPERU and its subsidiaries cannot transfer control to the private sector.
- The National Commission of Electricity Tariffs (CDT) (Article 25 and the following) is the agency charged with regulations and tariff setting on the basis of technical and accountable criteria.
- The work plan and interconnections of regional systems are focussed on ELECTROPERU.
- The obligatory nature of service is established within the geographical area of the regional power company, including the charging of contributions to users destined for the Expansion Fund.
- Creation of various funds: for expansion, electric power development, social interest and generation compensation tending to make tariffs uniform on a national level.
- Supervision, implemented by the Ministry of Energy (MEM). Covering from the **"Rational Use of Resources for Electricity Generation"**, to the receipt of projects, system operation, commercialization and company management.

Although sector standardization, through the LGE and regionalization of the electric power subsector are crucial matters, the present structure presents serious problems impacting efficiency and effective decentralization, as well as the necessary deconcentration of the system. Among these the following should be noted:

- Strong and almost exclusive state commitment in subsector operation and development.

- Monopolization of electric power development in a single state company (ELECTROPERU). This, along with the high subsidy implicit in almost all electric power tariffs, is translated into scarce and nil interest, both of the private sector and other state enterprises and agencies, particularly in the electric power subsector.
- Institutionalized confusion of the state's standard-setting and managerial roles, thus making the involvement of other agencies in subsector development impossible and limiting the state's capacity to be an effective counterpart of the State electric power company.
- Lack of clear, stable and economically efficient tariff-setting criteria and procedures. Tariffs based on accountable criteria (historic costs), with "guaranteed" yields which are usually not respected, not recognizing the implicit economic cost in electric power generation, transmission and distribution. The existence of several different tariffs, directed by the political and social criteria of the situation more than by a healthy economic rationale. The CDT, although an institutionally adequate organization, has low autonomy and political leverage. This, along with the high inflation prevailing in Peru, make it inoperative. All the above entails large and permanent distortions in tariffs, with the consequently poor allocation of resources, waste and inefficiencies. It should be noted that the indirect subsidy through electric power tariffs, frequently supported by the managerial sectors, have a much higher cost for the country than their apparent benefit.
- Unbalanced tariff setting and a lack of clear rules concerning the State/company interaction the make objective assessment of the latter impossible, that is, by performance (profits). This enables administrative inefficiencies to remain in utilities, such as excess personnel in certain areas, poorly used technical overcapacity, prevalence of short-term "survival" criteria, bureaucratization and dilution of relevant decisions, action by reaction to relevant situations not in keeping with established plans and programs and labor/syndicate restlessness which threatens the stability of employment, etc. All the aforementioned difficulties and problems are recognized, directly or indirectly, in available studies and interviews between subsector enterprises and institutions. Although, possible solutions to significant problems are outlined in such papers, a major problem--the confusion of the State's standard-setting and managerial role, and consequently a lack of clarity in the interaction between the technical/economic and the political level--is not clearly emphasized and thus proposed solutions tend to maintain the situation. With the aim of contributing to order ideas and propose solutions within a scheme which, differentiating state-owned companies from the State itself, enables coordinated and efficient sector operation contributing to permanently resolve the difficulties being

confronted today, the following aspects will be dealt with:

- Desirable objectives for an electric power policy.
- Components for an institutional organization of the subsector.
- Planning and investment conditions.
- Company/State relationship: profits and reinvestment.
- Dissemination of ownership.

DESIRABLE OBJECTIVES FOR AN ELECTRIC POWER POLICY

Among the basic objectives associated with an electric power policy able ensure a fluid interaction between technical, economic and political factors, the following should be taken into account:

- Establishment of conditions providing incentive for economically efficient operation and development of the electric power subsector.

- **Efficiency** is achieved by letting the market operate as a tool to allocate resources correctly (ie. marginal electric power tariffs), and through decentralization, deconcentration and eventual access of private capital to the electric power subsector.

- **Stability** is achieved with an adequate legal framework, which, in short, should tend to:
- Explain the rules of the game, both for state-owned enterprises, and mixed-ownership and private companies, based on objective and efficient standards including the necessary regulation in those sector activities of a monopolistic nature. These regulations should be based on a clear regime of obligations and rights for the concessionary enterprises, which develop activities like distribution to residential clients and small- and medium-sized industries.

- Decentralize and deconcentrate generation and distribution.

- Create coordination agencies in the operation of interconnected systems.

- Establish marginal tariffs, introducing effective readjustment mechanisms.

- Avoid subsidies and, if necessary, establish them directly, explaining their amount, with the State compensating companies for the difference in earnings generated thus, not distorting its managerial role.

- Establish necessary and sufficient control mechanisms to provide rational and fluid sector operation, within the above-mentioned framework of decentralization and deconcentration, by eliminating external and artificial controls and regulation

which unnecessarily hinder sector development.

The majority of the above-mentioned points are presently found, in one way or another, in a somewhat dispersed form, in the LGE and in the present sectoral organization. This is reflected in actions such as the decentralization of Regional Electric Power Utilities, the proposal for a new scheme of marginal tariffs and elaboration of a master plan, etc. All these efforts, highly worthwhile for certain, obey fairly independent motivations, with no, at least formal, common and integral focus enabling discussion and implementation of the proposed measures.

In view of the current regionalization program and effective transfer of property from selected electric power companies in the regions, it seems urgent to revise current legislation, especially that relating to the majority of activities focussed in ELECTROPERU, since the law (1982) assumes that the regional companies are subsidiary companies of ELECTROPERU and not independent or semi-independent.

A special mention should be made on the "Electricity Border Expansion Plan", which is destined to meet the needs of isolated and small localities electric power systems. In the General Electricity Law (Title VIII, Articles 51, 53, 55 and 56), establishing the legal framework, the need for coordination between this plan and the master plan is indicated, as well as the coordination of the prioritization criteria for its implementation. Both plans are the responsibility of ELECTROPERU, the Regional Utilities having to present their proposals to this company. The only thing about this program is that it relies on a source of funding (DL No. 163), current standards ensuring the destination of at least part of these funds to rural electrification. Within the regionalization framework and with the transfer of responsibilities to regional electric utilities, it seems reasonable to decentralize this process by directly allocating the authorized funds to the regions, which will be prioritized according to their own regional criteria and needs, maintaining a certain degree of coordination with the "Master Plan" for the eventual interconnections to major systems. If this occurs, the system will no longer be isolated and will shift to being monitored by the general standards of interconnected systems.

ISSUES FOR AN INSTITUTIONAL ORGANIZATION OF THE SUBSECTOR

For the above-mentioned reasons and in view of the available background, the first issue is the need to provide the subsector with a clear and hierarchical institutional organization, explicitly separating the State's standard-setting role from its managerial role.

The present difficult situation and the experience of other countries point to the advisability of relying on a ministerial-

level organization, directly involving the most relevant State Ministries for the problem (Economy and Finances, Energy and Mines, Industry, Presidential Office) from which a small, but highly qualified Technical Secretariat would depend, thus bringing together high-level politics with adequate, independent, technical support. Although a National Energy Commission (also in charge of standards, the hydrocarbons subsector and mining and renewable resources) with the aforementioned structure seems desirable, it is possible that the structure of the present Tariff Commission may be adapted to this scheme, under the aforementioned superior political level. This organization would be in charge of supervision, implementing the new national tariff-setting scheme to prepare the Master Plan, supervising the sector's proper operation and above all, coordinating the orderly transition from the present situation to the desired situation, both in regionalization matters like restructuring the generating sector associated with interconnected systems.

Regionalization and the new electricity law decentralize power distribution and part of local generation. It seems advisable to separate the generation and transmission activity from distribution itself, as these activities have marked differences in operation, investment and regulation. The new marginal tariff proposed implicitly has this differentiation, since the marginal cost or price of energy and power should be determined for generation. This is one figure in distribution which must be transferred to the consumer by adding a distribution margin. Likewise, even when generation prices are distorted, distribution may be structured as a reasonable company if distribution margins are well determined. This observation is very important since in this way the regions may from now on organize their distribution optimally without having to wait for a total rationalization of current tariffs, according to the scheme proposed by the Tariff Commission.

In the separation of generation, bearing in mind the characteristics it has in this country, it appears advisable to differentiate it by size and access of generating units to some interconnected system. A possible separation would be:

a) Small and isolated systems.
b) Large and isolated systems.
c) Small stations in interconnected system.
d) Large stations in Interconnected system.

Generally for each case the following points should be envisaged:

In small isolated systems, the regional utility should be left to organize the subsector and establish tariffs in keeping with the communal entities and allocating budget according to the social and economic development criteria adopted by the region (locally agreed Tariffs).

For large isolated systems, the energy price and capacity should be established in keeping with the marginal criteria regulating the distribution tariffs. Regarding the latter, it seems more advisable to regulate them in relation to a "Company Model" which relies on purely accountable criteria. In any case, this topic is covered in the new Electricity Tariff.

Finally, it is advisable to differentiate between stations which, due to their size, do not get directly involved in the economical despatch of load from those obliged to do so. This is an arbitrary differentiation that responds to the agreement to maintain a certain balance in dispatch. If implemented, and by way of an example, the central-north interconnected system would have at least 3 generating companies: ELECTROPERU, ELECTROLIMA (Generation) and ELECTRONORTEMEDIO (HIDROANDINA). Within this context, these companies would not be tied to a particular region but to the interconnected system.

The creation of more than one generating company in the central-north interconnected system, although it involves changes in the current legislation, has obvious advantages, among which the following should be emphasized:

- Deconcentration of the generation sector, even when the State is the sole owner, introduces a certain degree of competition, both on the level of projects and their construction, such as engineering capacity development and many other activities associated with the electricity business. Thus, the capacity to offer maintenance services to regional power stations, identification, design and supervision of small regional power station operation (or not so small), are all tasks stimulated by healthy competition. Moreover, the State has access to independent criteria, derived from the experience of different sector utilities. Thus, discussions are more focussed on the technical and economic considerations than on the capacity of political pressure of a given company.

- Generating sector deconcentration is needed for the effective decentralization of the regions, which should sell to and buy from the system. This (marginal cost) should guide auto-generation decisions in relation to the design of its own installations and its purchase/sale ratio with the system, as well as the development of private projects. That is, the possible involvement of local auto-generators in public service supply should be founded in solid economic and commercial discussions instead of artificial legal obligations. Also, bearing in mind that the support reserves for auto-generators are normally thermal units, oil price deregulation is essential for the power sector marginal tariffs to make sense.

INVESTMENT PLANNING AND COORDINATION

Regarding this topic it is advisable to analyze the distribution of high-voltage generation and transmission separately.

Distribution

This activity is concentrated, in accordance with the law, in the regional companies. Because this is a completely decentralized activity, each company's investment decisions should be taken in keeping with the technical, social and economic situation each region faces.

It should be noted that within a regional company there may be one or several distributors, isolated or interconnected, depending on the way that the region wants to be organized. In any case, given the natural monopoly character of distribution, aspects concerning the obligatory nature of service, tariffs (distribution margins) and quality of service should be clearly regulated.

The investments associated with the current distribution network are moderate and relatively uniform, so that if distribution margins are correctly calculated their financing should not present a major problem.

Regarding new developments and rural electrification, current technical and financial facilities (such as DL 163 of 1981) should be abolished and replaced with regional budgets explicitly specified for these activities and whose financing should be charged to the regional budget.

In technical matters associated with the maintenance and development of distribution systems, regional companies should resort to specialized contractors, private companies and services offered by those regional companies with the necessary infrastructure and experience (ELECTROLIMA, ELECTROPERU), thus avoiding the formation of an expensive permanent technical staff and only maintaining the specialized personnel strictly necessary.

Likewise, and to avoid an excessive bureaucratization, regional companies should rely on external services for materials like cashing invoices, computer systems, etc. This, along with stimulating greater private involvement, introduces the competition needed to increase operating efficiency.

Generation

For generation and transmission it is advisable to separate, as already indicated, the generation linked to an interconnected system from that supplying an isolated system. In fact, this separation is arbitrary since it has to do with the size of the system itself and the country's geographical and political

conditions.

In the Peruvian system two interconnected systems can basically be distinguished: a large one, which goes from Cajamarca to Ica, in which several regional companies and ELECTROPERU are involved. The other is in the southern region and is much smaller. Those two systems represented, in 1988, 85% of installed capacity and 90% of generated power, and have about 25 predominantly hydraulic power stations.

The major and minor isolated systems are mainly thermal, based on some 330 power stations, and are dispersed throughout the country.

In interconnected electric power systems, generation developments focus on a few large-scale, capital-intensive projects, whose economic attraction depends on the present and future state of the electric power system. All this points to the advisability of relying on adequate planning and coordination, permitting the total supply cost to be minimized. This is what justifies the development of periodic "Master Plans".

In minor projects, coordination is not necessary because it does not significantly affect system optimization and, therefore, relevant investment decisions may be adopted in a decentralized way by the regional, autogenerator or private investment company. To achieve this, the law is required to provide greater facilities so that these developments are produced, guarding the technical aspects of security and environmental needs. Likewise, it appears recommendable to make the relative legal regulations concerning the use of renewable energy resources flexible, facilitating their development by local companies or use for the Public Service. The LGE appears, in these subjects, very restrictive.

In coordinating development of large power stations, the State has a central role for the following various reasons:

- Due to its dominant share in electric power system ownership, which means that the sector is subject to public sector investment control.

- The need to rely on adequate and updated information regarding the evolution of demand and supply, because this is its responsibility, thus anticipating possible demand and supply imbalances.

- Due to the current relation between tariffs and optimal development of electric power supply. This is particularly important if the tariff scheme has a marginalist orientation, like the proposal for the Tariff Commission.

A plan to expand the electric power sector basically consists

in determining the sequence of projects (generation and corresponding transmission lines) of updated minimum cost, investment, operation (and outage), for a determined scenario of demand growth and fuel prices. To achieve this there are many adequate, widely disseminated methodologies which are very familiar to Peruvian specialists. A central element is the timely identification of possible hydropower or thermal stations as candidates to prepare the Master Plan. As not only ELECTROPERU, but also the regional utilities, and other state or private industrial companies have projects planned, it appears highly advisable that this planning be developed by an entity different to the interested companies, to guarantee the independence and technical/economic capacity for the optimization of the program under the objective criteria. Within the context of what is proposed here, the Tariffs Commission, with a structure like that previously indicated, could be, with the collaboration of the Generating Companies, the entity in charge of this planning. The technical recommendations and options developed by the Technical Secretariat would submitted for consideration by the high-level commission members who would make a final recommendation, adding the relevant political, social and financial considerations. With respect to this last point, and considering the State's involvement in the sector, the need to involve the highest economic authority in this process is strengthened.

Regarding the implementation and financing of the selected project, the Tariffs Commission should design the more relevant focus, considering the possible involvement of one or several generators, state or private industries, as well as fresh fiscal contributions and access to lines of credit from international organizations (IDB, World Bank). It should be pointed out that the selected project may be structured as a new generating company, with multiple shareholders, rather than passing to be part of another existing company.

In any case this would change to form part of the economical load dispatch, supplying its power to the interconnected network under the conditions predicted below.

COORDINATION OF THE OPERATION

A central element to ensure the deconcentration and competition of electric power generation comprises, for each interconnected system, the creation of an Economical Load Dispatch Center (Centro de Despacho Económico de Carga-CDEC), ensuring the necessary coordination of the efficient and secure operation of interconnected power stations and transmission systems. The implementation of a new marginal tariff in the Peruvian electric power system provides an excellent opportunity for its progress.

CDEC is an essential element for facilitating the presence of

many independent generating companies operating efficiently and economically in an interconnected system. CDEC is responsible for establishing the following:

- Interconnected system operation criteria.
- Criteria to value the transfer of electric capacity between generating companies.
- Criteria for the payment of shared use of the transmission system.
- Coordination of generating station maintenance programs.

With respect to its organization there are several ways of looking at this, but in essence it is a club of large-scale generating companies. CDEC is responsible for the yearly, monthly, weekly and daily planning of the system's operation, but not of its operation in real time. The essential operation criteria of CDEC is the security of service and its second priority is the minimization of overall cost.

Considering the high technical level and knowledge of specialized personnel of the generating companies, and taking into account that the ownership of all of them is common (the State), it is perfectly possible to initiate CDEC only with basic rules and to perfect its operation in view of the experience acquired, with the aim of providing an adequate legal framework for it in time. This same consideration is valid for the starting of the marginal tariff system designed by the Tariffs Commission. Very large studies and highly sophisticated procedures provide excuses to delay necessary policy decisions required for its implementation. Conceptual studies, at this stage, should serve as a reference and framework to orientate a gradual transition, which by preserving the central theme in turn provide sufficient flexibility so that the policy-forming authority may promote it. One way, whether conscious or not for the strictly state companies not to move towards greater competition, clarity and efficiency, is to maintain discussions with the policy-making authority in an intransigent technical plan, based on an exaggerated perfectionism of "all or nothing". Again, the presence of a recognized and independent high political level and technically competent Energy Commission avoids these difficulties, facilitating the transition from one system to another.

The establishment of marginal tariffs for all the energy products, system development on the basis of minimum cost planning and load dispatch are the basic ingredients for ordering the sector on a solid and stable basis.

COMPANY/STATE RELATIONS: THE TRANSITION

An institutional order such as the one outlined here would enable the State's standard-setting role to be clearly separated from its managerial role as owner of subsector utilities. In

principle, isolated generators and distributors assigned to interconnected systems would operate efficiently, with a healthy financial situation and, therefore, with the ability to generate surpluses (profits). As in every company, it is the prerogative of the owner (in this case the State) to decide the destination of these surpluses. Part of these profits might go to capitalization, investments in new projects or relevant activities, and the division of dividends, contributing them to fiscal income so that they can be redistributed in keeping with established social and economic priorities. In other words, the electric power subsector should not only stop being a charge for the national budget but rather contribute to it, efficiently repaying, within the legal/tariff-setting framework adopted, the capital which the Peruvian contributors, through the State, have deposited in it. It should be understood that electricity generation is an economic good like any other and that the State's involvement in it obeys political and relevant historical reasons more than economical ones. Therefore, the generation of profit is the necessary condition for the State to show it is making intelligent and rational use of the resources allocated to the subsector. The use or destination of these profits may be oriented by political and social criteria, reflected in direct subsidies to certain categories of users or support to regional investment projects whose social assessment merits it.

From the point of view of the company, the "owner's" demand to obtain profits is the essential motor for its internal rationalization. Here again, the implementation of a marginal tariff, instead of average historic and accountancy expenditure with supposedly guaranteed yields, is a basic element to foster, in a decentralized way, efficiency of the generation/transmission and distribution companies.

Although this proposal is highly desirable, the current distorted situation requires the definition of a gradual strategy enabling the political and social factors involved to evolve in a reasonably balanced way. The essence of this implementation should be achieved in relatively short periods since the support of public opinion in these matters is usually achieved for only limited periods of time. Likewise, seeking a perfect solution should not prevent improvement and although it is good to rely on completed studies regarding such basic topics as marginal tariff-setting or economical load dispatch, implementation of these activities should be started in a few companies, focussing on the basic aspects essential to their incorporation thereinafter, in agreement with the studies available and real accumulated experience, major sophistications, as well as their extension to other entities.

Concretely, the new marginal tariff structure proposed could rapidly produce a level of generators participating in interconnected systems as well as in large isolated generating systems. In the case of the large interconnected generators, this

would represent the first step toward CDEC formation and operation. It should be pointed out that:

- The technical capacity to determine these high-voltage tariff levels (potential and energy) is available.

- On these generating companies being structured as independent companies and on relying on economically efficient tariffs, at least in principle, their order will essentially depend on the subsidy elimination program adopted by the State, thus enabling companies' effective access to these tariffs.

- This program could be substantially accelerated is the State directly recognizes the amount of subsidy involved, providing it for the company. At the same time, the State should structure the financial situation of companies in a way that allows them normal operation in the financial market. This means that in certain cases part of the companies' liabilities to the State should be capitalized or directly transferred to the Treasury, leaving the company with a reasonable debt/capital ratio.

- The rationalization of subsidies mainly stems from distribution. Likewise, although it is clearly desirable that electric power tariff subsidies not continue, reality imposes the gradual design of a program in this respect. From the information available, it is implied that major tariff distortions stem from domestic consumption and public lighting and to a lesser extent, the industrial sector. In the short term, all subsidies should be eliminated maintaining, for social reasons, only those concerning consumption levels, that is, those less than 30 to 50 Kwh per month. This limit is a political decision and may be flexible to facilitate the transition. It should be observed that in Lima, on the basis of 1988 information, about 38% of residential users consumed less than 100 Kwh per month, the average being 52 Kwh per month. If the range reaches 200 Kwh per month, this includes more than 70% of users, with an average consumption of 95 Kwh per month (34% of billed residential power). The remaining users, 30% absorb 66% of the power with an average consumption of 450 Kwh per month. All levels currently enjoy a high degree of subsidy, and although it is certain that some taxes burden high consumers more (DL 163 taxes by 25% consumptions above 150 Kwh per month, DL 532 by 10%, Selective Consumption Tax by 60%), with the current tariff levels a large part of the high consumption residential sector subsidy is not socially justified. In short, a substantial tariff rationalization is socially possible enabling distributors to pay the generators something very close to the marginal tariff aim, thus giving rise to the process of decentralized order at the generating company level.

With respect to the distributors, as mentioned above, regarding their natural monopoly character, their tariffs must be regulated. But this regulation should be focussed on the aggregate distribution costs which are dealt with thoroughly in the new tariff proposal. Perhaps to simplify determination, as well as the regulatory authority's distribution margin administration and monitoring mechanics, one might resort to optimally sized and efficiently administrated model companies operating in areas with different distribution densities. This has the advantage of providing an incentive to the distributors to look for efficiency (because every saving that makes costs fall, at least in the model company, produces a profit) since with this procedure their own costs are not recognized from each other (with the implied inefficiencies) and those of the optimal model company are applied.

Regarding the specific adjustments associated with transfer, especially DL 163, it would be advisable to study, once the system is operating, its elimination and replacement by withdrawal of profits, which may be destined directly for the State for the same purposes.

OWNERSHIP DISSEMINATION AND PRIVATIZATION

Peru is in the process of decentralizing the electric power activity both in generation and transmission, as well as distribution. If this process is channelled through a scheme like the one presented here, an increase in sector efficiency and productivity should be expected in the relatively short term. Being the State, either directly or through regional governments, its main owner, the results of this greater efficiency should first be reflected in a reduction of direct State support and then in net income generation for the Treasury. In view of the separation between the State as a standard-setting and managerial entity, which the proposed strategy involves, the State's decision to reduce its managerial presence is perfectly legitimate. Although this has already been done in a way with the transfer of the regional companies, there has not been a real widening of ownership, since this is still in the hands of the State.

The dilution of ownership, with the involvement of institutions and persons responsibly assuming the consequences, both positive and negative, deriving from their own decisions, is an efficient way of consolidating the initiated decentralization process. The reality of this involvement depends on important macroeconomic aspects and the characteristics of the constituted companies themselves. But without doubt, the central element for this process, once initiated, to evolve in the correct direction is the clarity and stability of sector government policies, especially those concerning its own involvement, tariff-setting policies, competitive use of transmission systems, and access to sources of financing and saving.

The dilution of property along with the gradual reduction in the State's responsibility as sector manager, creates interests that ensuring the system's stability and continuity. In addition to the decentralization in a number of companies, with different interests and priorities tending to develop effective participation of many national duty sectors, as well as contributing in an important way to financial and capital market development and consolidation, with a long-term view, inherent in the characteristics of subsector investments (especially generation).

The gradual increase in private sector participation may be achieved in several ways, emphasizing the following facilities, among others:

- Private sector incentives to develop new projects: flexibilization of the current legislation in the sense of the maximal facilitation of power projects (hydro and thermal) by investors or autogenerators, including the state mining companies among the latter. This involves the explanation of purchase conditions, if this is the case, of power and potential by the local network in a commercial and non-compulsory framework.

- Gradually transferring regional distribution company ownership to the local and national community. Concretely, this process may be initiated with the present contracted commitments of personnel retirement funds in shareholding ownership. Certainly, this provides a strong incentive for the workers to generate profits and share dividends, as well as having a liquid market to be able to cut off these shares. In addition, part of salary increases may be implemented through disbursement share emissions. Likewise, the contributions requested by concessionary distribution companies from their users under defined conditions, may be reimbursed through shares. In minor isolated systems, ownership may be transferred directly to the Municipality.

- Selling small- and medium-scale generation companies. In isolated systems, by separating generation from distribution it is possible that any industrial or local mining client is ready to take charge of generation, establishing the sales contract for local distribution.

- In major generating or generating and distribution companies, in addition to the above-mentioned facilities for worker involvement, the large-scale sale of shares could be promoted converting committed State retirement funds in other companies or public share issues, issuing small packets of shares on the Stock Exchange, and providing incentives for the participation of institutional investors (pension funds and insurance companies). In addition, the participation of foreign banks should be considered through foreign debt conversion

facilities.

Certainly, depending on the condition of each company and stable sector operation, the economic value of so-called shares will be lower or higher. There will always be the argument that "it was sold too cheaply", that "the national patrimony has been depleted" and that the company now generates profits, so that the aforementioned reasons of efficiency are obeyed. The election of one or several of the aforementioned facilities depends on the legal, regional, economic and social circumstances, which must be analyzed on a case by case basis. Then, in this context, it is important to take special care so that sales or, company or share transfers are implemented with utmost prudence, clarity, wide dissemination and information, equality of opportunities for their selection (public issue) and equity.

Experience in other countries indicates that obviously at the start of the privatization process, the usual uncertainty of the stability of established rules, will induce high discount rates in the interested investors, either in the acquisition of shares or the tackling of new projects. The political authorities should be prepared for this, transferring the goods, with equity and clarity, at the economic amounts perceived by the market without imposing artificial accountable valuations. Nevertheless, on emphasizing the privatization process and demonstrating the stability of sector rules, the investor's risk premium automatically drops and consequently the value of goods sold rises.

When or how to initiate this process is a political decision which must be assessed on the basis of relevant conditions more than an established program. Again, the high-level institutional advisory agency created to structure the sector should be involved in the policies and conditions of transfer, as well as the necessary coordination between companies, the State and its institutional organizations involved (treasury, domestic taxes, public company regulatory organizations, central bank, etc.)

FINAL REMARKS

Although the institutional order and establishment of a strategy for the sector are two faces on the same coin, it is perfectly possible to initiate the process outlined here by making use of the prevailing institutional structure with only important, minor modifications. Thus, for example, the Tariff Commission may increase political leverage if the Ministers of Economy, Energy and Mines, and the Government are involved in it at the highest organizational level. This ensures the political level and technical and economic coherence with the recommendations elaborated by the Executive Secretary of the institution.

In technical matters, there is already a concrete proposal to

implement a new electric power tariff scheme which should gradually be started, in short, under the coordination of the New Tariff Commission. Likewise, elaboration of a new Master Plan could easily be developed with the assistance of ELECTROPERU, ELECTROLIMA and other generators, as well as possible autogenerators. Finally, load dispatch may be implemented, gradually dividing a nucleus of professionals from the three above-mentioned generating companies that are linked with the Central-North Interconnected System.

The revision and adaption of the General Electricity Law is a task which could be implemented at the same time, under coordination of the Tariff Commission, in the medium term.

Once a certain unity of technical and economic proposals and the understanding and willingness needed on a political level are obtained, the program here outlined should evolve fairly rapidly. Certainly there are going to be complications and often the difficulties will seem unsurmountable, but the quality of professionals in the sector, along with a coherent strategy and firm political decision to carry it out, will ensure its success in a considerably shorter time than currently imagined.

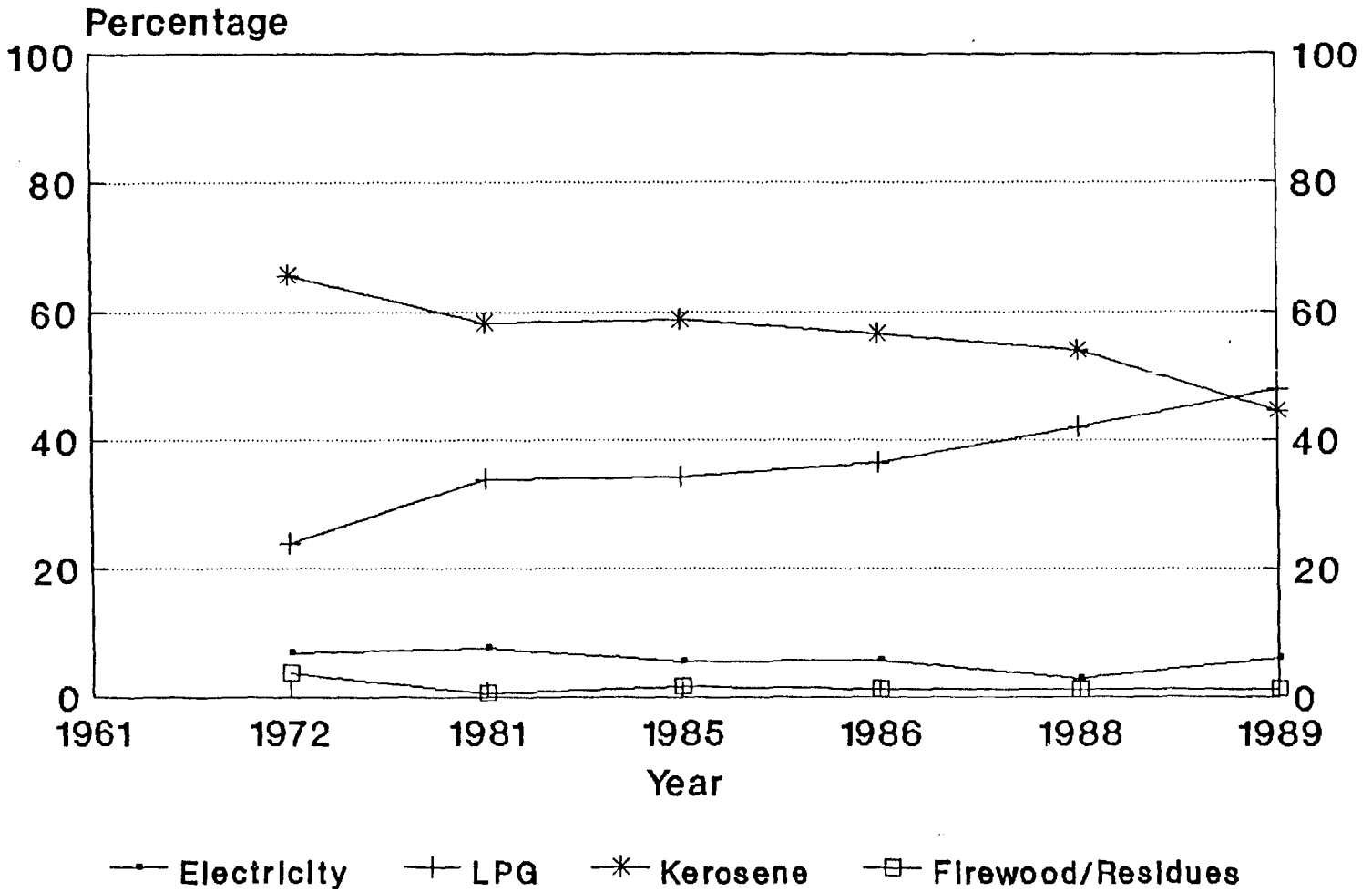
ANNEX 4

Table 1: Main Fuel for Food Cooking
%

	1961	1972	1981	1985	1986	1988	1989
URBAN LIMA (thousand)		3168.8	745.7				
Electricity		6.7	7.5	5.4	5.6	2.8	6.0
LPG		23.8	33.8	34.2	36.5	42.0	48.0
Kerosene		65.8	58.3	58.9	56.7	54.0	44.7
Fuelwood/Residues		3.7	0.5	1.5	1.3	1.2	1.2
OTHER URBAN		4672.7	1291.0				
Electricity		1.8	2.5	1.0			
LPG		8.3	12.2	12.8			
Kerosene		54.4	62.3	75.6			
Fuelwood/Residues		34.8	23.0	10.6			
URBAN TOTAL	4514.9	7841.6	2036.7				
Electricity	4.1	3.7	4.4	3.3			
LPG	2.0	14.6	20.4	23.9			
Kerosene	56.1	59.2	60.7	66.9			
Fuelwood/Residues	37.8	22.4	14.4	5.9			
RURAL	5100.3	5433.6	1220.4				
Electricity	0.1	0.1	0.2	0.2			
LPG	0.1	0.4	0.6	0.5			
Kerosene	7.2	8.0	10.8	10.4			
Fuelwood/Residues	92.7	91.5	88.4	88.9			
PERU	9615.2	13275.2	3257.1				
Electricity	2.0	2.3	2.8	2.1			
LPG	0.9	8.8	13.1	15.0			
Kerosene	29.5	38.1	42.3	45.5			
Fuelwood/Residues	67.5	50.8	41.8	37.4			

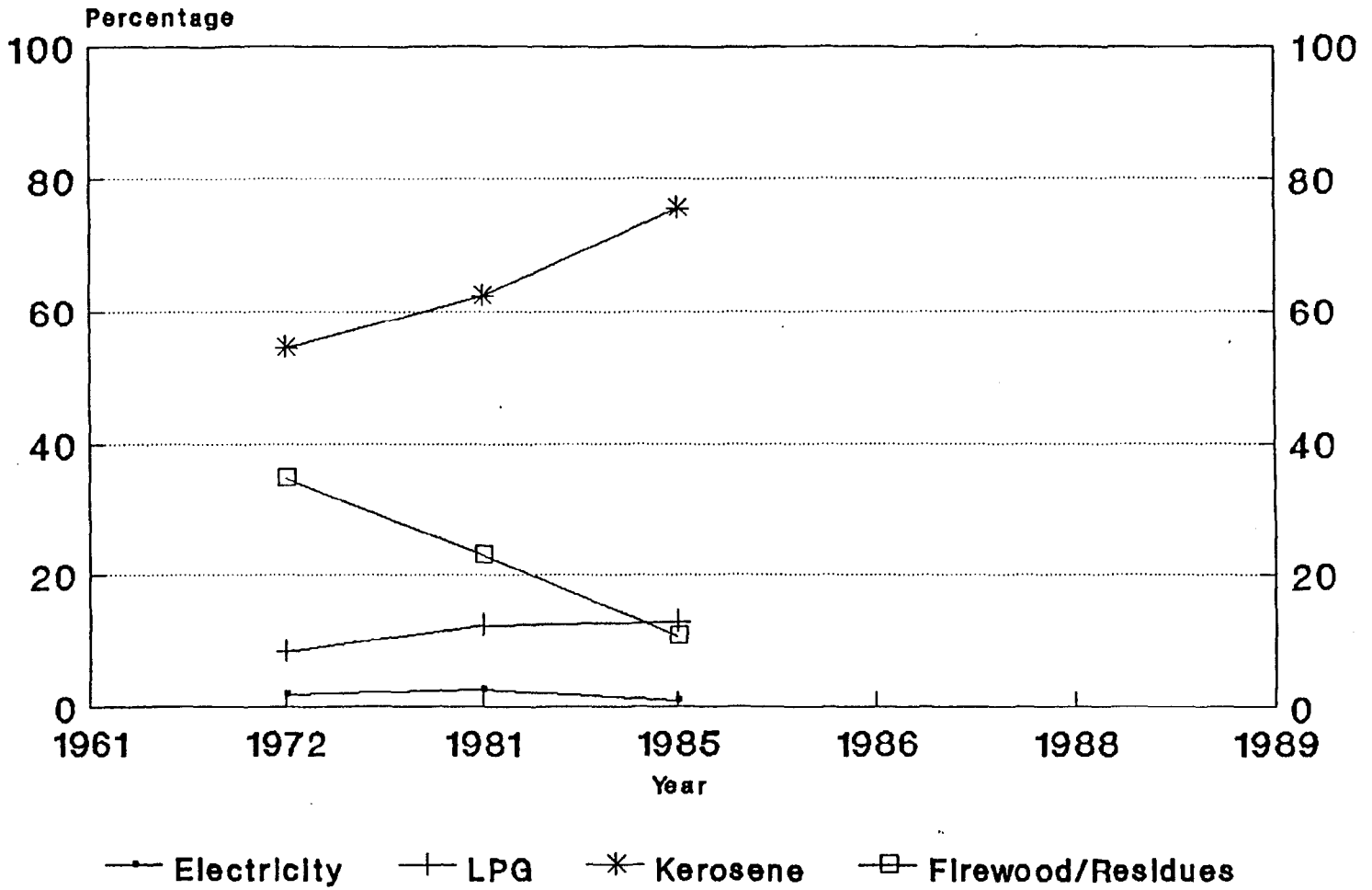
Source: INE
Distribution in % of households (81/85/86/88/89) or in % of inhabitants (61/72)

MAIN COOKING FUEL
LIMA



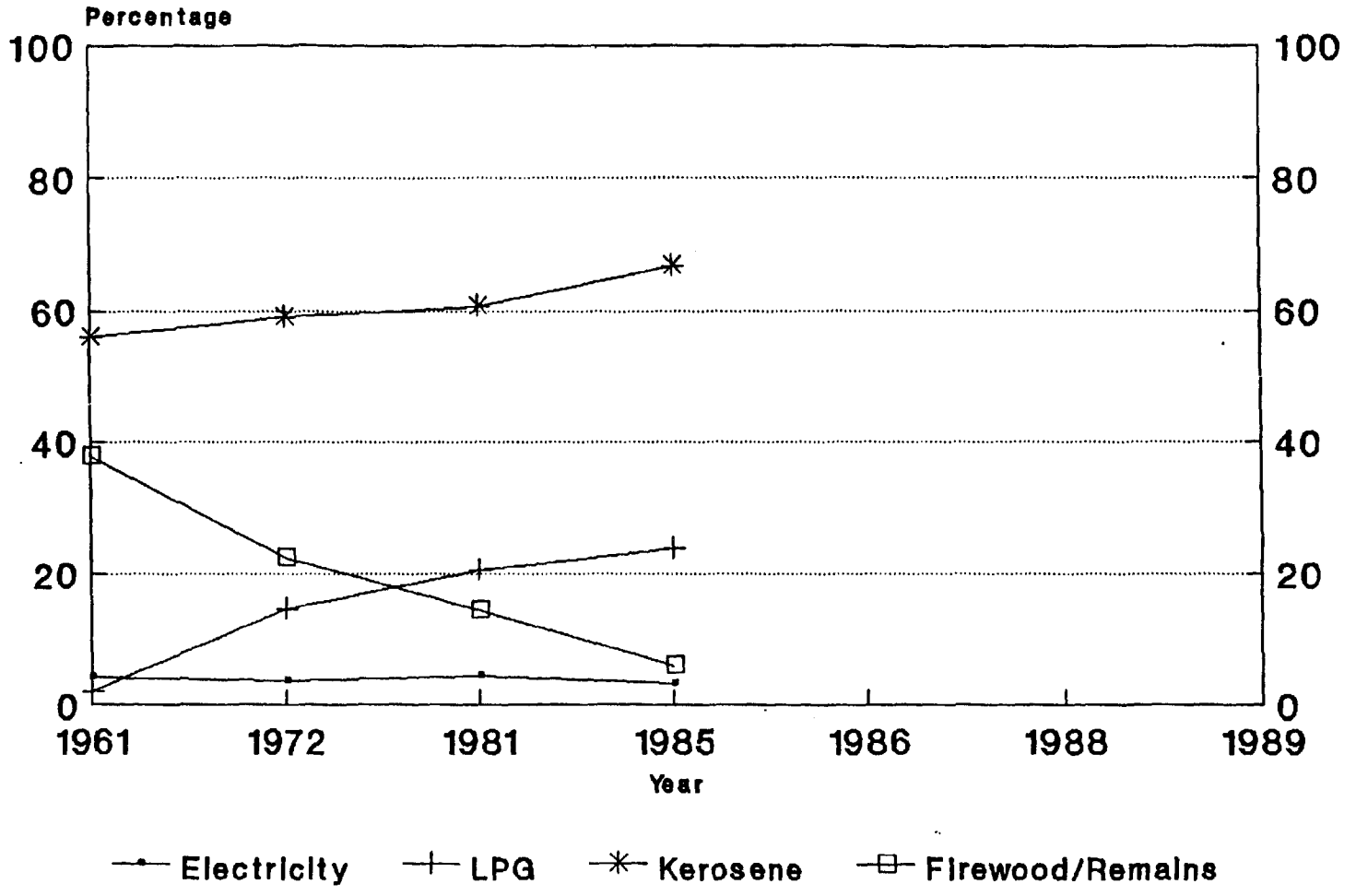
Source: INE

MAIN COOKING FUEL
OTHER URBAN



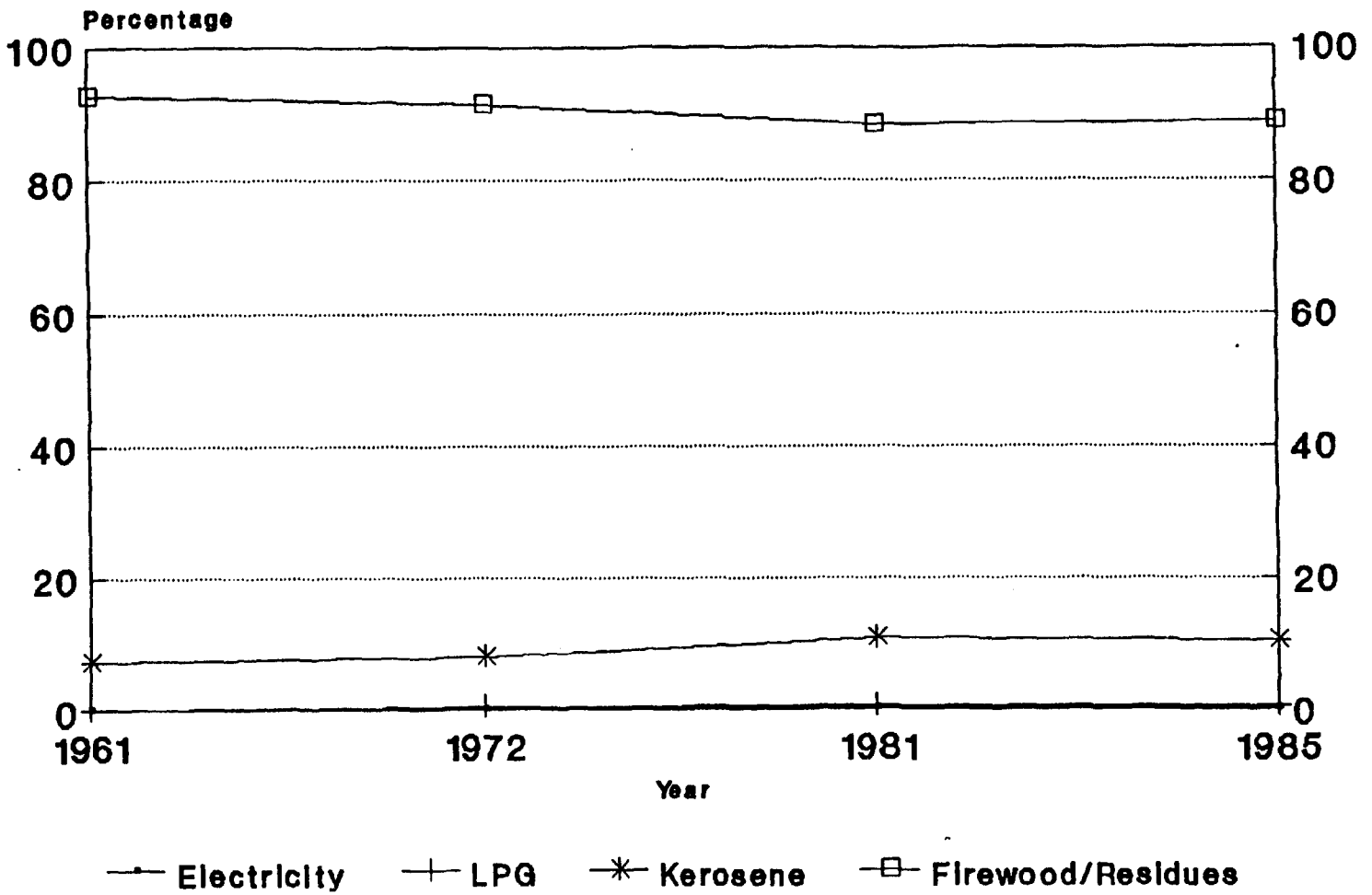
Source: INE

MAIN COOKING FUEL
TOTAL URBAN



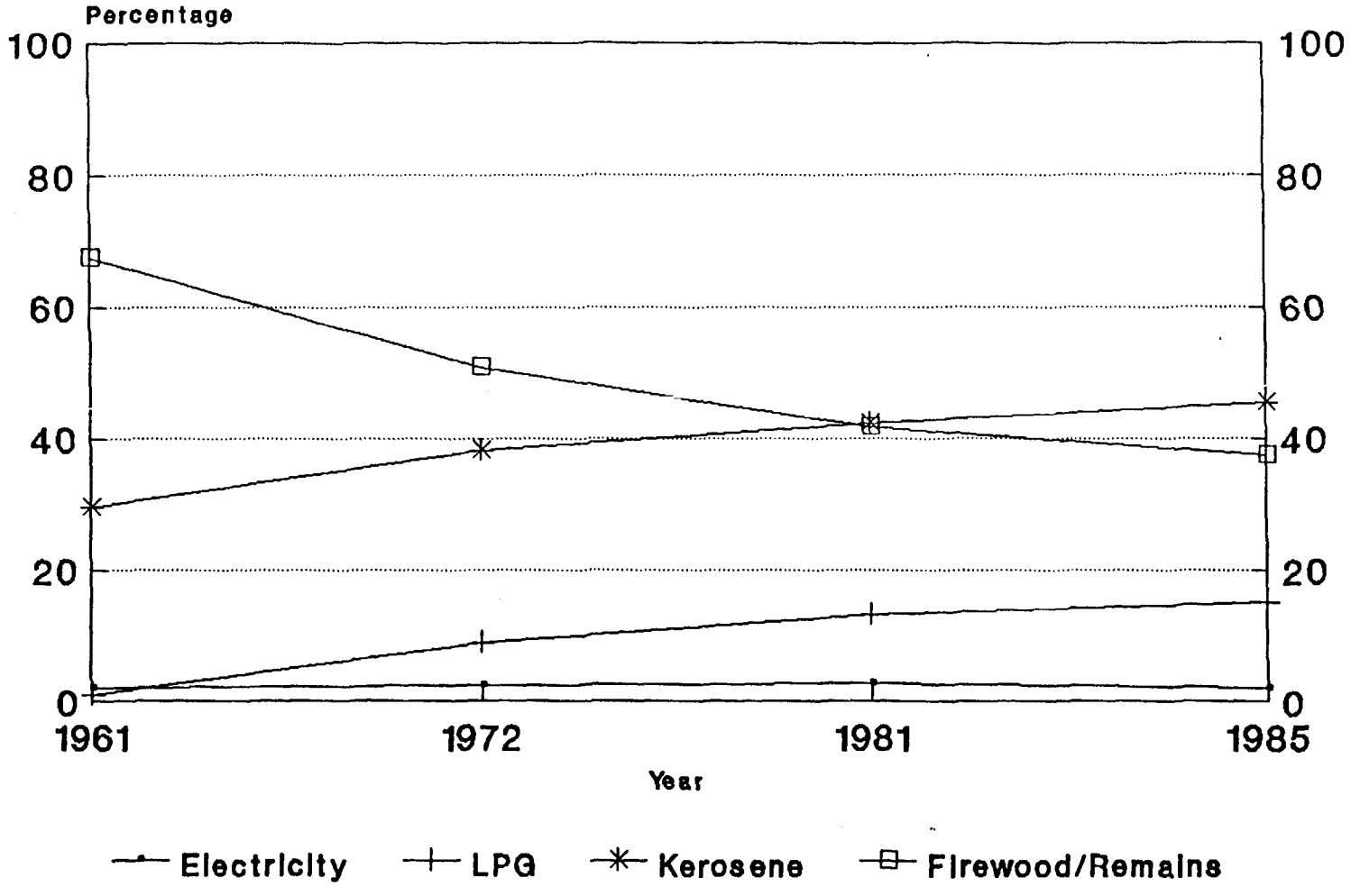
Source: INE

MAIN COOKING FUEL
RURAL



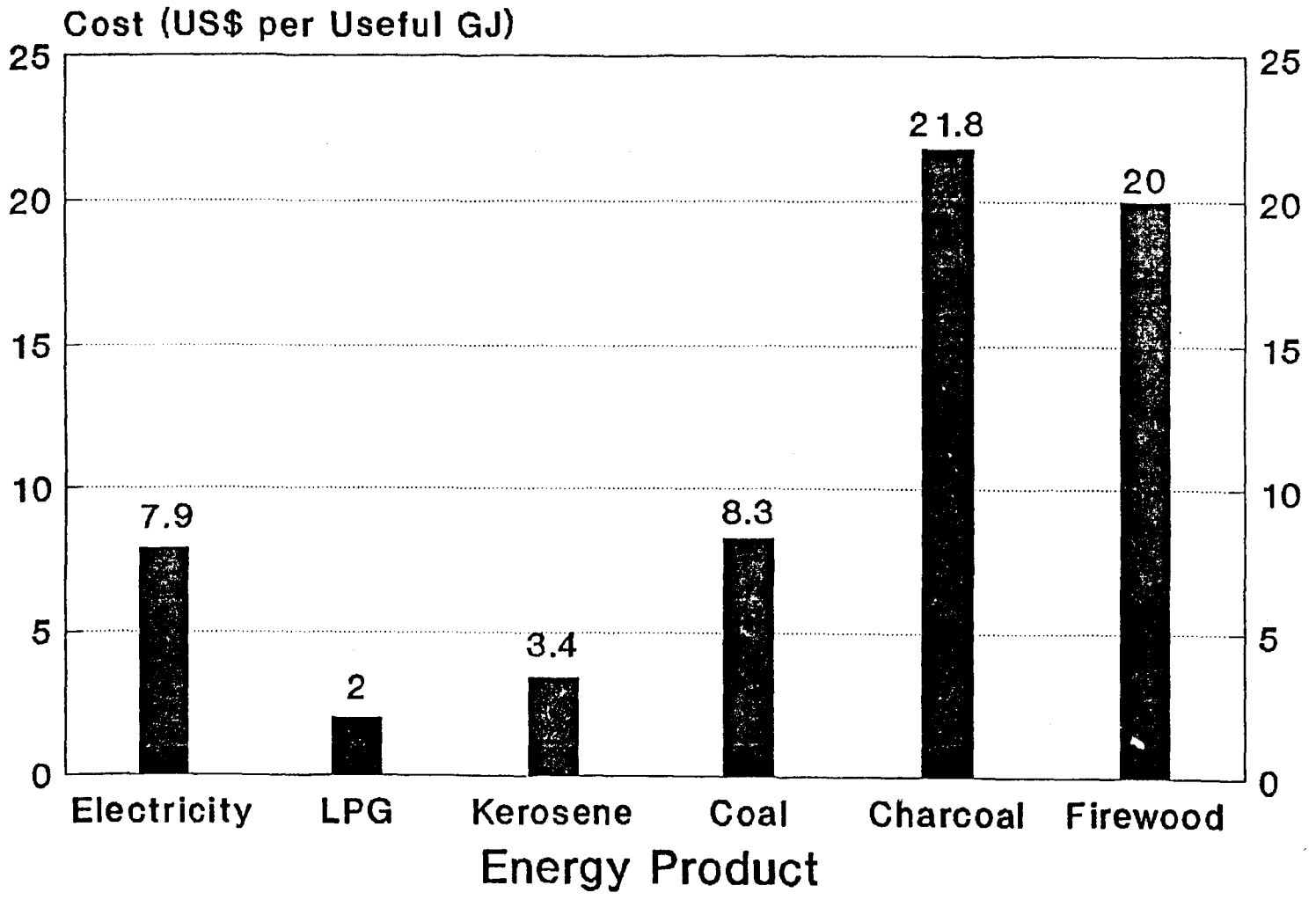
Source: INE

MAIN COOKING FUEL
PERU



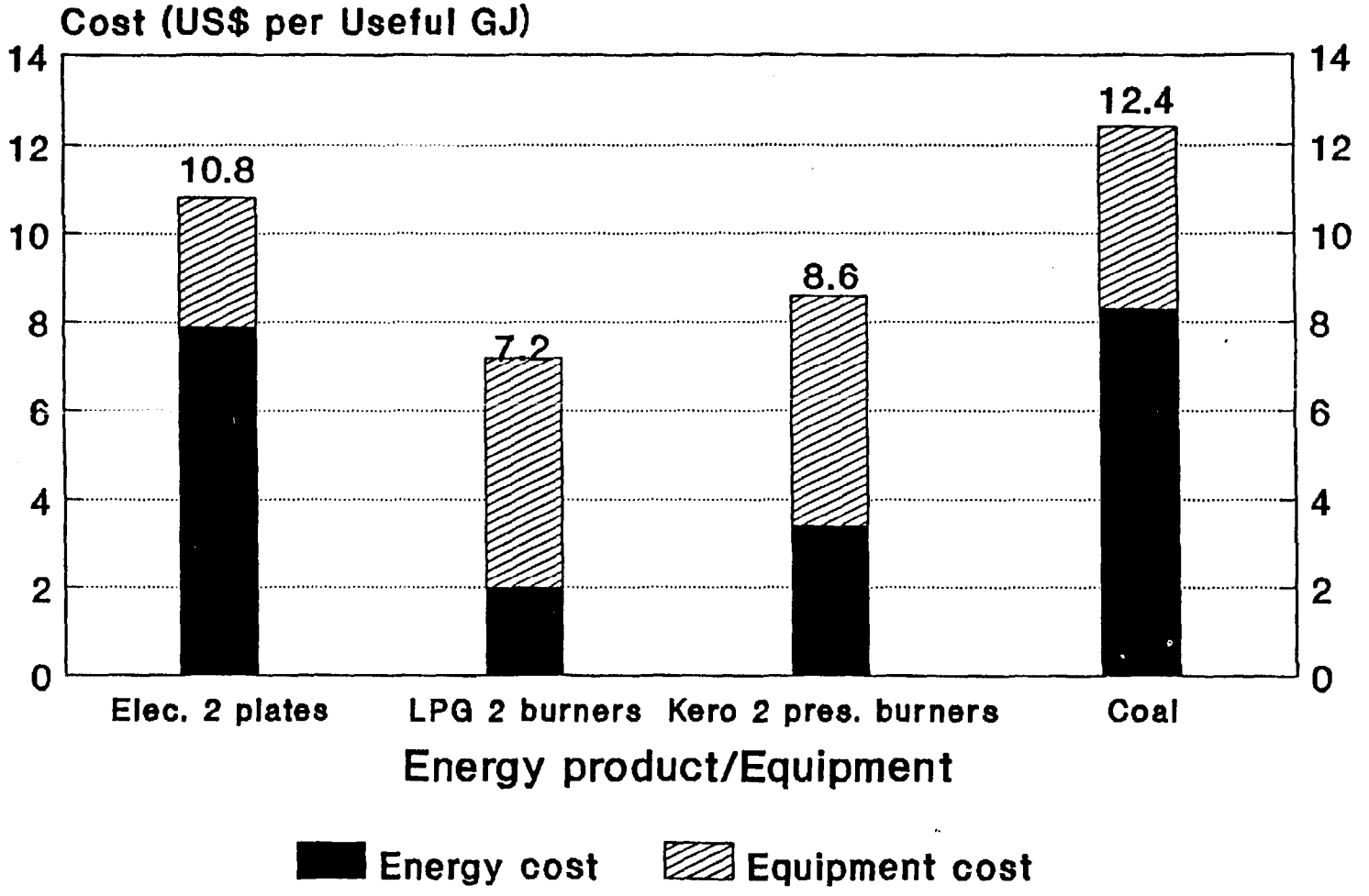
Source: INE

PRICES OF USEFUL ENERGY FOR COOKING
LIMA



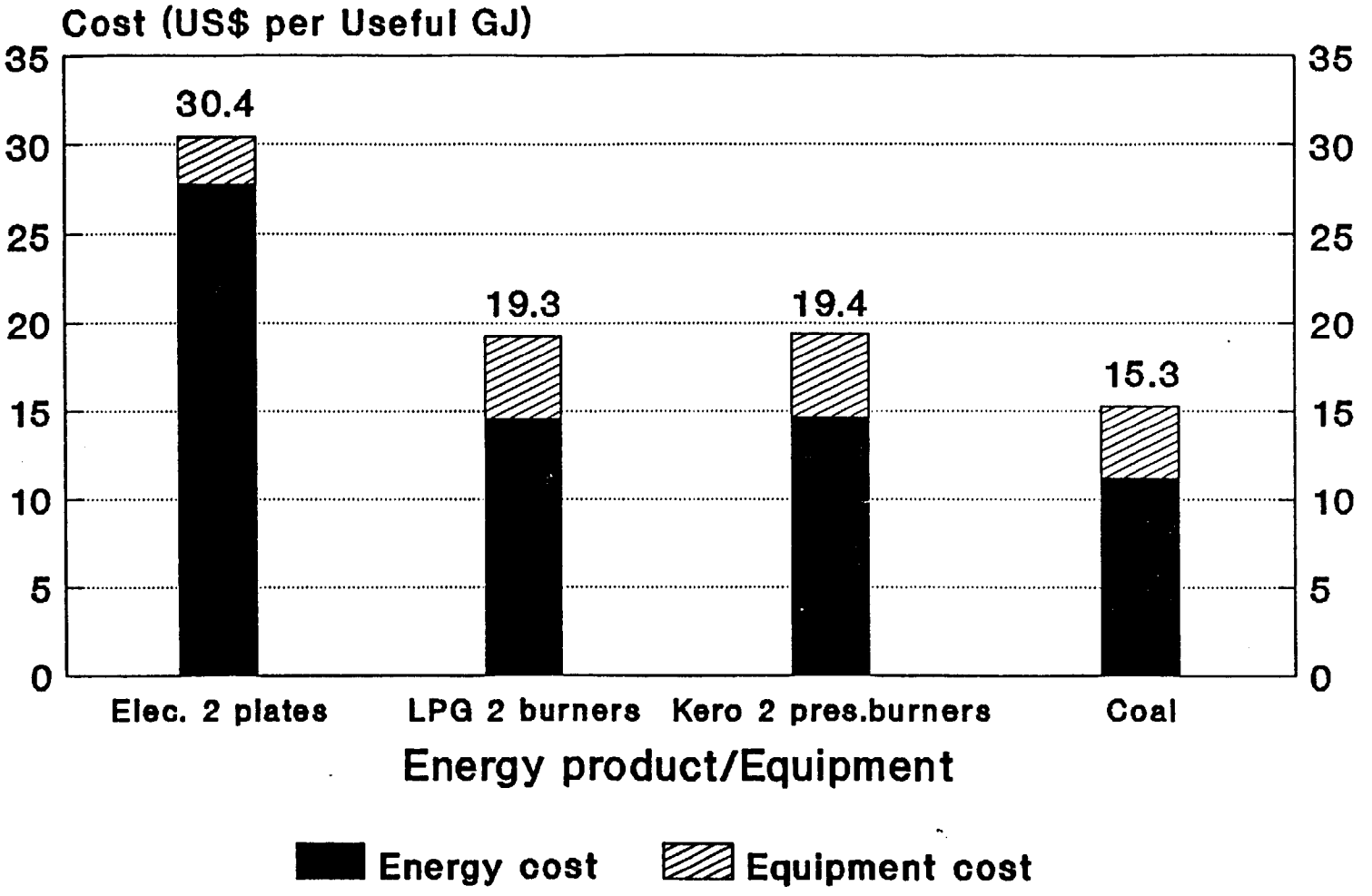
Source: Mission estimates

FINANCIAL COOKING COSTS
LIMA



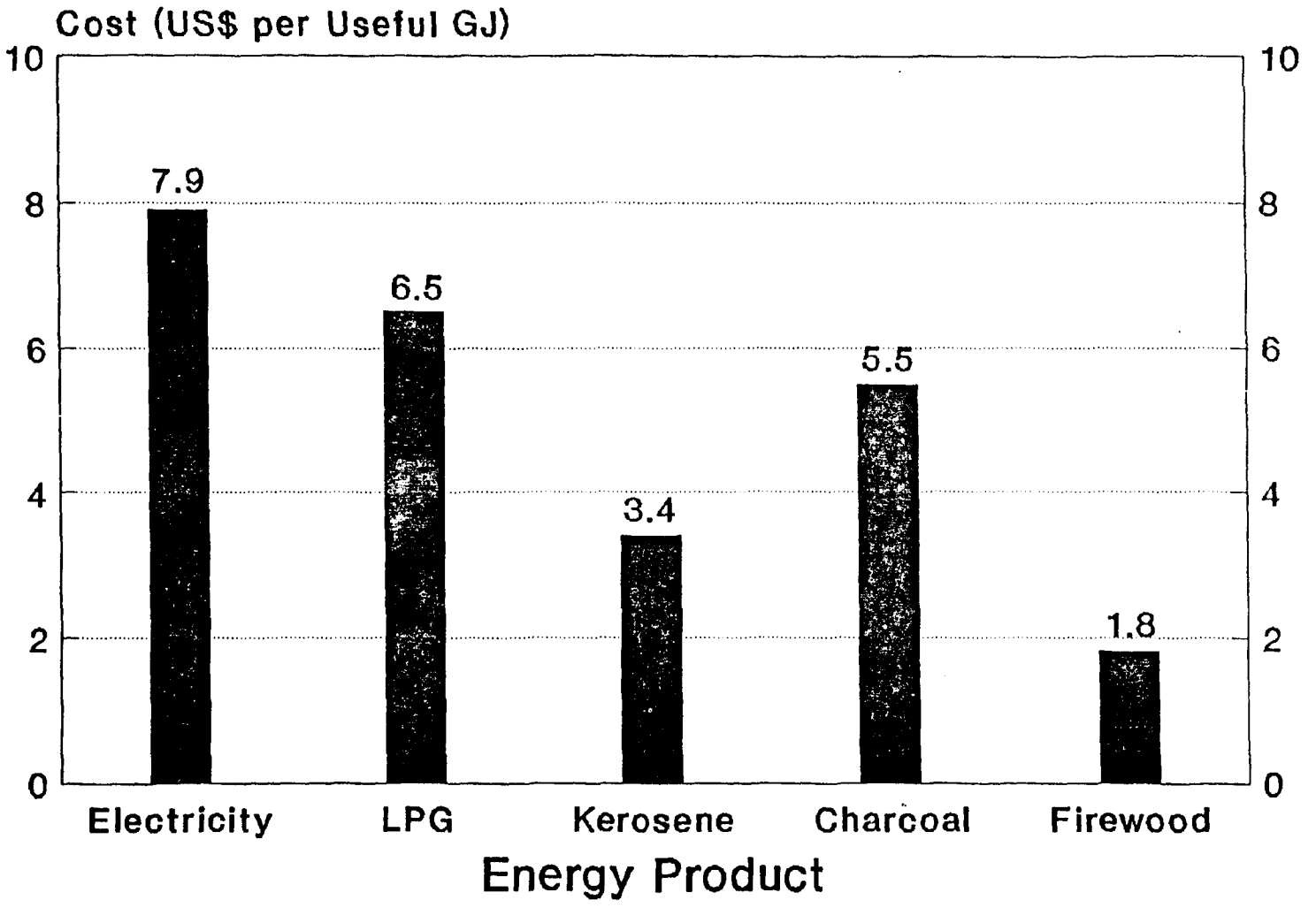
Source: Mission estimates

ECONOMIC COOKING COSTS
LIMA



Source: Mission estimates

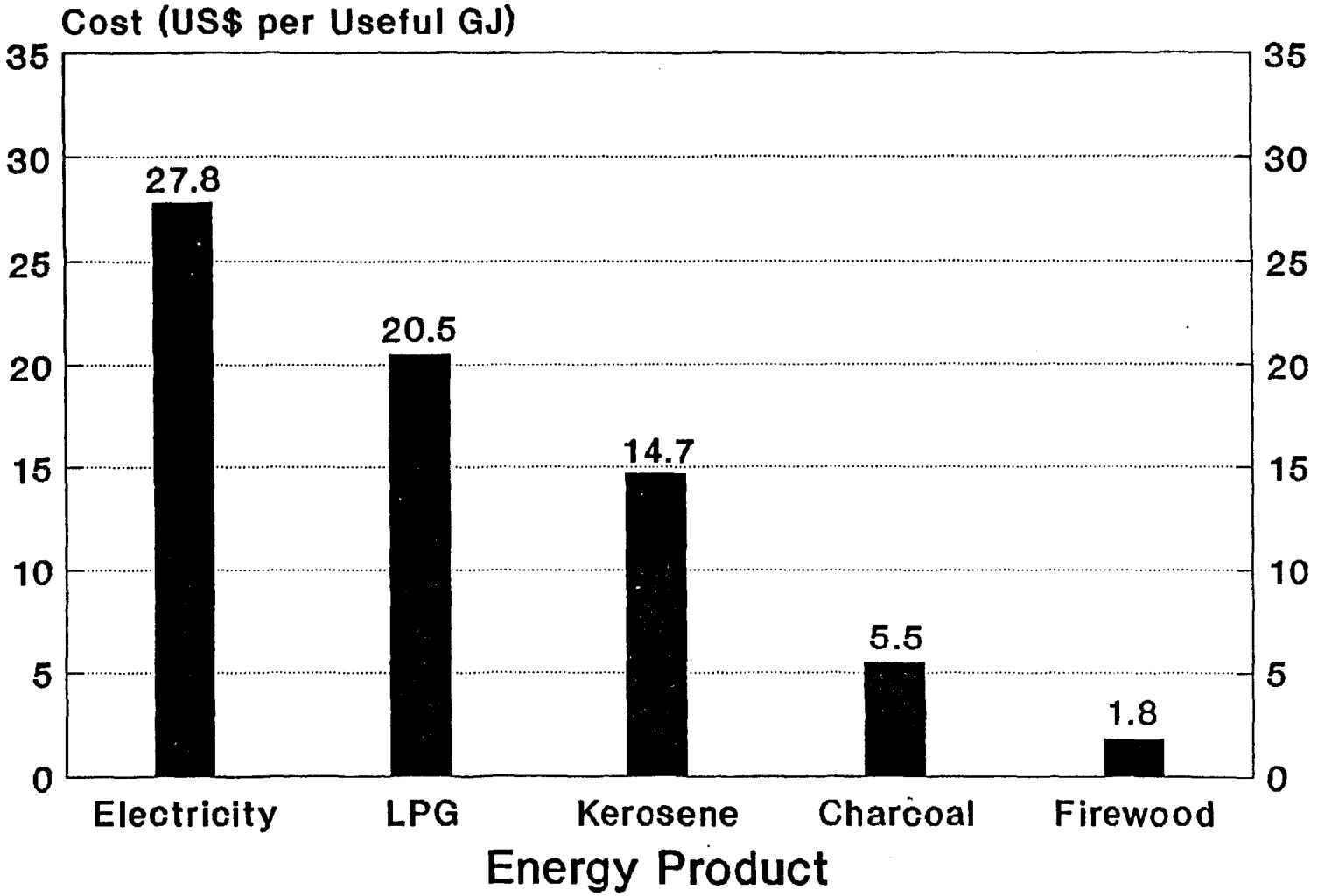
PRICES OF USEFUL ENERGY FOR COOKING
SIERRA CITIES



Source: Mission estimates

COSTS OF USEFUL ENERGY FOR COOKING

SIERRA CITIES Current firewood structure



Source: Mission estimates

Table 2: Comparative Financial Cooking Costs
Lima, July 1, 1990

Combustible/ Tipo de cocina	Unidad	Electricidad 2 placas	Electricidad Horno	GLP 2 quemador	GLP Horno	Kerosene Mecha Placa 2 quem.	Kerosene Presion Placa 2 quem.	Carbon Estufa con chimenea
Precio de venta	US$	0.02	0.02	0.55	0.55	0.18	0.18	0.17
Unidad		Kwh resid.	Kwh resid.	24 libras	24 libras	Galon	Galon	Briqueta (2)
Precio de venta	US$/kg o kWh	0.02	0.02	0.050	0.050	0.058	0.058	0.048
Valor calorico	MJ/kg o kWh	3.6	3.6	45.7	45.7	43.1	43.1	19.2
Precio/energia bruta	US$/GJ	5.56	5.56	1.10	1.10	1.35	1.35	2.50
Rendimiento equipo	%	70	70	55	55	35	40	30
Costo/energia util	US$/GJ util	7.94	7.94	2.01	2.01	3.85	3.37	8.34
Costo del equipo	US$	40	120	80	160	25	53	30 (3)
Duracion de vida	Anos	5	5	5	5	2	3	2
Costo actualizado (10%)	US$/ano	12.8	38.6	23.3 (1)	49 (1)	21.8	23.5	18.2
Energia util anual promed	MJ/ano	4500	4500	4500	4500	4500	4500	4500
Costo equipo/energia util	US$/GJ	2.84	8.58	5.18	10.89	4.84	5.22	4.04
Costo total/energia util	US$/GJ	10.78	16.51	7.19	12.90	8.69	8.59	12.39 (4)

Fuente: Estimaciones mision.

Notes :

US$1 = I./100,000.00

(1) Incluye costo de cilindro y valvula (US$40) amortizado sobre 10 anos

(2) Estudio de factibilidad 1986 actualizado a 1990

(3) Estimado

(4) Se estima que en Trujillo este costo sera inferior en un 25% (i.e. US$9.3/GJ util)

Table 3: Comparative Economic Cooking Costs
Lima, July 1, 1990

Combustible/ Tipo de cocina	Unit	Electricidad 2 placas	Electricidad Horno	GLP 2 quemador	GLP Horno	Kerosene Mecha Placa 2 quem.	Kerosene Presion Placa 2 quem.	Carbon Estufa con chimenea
Costo economico	US$	0.07	0.07	4.0	4.0	0.76	0.76	0.23
Unidad		Kwh resid.	Kwh resid.	24 libras	24 libras	Galon	Galon	Briqueta (2)
Costo economico	US$/kg o kWh	0.07	0.07	0.37	0.37	0.25	0.25	0.065
Valor calorico	MJ/kg o kWh	3.6	3.6	45.7	45.7	43.1	43.1	19.2
Costo/energia bruta	US$/GJ	19.44	19.44	8.03	8.03	5.89	5.89	3.37
Rendimiento equipo	%	70	70	55	55	35	40	30
Costo/energia util	US$/GJ util	27.78	27.78	14.60	14.60	16.83	14.72	11.24
Costo del equipo	US$	36	108	72	144	22	48	30 (3)
Duracion de vida	Anos	5	5	5	5	2	3	2
Costo actualizado (10%)	US$/ano	11.6	34.8	21 (1)	44.1 (1)	19.6	21.2	18.2
Energia util anual promed	MJ/ano	4500	4500	4500	4500	4500	4500	4500
Costo equipo/energia util	US$/GJ	2.58	7.73	4.67	9.80	4.36	4.71	4.04
Costo total/energia util	US$/GJ	30.36	35.51	19.27	24.40	21.18	19.44	15.28 (4)

Notes :
US$1 = I./100,000.00
(1) Incluye costo de cilindro y valvula amortizado sobre 10 anos
(2) Incluye el efecto (+35%) del ajuste de los precios de la energia a sus costos economicos
(3) Estimado
(4) Se estima que en Trujillo este costo sera inferior en un 30% (i.e. US$10.7/GJ util)

Table 5: Annual Consumption and Kerosene and LPG Prices

Ano	Tasa de cambio Soles/US$ o Intis/US$ (Fin periodo)	KEROSENE DOMESTICO Consumo Miles de Barriles	Consumo Miles de Tonela.	Precio I/ o s/ per litro	Precio US$/ton	GAS LICUADO Consumo Miles de Barriles	Consumo Miles de Tonela.	Precio per cilindro	Precio US$/ton
1980	344	5965	758.7	12	43.6	1335	116.7	570	152.0
1981	510	6204	789.1	34	83.3	1415	123.7	1243	223.6
1982	996	6531	830.7	84	105.4	1497	130.9	2381	219.3
1983	2307	5672	721.5	302	163.6	1304	114.0	7200	286.3
1984	5819	5542	704.9	700	150.4	1390	121.6	16400	258.6
1985	17.4	5594	711.6	1.1	79.0	1344	117.5	53	279.4
1986	20	6592	838.5	1.2	75.0	1476	129.1	53	243.1
1987	62.8	7339	933.5	1	19.9	1662	145.3	64	93.5
1988	500	7832	996.2	36	90.0	1850	161.8	900	165.1
1989	12473			698	70.0			7226	53.1
1990	100000 *			4749	59.4			55000	50.5

FUENTE: INE, MEM
* 1 Julio 1990
Densidad kerosene = 0.8
Densidad GLP = 0.55
1 barril = 159 litros

Table 6: Average Consumer Price Index (December of each year)
Metropolitan Lima. Basis: 1979 = 100

	General	Alimentos/bebida	Energia global	Electricidad **	Combustibles	Kerosene *	GLP *
1979	122.1	123.7	118.5	116.6	119.3		
1980	196.3	194.7	144.3	147.8	143.0	120	126
1981	339.0	327.6	359.3	318.7	375.3	340	274
1982	586.3	563.8	785.8	542.5	881.7	840	526
1983	1,320	1,329	2,465	969	3,054	3,020	1,589
1984	2,790	2,687	5,660	3,025	6,699	7,000	3,620
1985	7,206	6,816	11,939	8,467	13,307	11,000	11,700
1986	11,739	10,919	12,445	9,622	13,557	12,000	11,700
1987	25,182	20,737	16,871	17,789	16,509	10,000	14,128
1988	458,895	325,160	301,423	144,904	363,082	360,000	198,675
1989	13,196,060	7,940,844	3,603,512	1,137,207	5,567,862	6,980,000	1,595,143
1990 Junio	77,064,990			6,895,830 Mayo		47,489,322	12,141,613

Fuente: INE
* Base: Diciembre 1979 = 100
** Tarifa domestica hasta 180kWh

Table 9: Population Projection
In thousand people

	1989	1990	1995	2000
GLOBAL				
Total	21,792	22,332	25,123	27,952
Rural	6,684	6,733	6,946	7,095
Urbana	15,107	15,599	18,177	20,857
CIUDADES				
Lima Metropolit	6,234	6,415	7,338	8,300
Arequipa	612	635	752	874
Trujillo	513	532	625	719
Chiclayo	410	426	505	584
Piura	310	325	393	461
Chimbote	287	297	346	401
Iquitos	253	270	324	378
Cuzco	264	275	324	374
Huancayo	203	208	229	248
Tacna	143	150	182	214
REGION				
Costa	11,430			
Sierra	7,900			
Selva	2,461			

FUENTE : INE

Table 10a:LPG Pricing Structure

RUBRO	15 JULIO 1985 I/galon	%	27 JUNIO 1990 I/galon	I/ de 7/85 per galon	%
Precio PETROPERU	3.38	38.6	4,628	0.347	43.5
Impuesto	3.56	40.7	1,110	0.083	10.4
Margen distribucion	1.81	20.7	4,900	0.367	46.0
Envasadora	1.12	12.8	3,240	0.243	30.5
Distribuidores	0.69	7.9	1,660	0.124	15.6
Precio al publico	8.75	100.0	10,638	0.797	100.0

Fuente : SOLGAS

Table 10b: Average Distribution of LPG Distribution Margins (May 1990)

	I./ 24 lb	%	%
Envasadora	8,690	62.0	31.0
Flete a granel	357	2.5	1.3
Flete a deposito	2,256	16.1	8.1
Margen y otros gastos	6,077	43.3	21.7
Distribuidor	5,337	38.0	19.1
Total	14,027	100.0	50.1
P.venta Petroperu	13,973		49.9
Precio al publico	28,000		100.0

Nota: 1 cilindro de 24 libras tien 5.24 galones de GLP

Table 10c:LPG Bottling Companies and Sales to the Residential-Commercial Sector

	% ventas 1975	1980	1985	1989 % ventas	# plantas
ZONA METRO. + PROVINCIAS	67.1	67.3	66.1	66.2	11
SOLGAS	43.9	43.0	43.3	45.2	6
LIMAGAS	23.2	24.3	19.2	17.7	3
ULIROD	0.0	0.0	3.6	3.3	2
ZONA METROPOLITANA	23.1	25.9	31.2	27.5	17
FLAMAGAS	0.0	0.0	7.7	6.3	1
LLAMAGAS	0.0	5.2	4.5	5.8	1
DELTAGAS	8.6	5.7	5.1	2.8	2
VISIGAS	2.5	5.3	5.3	2.3	2
11 otras	12.0	9.7	8.6	10.3	11
PROVINCIAS	9.8	6.8	2.7	6.3	13
TRUJILLO GAS (Trujillo)	0.0	1.4	0.0	1.9	1
PRONTOGAS (Huacho)	3.3	1.7	1.1	1.2	1
GAS DEL SUR (Chincha)	0.9	0.6	0.8	0.9	1
10 otras	5.6	3.1	0.8	2.3	10
TOTAL (Miles toneladas)	97.5	113.5	114.3	151.2	41

Fuente : PETROPERU

Table 15: Average Household Expenditure According to Socioeconomic Level

	10% mas pobre	30% mas pobre Peru	30% mas pobre Urbano	Otro 70%	Todo Peru
Electricidad	0.3	0.5	1.4	1.0	0.9
(% que usa)	(11.7)	(21.6)	(56.1)	(58.8)	(47.6)
Gas Licuado	0.0	0.1	0.3	0.4	0.4
Kerosene	0.7	1.3	3.1	0.9	0.9
Transporte Publico					
Local	0.8	1.7	3.6	2.3	2.2
Larga distancia	1.0	0.9	0.9	1.2	1.2
Utilizacion vehiculos	0.0	0.0	0.0	1.9	1.7
(% que usa)	(0.8)	(1.1)	(0.5)	(11.2)	(8.2)

Fuente : Encuesta de Niveles de Vida 1985-1986. INE

Table 1
Summary of Supply and Demand 1989

Producción de crudo	MBD
Nor-oeste	47.9
Selva Este	82.5
Total	130.4
Exportaciones	1.0
Para refinerias	129.4
mas importaciones	18.8
Total Refinado	148.2

	Ventas Domésticas	Import.	Export.
LPG	4.7	0.5	
Gasolinas	24.6		4.5
Destilados medios	55.1	9.3	
Residuales	32.8		36.0
Totales	117.2	9.8	40.5

Table 2
Peruvian Energy Strategy

Valores de Paridad de Importación — Import ex Curacao — A: Talara
Fecha: Abril 1990
World scale 8.18
Diesel, gasolina — %ws limpios 200.00
Residual y asfaltos — %ws negros 100.00

Producto	S.G.	FOB c/USG	$/Bbl	Flete $/T	$/Bbl	Otros Cargos $/Bbl	CIF $/Bbl
Gaso 95	0.75	64.00	26.88	16.36	1.95	0.10	28.93
Gaso 84	0.75	59.00	24.78	16.36	1.95	0.10	26.83
Kero	0.82	64.00	26.88	16.36	2.13	0.10	29.11
Diesel	0.87	60.00	25.20	16.36	2.26	0.10	27.56
FO 6	0.95		13.50	8.18	1.24	0.10	14.84

Valores de Paridad de Exportación — Export. a US Gulf — De: Talara
Fecha: Abril 1990
World scale 9.20
%ws limpios 200.00
%ws negros 100.00

Producto	S.G.	FOB c/USG	$/Bbl	Flete $/T	$/Bbl	Otros Cargos $/Bbl	CIF $/Bbl
Gaso 95	0.75	67.00	28.14	18.40	2.19	0.10	25.85
Gaso 84	0.75	62.00	26.04	18.40	2.19	0.10	23.75
Kero	0.82	64.00	26.88	18.40	2.40	0.10	24.38
Diesel	0.87	61.00	25.62	18.40	2.54	0.10	22.98
FO 6	0.95		16.00	9.20	1.39	0.10	14.51

Table 3
Comparison of Crude Oils

La Pampilla: Loreto

	Atm. Distn. %	Atm. Distn. MBD	Vac. Dist. %	Vac. Dist. MBD	Craqueo Catalit. %	Craqueo Catalit. MBD	Mezcla MBD	Valor $/B	Valor $M/D
Aceite crudo	100.00	90.00					-90.00	12.92	-1162.80
Gasolina Natural	0.10	0.09			3.20	0.14	0.23	13.34	3.03
LPG	0.07	0.06			31.20	1.34	1.40	22.83	31.92
Gasolina	12.24	11.02			52.60	2.25	13.27	28.93	383.92
Kero	13.26	11.93				0.00	11.93	29.11	347.43
Diesel	10.63	9.57	7.70	1.04	15.50	0.66	11.27	27.56	310.63
Crudo reducido	62.99	56.69	100.00	-13.50	7.10	0.30	43.49	13.34	580.22
Combustible	0.71	0.64	0.60	0.08	0.00		0.72		
Vac G.O.			31.70	4.28	100.00	-4.28	0.00		
Carga máxima		90.00		13.50		8.00		Total	494.25

La Pampilla: Oriente

	Atm. Distn. %	Atm. Distn. MBD	Vac. Dist. %	Vac. Dist. MBD	Craqueo Catalit. %	Craqueo Catalit. MBD	Mezcla MBD	Valor $/B	Valor $M/D
Aceite crudo	100.00	90.00					-90.00	16.16	-1454.40
Gasolina	0.60	0.54			3.20	0.14	0.68	13.34	9.03
LPG	0.60	0.54			31.20	1.34	1.88	22.83	42.81
Gaso	18.00	16.20			52.60	2.25	18.45	28.93	533.80
Kero	19.90	17.91				0.00	17.91	29.11	521.41
Diesel	11.50	10.35	7.70	1.04	15.50	0.66	12.05	27.56	332.21
Crudo reducido	49.30	44.37	100.00	-13.50	7.10	0.30	31.17	13.34	415.86
Combustible	0.10	0.09	0.60	0.08	0.00		0.17		
Vac G.O.			31.70	4.28	100.00	-4.28	0.00		
Carga máxima		90.00		13.50		8.00		Total	400.72

Table 4
Analysis of Refinery Margins

Refineria: Talara
Periodo: 1989 Producción total a precios corrientes

Producción:	(1) NW	(2) Ecuador	(3) Loreto
Tipo de crudo:			
%vol Gaso			
%vol Kero			
%vol Diesel			
%vol FO6			
%vol Combustible/Pérdida			
Comp. Alimentación de Crudo			

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		46.51	17.00	791		Valor de export. est.
Crudo 2		7.60	16.16	123		Oriente
Crudo 3		0.35	12.92	5		Valor de export.
Total	100.00	54.46		918		
GLP	5.16	2.81	22.83	64		Paridad de import.
Gaso 95	6.94	3.78	28.93	109		Paridad de import.
Gaso 84	26.85	14.62	26.83	392		Paridad de import.
Kero	20.75	11.30	29.11	329		Paridad de import.
Diesel	21.69	11.81	27.56	326		Paridad de import.
HFO	15.63	8.51	13.34	114		Valor de export.
Combus./Pérdida	2.99	1.63	0.00	0		
Total	100.00	54.46		1334		
		Margen Bruto		416	152	
Costos de operación			2.18	119	43	
		Margen Neto		297	108	

Table 5: Annual Consumption and Kerosene and LPG Prices

Ano	Tasa de cambio Soles/US$ o Intis/US$ (Fin periodo)	KEROSENE DOMESTICO Consumo Miles de Barriles	Consumo Miles de Tonela.	Precio I/ o s/ per litro	Precio US$/ton	GAS LICUADO Consumo Miles de Barriles	Consumo Miles de Tonela.	Precio per cilindro	Precio US$/ton
1980	344	5965	758.7	12	43.6	1335	115.7	570	152.0
1981	510	6204	789.1	34	83.3	1415	123.7	1243	223.6
1982	996	6531	830.7	84	105.4	1497	130.9	2381	219.3
1983	2307	5672	721.5	302	163.6	1304	114.0	7200	286.3
1984	5819	5542	704.9	700	150.4	1390	121.6	16400	258.6
1985	17.4	5594	711.6	1.1	79.0	1344	117.5	53	279.4
1986	20	6592	838.5	1.2	75.0	1476	129.1	53	243.1
1987	62.8	7339	933.5	1	19.9	1662	145.3	64	93.5
1988	500	7832	996.2	36	90.0	1850	161.8	900	155.1
1989	12473			698	70.0			7226	53.1
1990	100000 *			4749	59.4			55000	50.5

FUENTE: INE, MEM
* 1 Julio 1990
Densidad kerosene = 0.8
Densidad GLP = 0.55
1 barril = 159 litros

Table 6: Average Consumer Price Index (December of each year)
Metropolitan Lima. Basis: 1979 = 100

	General	Alimentos/bebida	Energia global	Electricidad **	Combustibles	Kerosene *	GLP *
1979	122.1	123.7	118.5	116.6	119.3		
1980	196.3	194.7	144.3	147.8	143.0	120	126
1981	339.0	327.6	359.3	318.7	375.3	340	274
1982	586.3	563.8	785.8	542.5	881.7	840	526
1983	1,320	1,329	2,465	969	3,054	3,020	1,589
1984	2,790	2,687	5,660	3,025	6,699	7,000	3,620
1985	7,206	6,816	11,939	8,467	13,307	11,000	11,700
1986	11,739	10,919	12,445	9,622	13,557	12,000	11,700
1987	25,182	20,737	16,871	17,789	16,509	10,000	14,128
1988	458,895	325,160	301,423	144,904	363,082	360,000	198,675
1989	13,196,060	7,940,844	3,603,512	1,137,207	5,567,862	6,980,000	1,595,143
1990 Junio	77,064,990			6,895,830 Mayo		47,489,322	12,141,613

Fuente: INE
* Base: Diciembre 1979 = 100
** Tarifa domestica hasta 180kWh

Table 9: Population Projection
In thousand people

	1989	1990	1995	2000
GLOBAL				
Total	21,792	22,332	25,123	27,952
Rural	6,684	6,733	6,946	7,095
Urbana	15,107	15,599	18,177	20,857
CIUDADES				
Lima Metropolit	6,234	6,415	7,338	8,300
Arequipa	612	635	752	874
Trujillo	513	532	625	719
Chiclayo	410	426	505	584
Piura	310	325	393	461
Chimbote	287	297	346	401
Iquitos	253	270	324	378
Cuzco	264	275	324	374
Huancayo	203	208	229	248
Tacna	143	150	182	214
REGION				
Costa	11,430			
Sierra	7,900			
Selva	2,461			

FUENTE : INE

Table 15: Average Household Expenditure According to Socioeconomic Level

	10% mas pobre	30% mas pobre Peru	30% mas pobre Urbano	Otro 70%	Todo Peru
Electricidad	0.3	0.5	1.4	1.0	0.9
(% que usa)	(11.7)	(21.6)	(56.1)	(58.8)	(47.6)
Gas Licuado	0.0	0.1	0.3	0.4	0.4
Kerosene	0.7	1.3	3.1	0.9	0.9
Transporte Publico					
Local	0.8	1.7	3.6	2.3	2.2
Larga distancia	1.0	0.9	0.9	1.2	1.2
Utilizacion vehiculos	0.0	0.0	0.0	1.9	1.7
(% que usa)	(0.8)	(1.1)	(0.5)	(11.2)	(8.2)

Fuente : Encuesta de Niveles de Vida 1985-1986. INE

Table 1
Summary of Supply and Demand 1989

Producción de crudo	MBD
Nor-oeste	47.9
Selva Este	82.5
Total	130.4
Exportaciones	1.0
Para refinerias	129.4
mas importaciones	18.8
Total Refinado	148.2

	Ventas Domésticas	Import.	Export.
LPG	4.7	0.5	
Gasolinas	24.6		4.5
Destilados medios	55.1	9.3	
Residuales	32.8		36.0
Totales	117.2	9.8	40.5

Table 2
Peruvian Energy Strategy

Valores de Paridad de Importación — Import ex Curacao — A: Talara
Fecha: Abril 1990
World scale 8.18
Diesel, gasolina — %ws limpios 200.00
Residual y asfaltos — %ws negros 100.00

Producto	S.G.	FOB c/USG	$/Bbl	Flete $/T	$/Bbl	Otros Cargos $/Bbl	CIF $/Bbl
Gaso 95	0.75	64.00	26.88	16.36	1.95	0.10	28.93
Gaso 84	0.75	59.00	24.78	16.36	1.95	0.10	26.83
Kero	0.82	64.00	26.88	16.36	2.13	0.10	29.11
Diesel	0.87	60.00	25.20	16.36	2.26	0.10	27.56
FO 6	0.95		13.50	8.18	1.24	0.10	14.84

Valores de Paridad de Exportación — Export. a US Gulf — De: Talara
Fecha: Abril 1990
World scale 9.20
%ws limpios 200.00
%ws negros 100.00

Producto	S.G.	FOB c/USG	$/Bbl	Flete $/T	$/Bbl	Otros Cargos $/Bbl	CIF $/Bbl
Gaso 95	0.75	67.00	28.14	18.40	2.19	0.10	25.85
Gaso 84	0.75	62.00	26.04	18.40	2.19	0.10	23.75
Kero	0.82	64.00	26.88	18.40	2.40	0.10	24.38
Diesel	0.87	61.00	25.62	18.40	2.54	0.10	22.98
FO 6	0.95		16.00	9.20	1.39	0.10	14.51

Table 3
Comparison of Crude Oils

La Pampilla: Loreto

	Atm. Distn. %	Atm. Distn. MBD	Vac. Dist. %	Vac. Dist. MBD	Craqueo Catalit. %	Craqueo Catalit. MBD	Mezcla MBD	Valor $/B	Valor $M/D
Aceite crudo	100.00	90.00					-90.00	12.92	-1162.80
Gasolina Natural	0.10	0.09			3.20	0.14	0.23	13.34	3.03
LPG	0.07	0.06			31.20	1.34	1.40	22.83	31.92
Gasolina	12.24	11.02			52.60	2.25	13.27	28.93	383.92
Kero	13.26	11.93				0.00	11.93	29.11	347.43
Diesel	10.63	9.57	7.70	1.04	15.50	0.66	11.27	27.56	310.63
Crudo reducido	62.99	56.69	100.00	-13.50	7.10	0.30	43.49	13.34	580.22
Combustible	0.71	0.64	0.60	0.08	0.00		0.72		
Vac G.O.			31.70	4.28	100.00	-4.28	0.00		
Carga máxima		90.00		13.50		8.00		Total	494.25

La Pampilla: Oriente

	Atm. Distn. %	Atm. Distn. MBD	Vac. Dist. %	Vac. Dist. MBD	Craqueo Catalit. %	Craqueo Catalit. MBD	Mezcla MBD	Valor $/B	Valor $M/D
Aceite crudo	100.00	90.00					-90.00	16.16	-1454.40
Gasolina	0.60	0.54			3.20	0.14	0.68	13.34	9.03
LPG	0.60	0.54			31.20	1.34	1.88	22.83	42.81
Gaso	18.00	16.20			52.60	2.25	18.45	28.93	533.80
Kero	19.90	17.91				0.00	17.91	29.11	521.41
Diesel	11.50	10.35	7.70	1.04	15.50	0.66	12.05	27.56	332.21
Crudo reducido	49.30	44.37	100.00	-13.50	7.10	0.30	31.17	13.34	415.86
Combustible	0.10	0.09	0.60	0.08	0.00		0.17		
Vac G.O.			31.70	4.28	100.00	-4.28	0.00		
Carga máxima		90.00		13.50		8.00		Total	400.72

Table 4
Analysis of Refinery Margins

Refineria: Talara
Periodo: 1989 Producción total a precios corrientes

Producción:	(1) NW	(2) Ecuador	(3) Loreto
Tipo de crudo:			
%vol Gaso			
%vol Kero			
%vol Diesel			
%vol FO6			
%vol Combustible/Pérdida			
Comp. Alimentación de Crudo			

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		46.51	17.00	791		Valor de export. est.
Crudo 2		7.60	16.16	123		Oriente
Crudo 3		0.35	12.92	5		Valor de export.
Total	100.00	54.46		918		
GLP	5.16	2.81	22.83	64		Paridad de import.
Gaso 95	6.94	3.78	28.93	109		Paridad de import.
Gaso 84	26.85	14.62	26.83	392		Paridad de import.
Kero	20.75	11.30	29.11	329		Paridad de import.
Diesel	21.69	11.81	27.56	326		Paridad de import.
HFO	15.63	8.51	13.34	114		Valor de export.
Combus./Pérdida	2.99	1.63	0.00	0		
Total	100.00	54.46		1334		
		Margen Bruto		416	152	
Costos de operación			2.18	119	43	
		Margen Neto		297	108	

Table 5

Refinería: Pampilla
Periodo: Producción 1989 en precios corrientes
Producción: (1) Loreto (2) Ecuador
Tipo de crudo:
%vol Gaso
%vol Kero
%vol Diesel
%vol FO6
%vol Combustible/Pérdida
Comp. Alimentación de Crudo

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		73.90	12.92	955		Valor de export.
Crudo 2		9.08	16.16	147		CIF Oriente
Crudo 3		0.00	0.00	0		
Total	100.00	82.98		1102		
GLP	1.92	1.59	22.83	36		Paridad de import.
Gaso 95	0.11	0.09	28.93	3		Paridad de import.
Gaso 84	13.32	11.05	26.83	296		Paridad de import.
Kero	11.81	9.80	29.11	285		Paridad de import.
Diesel	10.56	8.76	27.56	241		Paridad de import.
HFO	60.29	50.03	13.34	667		Valor de export.
Combus./Pérdida	2.00	1.66	0.00	0		
Total	100.00	82.98		1530		
		Margen Bruto		428	156	
Costos de operación			1.01	84	31	
		Margen Neto		334	126	

Table 6

Refinería: Conchán
Periodo: Producción 1989 total a precios corrientes

Producción:	(1) Loreto	(2) Ecuador	(3) Gaso
Tipo de crudo:			
%vol Gaso			
%vol Kero			
%vol Diesel			
%vol FO6			
%vol Combustible/Pérdida			
Comp. Alimentación de Crudo			

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		1.95	12.92	25		Valor de export.
Crudo 2		2.12	16.16	34		CIF Oriente
Crudo 3		0.43	26.80	12		Valor de export.
Total	100.00	4.50		71		
GLP	0.00	0.00	22.83	0		Paridad de import.
Gaso 95	1.11	0.05	28.93	1		Paridad de import.
Gaso 84	18.67	0.84	26.83	23		Paridad de import.
Kero	10.89	0.49	29.11	14		Paridad de import.
Diesel	13.33	0.60	27.56	17		Paridad de import.
FO6	47.33	2.13	13.34	28		Valor de export.
Combus./Pérdida	2.00	0.09	0.00	0		
Asfalto	6.67	0.30	20.00	6		Valores estimados
Total	100.00	4.50		89		
Margen Bruto				18	7	
Costos de operación			2.29	10	4	
Margen Neto				8	3	

Table 7

Refinería: Iquitos
Periodo: Febrero 1990

Producción:	(1) Loreto	(2) Cat Nap.	(3)
Tipo de crudo:			
%vol Gaso			
%vol Kero			
%vol Diesel			
%vol FO6			
%vol Combustible/Pérdida			
Comp. Alimentación de Crudo			

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		5.97	12.00	72		
Crudo 2		0.13	33.41			Cat Nap.
Crudo 3						Assume $12/Bbl
Total	100.00	6.10		72		Transporte
GLP	0.00	0.00				
Gaso 95	0.00	0.00				
Gaso 84	7.87	0.48	36.83	18		CIF Talara+$10/Bbl
Kero	17.54	1.07	39.11	42		CIF Talara+$10/Bbl
Diesel	27.70	1.69	37.56	63		CIF Talara+$10/Bbl
FO6	19.84	1.21	23.34	28		FOB Talara
Combus./Pérdida	26.72	1.63	12.00	20		Como para crudo
Asfalto	0.33	0.02	0.00	0		
Total	100.00	6.10		171		
		Margen Bruto		99	36	
	Costos de operación		6.97	43	16	
		Margen Neto		57	21	

Table 8

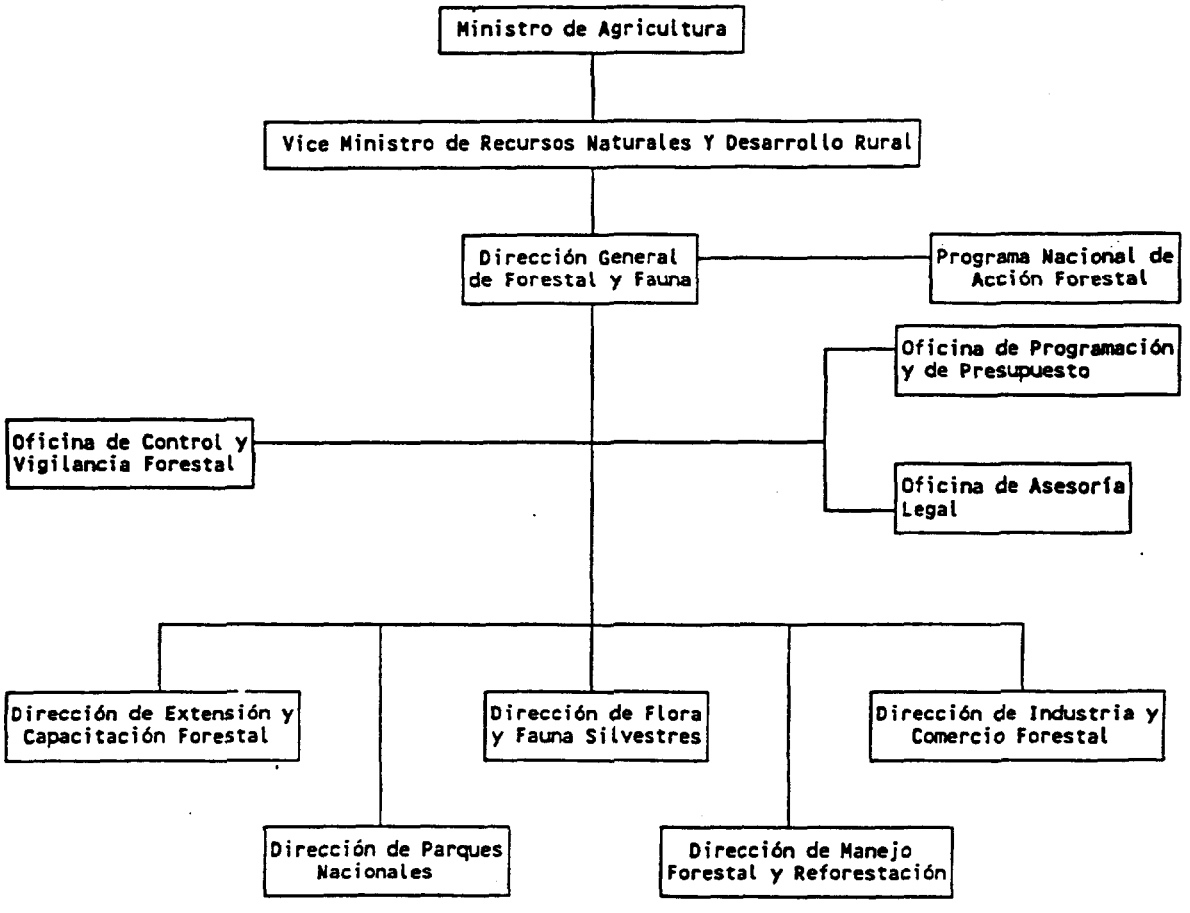
Refinería: Pucallpa
Periodo: Febrero 1990

Producción:	(1) Loreto	(2) Otros	(3) Gaso
Tipo de crudo:			
%vol Gaso			
%vol Kero			
%vol Diesel			
%vol F06			
%vol Combustible/Pérdida			
Comp. Alimentación de Crudo			

Cálculo de margen:

	%	MB/D	Valor $/B	M$/D	MM$/yr	Notas
Crudo 1		0.05	12.00	1		
Crudo 2		1.94	12.00	23		Valor estimado
Crudo 3		0.17	40.93	7		Valor estimado
Total	100.00	2.16		31		Valor export. + Transporte
GLP	0.00	0.00	0.00	0		
Gaso 95	0.00	0.00	0.00	0		
Gaso 84	18.06	0.39	38.83	15		Valores Talara
Kero	28.24	0.61	41.11	25		+ Transp. carreteras
Diesel	21.30	0.46	39.56	18		
F06	31.48	0.68	25.34	17		
Combus./Pérdida	0.93	0.02	0.00	0		
Total	100.00	2.16		76		
		Margen Bruto		45	16	
	Costos de operación		6.23	13	5	
		Margen Neto		31	11	

Annex 1
General Forestry and Fauna Directorate Organization



Annex 2
Reforestation Projects with Energy Component

NOMBRE	INSTITUCION	ZONA	PERIODO	REFORESTACION (Ha)		INVERSIONES		
				Meta Total	Meta a 1988	Presupuesto (Mill. I/.) Total	Parcial a '88	Donacion Miles US$
1) Proyecto reforestación	----	Sierra	86-92	26000	5810	17308'0	9417	---
2) Ampliación: Desarrollo Forestal Comunal	FAO/Holanda	Sierra	87-92	2900 (1)	490 (1)	97'0	DND	598.0
3) Agroforestería rural con alimentos	AID/CARE	Sierra	88-91	25225	1923	8215'0	237	190.0
4) Educación	FAO	Sierra	88-91	1730 (2)	970	DND	DND	59.5

Fuente: DGFF
(1) Dato incompleto
(2) Centros educativos promocionales
(3) Dato no disponible

Annex 3
National Forestry Action Plan 1988-2000
Investment by Program for the Next Five Years

Programa	Inversión nacional (miles de dólares)	Inversión externa (miles de dólares)	Total (miles de dólares)
1. La forestería en apoyo al desarrollo rural	21.420	51.335	72.755
2. Apoyo a la producción y conservación de la energía de la biomasa 1)	7.082	19.497	26.579
3. Manejo y desarrollo forestal industrial	19.900	60.550	80.450
4. Apoyo a la conservación de ecosistemas forestales y al manejo de la fauna silvestre	6.800	18.250	25,050
5. Instituciones	11.525	37.650	49.175
TOTAL	66.727	187.282	254.009