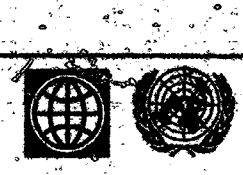
Report No. 6420-COB

Congo: Issues and Options in the Energy Sector

January 1988



Report of the Joint UNDP/World Bank Energy Sector Assessment Program

JOINT UNDP/WORLD BANK ENERGY SECTOR ASSESSMENT PROGRAM

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CONGO

Issues and Options in the Energy Sector

JANUARY 1988

This is one of a series of reports of the Joint UNDP/World Bank Energy Sector Assessment Program. Finance for this work has been provided, in part, by the UNDP Energy Account, and the work has been carried out by the World Bank.

ABSTRACT

Despite a substantial resource base consisting of biomass, hydropower, and hydrocarbons, energy consumption per capita remains low as compared to countries with similar revenues. The development of Congo's energy sector has been severely hampered these last years as a result of factors: inappropriate pricing policy with petroleum price levels below international prices, investment program planned on light oil exports revenues which did not materialize, etc.

This has been aggravated since 1986 by declining international prices of petroleum, the country's principal export commodity, which has been depressed by fiscal and foreign exchange earnings from the country's crude oil exports. Confronted with this situation, the government has started a series of policy reforms including the rehabilitation of energy sector enterprises, as part of his public enterprise rehabilitation program.

The report analyzes the basic energy supply and demand trends over the past years and assesses the main policy issues and options related to energy pricing, subsector investments, and institutional development at both the sectoral and enterprise levels. The report outlines a strategy aimed at strengthening energy sector management and highlights the core program for energy investment. It identifies technical assistance needs for priority investigations, and institution building including planning and training in areas pertaining to hydrocarbon production and distribution, electricity rehabilitation, and charcoal development and its promotion.

ACRONYMS

ATC	Agence Transcongolaise de Communications
CCCE	Caisse Centrale de Coopération Economique
CORAF	Compagnie Congolaise de Raffinage
DRP	Exploration and Production Directorate
EDF	Electricité de France
HydroCongo	Société Nationale Hydro-Congo
IBRD	International Bank for Reconstruction and Development
IMF	International Monetary Fund
MF	Ministry of Finance
MFE	Ministry of Forest Economy
MME	Ministry of Mines and Energy
SNE	Société Nationale d'Electricité
UAIC	Unité d'Afforestation Industrielle du Congo
UNDP	United Nations Development Program

ABBREVIATIONS

bbl	barrel
b/d	barrel(s) per day
b/y	barrel(s) per year
CIF	cost, insurance, freight
CNG	compressed natural gas
fob	freight on board
ft	feet
GDP	gross domestic product
GOR	gas/oil ratio
GWh	gigawatt-hour
ha	hectare
HV	high voltage
kcal	kilocalorie
kg	kilogram
kgoe	kilograms of oil equivalent
km	kilometer
km2	square kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
LPG	liquefied petroleum gas
LV	low voltage
m^3	cubic meter
MCF	thousand cubic feet
MV	medium voltage
MW	megawatt
NWE	Northwest Europe
OOIP	original oil in place
OGIP	original gas in place
scf	standard cubic feet
STB	stock tank barrel
toe	tons of oil equivalent
ton	metric ton
t/y	tons per year
T.D.	total depth
TSCF	trillion standard cubic feet
yr	year

CURRENCY AND FUEL EQUIVALENTS

Currency Unit - CFA Franc (CFAF)
Exchange Rate: 350 CFAF/US$ 1 a/

Fuel	Calorific Value (million kcal/ton)	t.o.e.
Crude Oil	10.2	
LPG (Butane)	10.8	1.059
Gasoline	10.5	1.029
Jet Fuel	10.4	1.020
Kerosene	10.3	1.007
Gas Oil	10.2	1
Fuel Oil	9.7	0.951
Firewood	3.5	0.343
Charcoal	7.0	0.6863

Electricity
4000 kwh = 1 t.o.e. for hydroelectric supply on a thermal replacement basis (thermal efficiency 34.4%).

11,628 kwh = 1 t.o.e. (end-use calorific value).

a/ Exchange rate at time of mission. Rate used in the report, unless otherwise noted.

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SUMMARY AND PLAN OF ACTION

Introduction

1. This Energy Assessment Report summarizes the findings of a mission fielded in April 1986. 1/ It draws upon the diagnostic evaluations of several recent energy sector studies. 2/ Rather than duplicate these analyses, the mission chose to validate their findings and to use these as the framework for examining the most pressing energy sector issues in the aftermath of the 1985 oil price decline (para. 6-9). The resulting report defines a coherent action plan of priority recommendations for policy, operations, investment, and institutional reform.

Overview of Energy and the Economy

2. This report reflects written comments made by the Government in March 1987, as well as comments made during discussions with the Minister of Mines and Energy in August 1987. It should be noted, however, that the Government has taken numerous steps since these dates leading to implementation of the Energy Assessment's recommendations. The mission has attempted to make note of this fact wherever possible in the text, and regrets if any of these notations have been ommitted.

3. The People's Republic of the Congo possesses significant petroleum, hydroelectric, and forestry resources. Its petroleum reserves, estimated conservatively to lie between 1,065 and 2,050 million standard barrels, are the lifeblood of the economy. An extensive network of tributaries of the Congo river provides a large hydroelectric potential, which has yet to be totally assessed. Forested regions, which

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1/ Members of the assessment team were: Abderrezzak Ferroukhi (Mission Leader, Senior Energy Economist), David Craig (Deputy Mission Leader, Economist), Lori A. Perine (Researcher), G. A. Chamot (Consultant, Petroleum Exploration and Production), P. Parriaud (Consultant, Petroleum Refining and Distribution), J. Hatfield (Consultant, Electric Power), and Jean-Roger Mercier (Consultant, Biomass and Household Energy). Principal authors of the report were L. Perine and D. Craig.

2/ Two extensive analytic studies of the sector were consulted by the mission: The People's Republic of the Congo: Power Sector Memorandum, IBRD Report No. 5272-COB, September 28, 1984 (Update: June 1985) and Etude de rationalisation des choix energétiques, TransEnerg, December 1984.

include dense tropical forests in the north, cover two-thirds of the land area of the country.

4. Per capita energy consumption, 290 kilograms of oil equivalent (kgoe) in 1985, is low relative to countries of similar income. Wood fuels and other biomass account for 46% of net domestic consumption, petroleum products another 45%, and electricity and crude oil (the latter consumed by the petroleum industry) account equally for the remainder. Households and transport are the major consuming sectors, representing 50% and 23% respectively of final demand, which was about 575,000 tons of oil equivalent (t.o.e.) in 1985. The petroleum industry ranks third with 14% of demand. A steady decline in the energy intensity of the economy since 1978, despite rapid growth of total energy consumption during the economic boom from 1979 to 1982, reflects the low energy consumption by energy-intensive productive sectors not related to petroleum.

5. The energy sector plays a crucial role in the development of the Congo because the national economy is overwhelmingly dependent on the petroleum subsector. The revenues from oil production, and the public investments which they finance, have dominated the economy since 1979. By 1985, oil accounted for 40% of GDP, 90% of exports, and two-thirds of budgetary receipts. At the same time, accelerated government spending had culminated in an acute liquidity crisis and an unsustainable accumulation of foreign debt. The oil price collapse in late 1985 further exacerbated the deterioration of economic stability, prompting the Government to seek International Monetary Fund (IMF) assistance to restructure its economic and financial policies. Regardless of the success of the IMF-supported adjustment program, the influence of petroleum on economic development will continue into medium term.

Priority Energy Sector Issues

6. The Government notes that, even though the petroleum sector has an important impact on the entire national economy, the contribution of petroleum to the national energy balance is relatively small, if wood fuels are taken into account. Petroleum resources are considered primarly a "stategic material", as opposed to an energy source for local use. Consequently, the objectives of national energy policy give preference to the use of hydroelectric power, and an imported crude better adapted to the needs of the Congolese market is being sought to replace the local Djéno crude which the Compagnie Congolaise de Raffinage (CORAF) processes in its facilities. CORAF currently is testing imported crudes to determine their product pattern. Still, the level of crude oil production is a key factor in energy sector development. The relative costs of supplying petroleum products are influenced by use of locally produced crude (Chapter III), although the amount used to meet local needs is small relative to total production, it affects the costs of supplying petroleum products. Exports of crude oil are of even greater importance for the sector: this determines in large part the financial

resources available for priority energy investments, as well as for the total economy.

Impact of the Oil Price Decline

7. The weight of the oil sector in the economy will remain such that, during the next five years, any changes in oil prices or production will have a much greater impact on economic stabilization than the effects of policy reforms or supply responses in other sectors of the economy. Even under the most optimistic oil price scenarios (para. 2.10), oil production is unlikely to generate sufficient revenues to bring total government revenues back to 1985 levels by 1990 (Table 2.3).

8. Future oil production, and consequently government revenues from that production, are highly sensitive to the price of crude oil. The mission estimated the 1990 government oil revenues using two alternative price paths and corresponding estimates of production profiles for major fields (para. 2.11-2.13). In nominal terms, the government take in 1990 varies between 18% and 71% of the 1985 total (225 billion CFAF). These results illustrate the enormous multiplier effect of relatively small increases in oil prices--by stimulating increased output, and by taking the larger fields back above the breakeven point for petroleum income tax liability.

9. The level at which oil revenues can be maintained will be crucial to the timing and financing of future public sector investment. The Government is now obliged to review, modify and possibly defer portions of its investment program: (a) to take into account the sudden scarcity of resources; and (b) to support structural adjustments. Its petroleum strategy must be redefined to optimize revenue generation for sustained economic recovery. This objective can be achieved in the short term through strategies to reduce costs and improve revenue generation from current fields and to enhance the medium-term potential for further development as prices recover.

10. The recommendations delineated by the mission to address this issue (para. 2.29) have been accepted by the Government. Major components/strategies include technical assistance to: (a) improve the monitoring of petroleum operations (para. 2.14-2.15); and (b) review the legal and fiscal framework (para. 2.16-2.17); and feasibility studies for rapid development of low-cost reserves (para. 2.18-2.20). The mission's recommendations for exploration promotion are given high priority in the energy sector action plan below (para. 31). These items were incorporated in a Second Technical Assistance Project, which was slated for implementation in 1987-88 and financed by the World Bank.

Refining/Product Supply

11. Under the technical configuration and economic conditions of early 1986, local refining was not competitive with product imports (para. 3.7-3.9). It cost the economy between US$8 and US$12.5 million to refine products rather than to import. Various factors contributed to high ex-refinery costs: Technical factors such as the low volume of refinery throughput, unsuitability of the local crude, and poor energy efficiency increase the unit cost per ton of processed crude (para. 3.10-3.12). Uneconomic export of surplus fuel oil and stagnating local demand were the major marketing difficulties encountered (para. 3.10, 3.13). Stagnating local demand was a constraint to increasing refinery throughput. Excess fuel oil was marketed under terms which underestimated its potential market value. Finally, economic and financial difficulties arose from high operating costs, attributable primarily to excess expatriate technical assistance, and financial charges on credit extended for crude oil purchases and unsecured sales to HydroCongo (para. 3.14).

12. The mission recommended that, in order to reduce the cost to the economy of supplying finished products, the Government adopt a least cost solution for product supply, based on sound economic criteria. Products should be purchased at or near import parity, whether they are refined locally or imported (para. 3.15). As an initial step, the Government should establish its ex-refinery prices based on the cost of importing products (para. 3.25). Then, the Government should consider the following supply options: (a) CORAF delivers products to HydroCongo at the new ex-refinery price; (b) alternately, or if the first option is not viable, the refining facilities are sold or leased to an independant operator, the supply of refined products is open to competitive bidding (in which the refinery is free to participate) and CORAF is abolished; (c) alternately, or if neither (a) nor (b) is viable, import all finished products for as long as the cost of importing is more competitive than refining costs (para. 3.25). A new procurement system and mechanisms for monitoring the efficiency of refining and/or procurement would have to be established in all cases (para. 3.26).

13. Many of the measures recommended by the Energy Assessment and by subsequent World Bank missions have been implemented since 1986 to improve the management of CORAF and to reduce its operating costs. The Government is testing a lighter crude, Palanca from Angola, to replace the local Djéno crude. In addition, CORAF had reduced the number of expatriates in its staff by 14 as of August 1987. As CORAF is one of the public enterprises which has been targeted by the Bank's Public Enterprise Sector Adjustment Operation, the Government has committed itself to taking action beyond the recommendations of the Energy Assessment to reform CORAF management and the resolve associated problem of excessive refining costs.

Product Distribution

14. Petroleum product distribution, handled by HydroCongo, is plagued by excess distribution costs. These are largely the result of the disproportionate increases in HydroCongo personnel and financial costs since 1974, when HydroCongo took over the assets of the oil companies active in product marketing. The incentives for HydroCongo to streamline its operations are limited. Efforts to reduce costs have been hampered by the lack of a cost accounting system for each product, with separate identification of each cost item from purchase through to final sale (para. 3.16-3.17).

15. HydroCongo has received a large amount of specialized technical assistance in recent years and the actions required for financial rehabilitation of the enterprise are well defined. In addition to recommending the immediate implementation of recommendations arising from previous technical assistance, the mission suggests that: (a) HydroCongo's legal monopoly on distribution be eliminated; (b) as many of HydroCongo's functions as possible be sold or sub-contracted; and (c) HydroCongo's role be restricted to that of a wholesaler (para. 3.18). In addition, a cost accounting system must be introduced to aid in the development of a product price structure reflecting actual economic costs (para. 3.23). These recommendations have been incorporated variously in the World Bank's Second Technical Assistance Project for petroleum and its Public Enterprise Sector Adjustment Operation.

Product Prices

16. The recommendations for both refining/product supply and product distribution should facilitate the correction of distortions found in the current price structure (para. 3.21-3.22). Based on these changes, the mission is recommending that the Government build up new product price structures for each major point of delivery, and define a matrix of taxes and government subsidies to account for differentials (para. 3.23). The Government must clearly define its subsidization policies to strike a balance between revenue requirements of product distribution and desired price levels for retail prices (para. 3.23). At the same time, the Government should make constructive use of its fiscal policy to serve as a revenue generation mechnanism and to recover the rent arising from fluctuations in the major cost components (para. 3.22-3.23).

Power Subsector Strategy

17. The clarification of commercial and adminstrative functions is a priority for facilitating subsector planning and assuring coherent subsector management. SNE is legally responsible for all aspects of public electricity supply. However in recent years, the planning, financing and execution of all new major generation and transmission projects has been taken over by the MME. Under these circumstances, the "de facto" role of SNE has been reduced to maintaining and operating the

generation and transmission facilities handed over to it by the MME, although it still has full authority over distribution system investments. As there is no integrated planning of operations and investments, system development has been haphazard and costly, making complete recovery of generation, transmission and distribution costs impossible. Both parties regard the present arrangements as transitional and recognize that SNE must be strengthened before resuming full responsibility for public sector electricity supply.

18. The next step is for the Government and SNE to agree as soon as possible on the scope and financing of a program to restructure SNE and a timetable for its execution. A policy framework must also be developed so that sector investments reflect the least cost means of meeting demand.

19. Electricity tariffs have not changed since 1976 in most of the country, and since 1982 in the area served by the Moukoukoulou hydro plant (para. 4.13). They were reviewed by Electricité de France (EDF) in 1982, with the aim of simplifying the structure and increasing rates to bring them more in line with marginal costs. SNE is reluctant to increase rates without first improving its reliability of service. However, in light of SNE's financial and budgetary difficulties, the mission recommends that the tariffs be progressively raised by 30-50% as soon as possible. Other required actions are: (a) the EDF study should be updated on the basis of a least cost development plan and (b) an institutional mechanism should be introduced to ensure regular tariff revisions (para. 4.14).

20. There is significant potential to mobilize additional resources (para. 4.15) in the medium term through improved revenue collection (para. 4.11), reduction of technical losses in the distribution systems (para. 4.21), and increased sales. Timely completion of the Moukoukoulou interconnection (para. 18) and the distribution rehabilitation program will contribute to increasing sales, which are essential to SNE's financial recovery.

21. The power supply system operated by SNE consists of two independent networks centered on the country's two population centers (Brazzaville and Pointe Noire). The distribution systems for the two networks are in very poor condition due to saturation and insufficient maintenance. This is the major factor in the low reliablity of supply from SNE, which otherwise has few problems with either generation or transmission failures. These networks are being linked by a 225 kV transmission line, which should be operational by late 1988 (para. 4.5). Surplus capacity at the Moukoukoulou hydro plant (located near Loudima) then will be absorbed into the system, significantly reducing current need for imports from neighboring Zaire (para. 4.18).

22. In the short term, while the subsector is being restructured and strengthened, SNE should concentrate its efforts on: (a) obtaining the greatest economic benefit from existing productive assets; and

(b) achieving acceptable levels of reliability. A project to rehabilitate the saturated distribution systems in Brazzaville and Pointe Noire is underway (para. 4.21-4.22). Disbursements have slowed as the Congo adjusts to the fall in oil prices, and work is now scheduled for completion in 1990. Problems still remain, however, in regard to: (a) the deteriorating condition of existing hydro plant; (b) the lack of backup capacity at Pointe Noire; and (c) the absence of an operating strategy for the interconnected network.

23. The full power output from both of the major hydro plants, Moukoukoulou and Djoué (located in Brazzaville) will be utilized once the interconnection is finished. Rehabilitation work required for Djoué has been budgeted into SNE's work program over the period 1986-1989 (para. 4.28). At Moukoukoulou, extensive work is needed on ancillary equipment and on other problems which must be corrected to improve output and increase/maintain the reliability of generating capacity (para. 4.28).

24. The need for backup at Pointe Noire cannot be eliminated. In the meantime, SNE should investigate ways to increase the reliability of the single 225 kV/110 kV line which links the city to Moukoukoulou. The program of preventive maintenance must be reviewed to ensure future system reliability (para. 4.23). Reliability standards for the system must be developed and implemented through a least cost combination of investments in transmission reinforcement, private thermal backup capacity from major autogenerators (para. 4.29-4.39). SNE should complete all necessary studies and subsequent investments no later than 1990.

25. A system operations strategy will be needed to realize the full benefits of the interconnected system upon completion and ensure that there are adequate arrangements for system operations (para. 4.25). In addition, a central system control center (para. 4.16) should be defined and implemented which would be compatible with the local control centers planned for the Brazzaville and Pointe Noire distribution networks.

26. The mission has recommended as a high investment priority the timely completion of the interconnection, based on its review of the costs associated with delaying completion (para. 4.19). Other than this, no large investments in generation or transmission will be required in the power subsector in the short- to medium-term. Therefore, SNE should defer all investment plans pending the rehabilitation of existing infrastructure and the restructuring of subsector organization. This includes deferring investment plans for rural electrification until a comprehensive review of rural energy needs and supply options is undertaken. (para. 4.33-4.39). The requirement for investment in backup capacity at Pointe Noire should be examined as recommended above (para. 24).

Demand Management and Wood Energy Strategy

27. Authorities are concerned by the relatively high supply costs for wood fuels: (a) because they are perceived as a measure of the extent of area deforestation (para. 5.7); and (b) because of their impact on household budgets (para. 5.9; Table 5.4). Two strategies are available to the Government to reduce these costs: finding new sources of supply closer to the market or improving end-use efficiencies.

28. Justification for the first strategy is predicated on the assumption that wood fuel demand is a principal factor in area deforestation. According to the mission's estimates, however, the connection between wood fuel demand and deforestation is not yet significant (para. 5.4). In addition, this option does not reduce supply costs (para. 5.8). The mission recommends that no further outlays be made for peri-urban plantations until the necessity of these projects is confirmed within the context of a global analysis of wood fuel supply and demand (para. 5.29-5.30).

29. On the other hand, there appears to be considerable potential for using wood residues from existing plantations for charcoal production (para. 5.15-5.23). Utilization of "free" residues from plantation operations offer a substantial reduction in charcoal production costs. Any charcoal production projects developed in the short term would have to be export-oriented. However, an increased supply of low-cost charcoal is likely to stimulate local demand in the medium term. A national charcoal production and marketing strategy should be investigated and developed (para. 5.29).

30. The most promising strategy for reducing wood fuel supply costs in the short term is found in improving end-use efficiencies, primarily through improved stove technology. With adequate training, consumers using improved stoves can reduce the amount of wood consumed by 40% to 55% (para. 5.12), while incurring limited additional investment costs. The drawdown on wood resources also is reduced proportionately. A program of demand management centered on utilization of improved stoves should be initiated (para. 5.12-5.14; para. 5.29).

Priority Action Plan

31. These key elements of the mission's recommendations for the energy sector have been selected for priority implementation for the period to 1990.

Core Program for Public Investment

32. The following projects, all in the power subsector, should receive absolute priority in the investment budget until 1990:

(a) completion of the Loudima-Brazzaville transmission link;

(b) completion of rehabilitation and conversion to 20 kV of the Brazzaville and Pointe Noire distribution networks; and

(c) Projects defined by the priority investigations listed below (para. 34).

33. Projects that should be deferred and reviewed subsequent to other recommended actions include:

(a) Major hydro and transmission projects for rural electrification (Chapter IV);

(b) Peri-urban fuelwood plantations -- pending the completion of a comprehensive analysis of household energy demand and its role in wood consumption/deforestation (Chapter V).

Priority Investigations and Promotions

34. The following investigations and promotions should be launched during 1987/88: 3/

(a) A review of petroleum development strategy, including possible improvements to the fiscal framework (US$140,000);

(b) Exploration promotion of onshore acreage (the Kayes permit of the Coastal Basin, and the Central Basin) and 1987 offshore relinquishments (US$0.7-1.3 million);

(c) Design of a network operating strategy for the new Brazzaville-Pointe Noire interconnected system (US$60,000);

(d) Definition of the least cost arrangement for ensuring adequate security of supply for electricity consumers in Pointe Noire (US$60,000);

(e) Feasibility studies of (i) rapid development of low cost, onshore oil fields (US$40,000), and (ii) recycling of the offshore Litchendjili gas-condensate field (US$50,000);

3/ Since the Energy Assessment mission, two donors have expressed interest in financing the highest priority investigations in the power subsector: (a) the World Bank, through its proposed Second Technical Assistance Project; and (b) the UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), using funds to be provided by the French Government.

(f) Detailed design of a rehabilitation program for the Djoué and Moukoukoulou hydro stations (US$120,000);

(g) Preparation of a program to promote private production and marketing of high efficiency woodstoves for household cooking (US$450,000); and

(h) Economic and financial evaluation of charcoal production, initially for export, from existing plantations at Pointe Noire (US$150,000).

Institutional Reform

35. The Government should take advantage of the current period of adjustment to remove the main organizational constraints to efficient operations in the energy sector:

(a) New ex-refinery pricing and/or procurement arrangements should be introduced to ensure that petroleum products are supplied to the country at the lowest possible cost.

(b) HydroCongo should sell or subcontract as many non-core functions as possible.

(c) The Government and SNE should agree as soon as possible on the scope, financing and timing of a program to strengthen SNE; the medium term objective is for SNE to take complete responsibility for public sector commercial electricity supply.

(d) The Government should assess ways to promote private generation by entrepreneurs or consumer cooperatives.

Manpower Planning and Training

36. In parallel with the program of institutional reform, the following manpower planning and training activities should be launched as soon as possible:

(a) technical assistance and training to develop MME's capacity to monitor petroleum operations and HydroCongo's capacity to audit the accounts of joint ventures;

(b) training of a small group of senior Congolese staff in the principles and operating methods of international oil markets; and

(c) continued technical assistance to SNE to improve customer and financial management, and additional inputs for: (i) design of a technical assistance and training program for the SNE staff who will operate the new interconnected network; (ii) establishment of a manpower planning system and overall staff training plan; and (iii) establishment and training of a

I. ENERGY IN THE ECONOMY

Country Background

1.1 The People's Republic of the Congo covers a roughly "J"-shaped area of 342,000 km^2 in equitorial Africa. An extensive network of tributaries of the Congo River, which forms the border with Zaire to the west, provides the primary transportation link between the populous south and the densely forested Central Basin in the north.

1.2 Since before independence in 1960, the Congo has been distinguished by its high degree of urbanization. Nearly 55% of the total population of 1.91 million is found in urban areas, primarily in the capital, Brazzaville (595,000 inhabitants) and in the port-industrial city of Pointe Noire (297,000 inhabitants). Over 80% of the total population lives in the axis delimited by these two cities.

The Economy

1.3. The Congolese economy is dominated by oil. In 1985, oil accounted for 40% of GDP (944 billion CFAF in total), 90% of exports and two-thirds of budgetary receipts. Trade, transport and services account for the second largest portion (29%) of GDP; oil revenues spawned rapid growth of activity in these sectors after 1979. By contrast, non-oil productive sectors such as agriculture and forestry contribute only 7% of GDP. Agricultural output has fallen in real terms since 1979, while forestry, once the principal source of export earnings, has remained stable.

1.4 The GDP grew at an annual rate of 14.2% in real terms from 1979 to 1983, only to slow in 1984 and 1985 as oil output declined. Public investments, which had quadrupled from 1979 to 1984, were scaled down. As a result, the Government experienced an acute liquidity crisis and incurred substantial arrears in foreign debt in 1984 and 1985. The Government attempted to stabilize the economy with a "structural adjustment program" developed on its own and adopted in mid-1985. However, the oil price collapse in late 1985 caused the situation to deteriorate rapidly. Projected oil revenues for 1986 and 1987 tumbled respectively to one-third and one-fifth of 1985 levels (223 million CFAF). In mid-1986, the Government requested IMF assistance to restructure its economic and financial policies in order to wean the economy from its overwhelming dependence on petroleum revenues. Petroleum's medium term influence will continue to be great, however.

Energy Consumption Growth Patterns

Commercial Energy

1.5 Table 1.1 summarizes the evolution of total commercial energy (electricity and petroleum products) from 1978-1985. Consumption grew at an average annual rate of 6.15% during the economic boom, then dropped sharply in 1984-85. Per capita consumption displayed similar growth, as the growth rate of energy consumption outstripped that of the population. By contrast, the energy intensity of the economy marked a consistent decline. This reflects the general low growth of the (non-oil) energy intensive sectors of the economy. A breakdown of commercial energy consumption by fuel and product is presented in Annex 1.

Traditional Energy

1.6 There is no documentation of the evolution of consumption of traditional fuels, primarily wood fuels (firewood and charcoal). In most sub-Saharan African countries, the consumption growth rate is at least equivalent to the population growth rate. Recent growth rates may be slightly less, as commercial fuels gradually are being substituted for traditional fuels. Based on the mission's observations of per capita consumption (para. 5.9), current consumption of wood fuels is estimated at 770,000 tons/yr (wood equivalent), 97% of which is consumed by households. Interestingly enough, household consumption of wood fuels is primarily in the form of firewood; estimates indicate that only 11,000 tons of charcoal are consumed annually.

Present Demand Structure

1.7 The 1985 energy balance for the Congo (Table 1.2) gives the structure of demand. Wood fuels and other biomass represent 46% of net domestic consumption, petroleum products another 45%, and electricity and crude oil (the latter consumed by the petroleum industry) account equally for the remainder. By sector, households are the largest consumers, accounting for 50% of the final demand; over 85% of household demand is satisfied by wood fuels. Transport, the major consumer of petroleum products, contributes to 23% of demand. The other major energy consuming sectors are the petroleum industry and other industry, which contribute 14% and 10%, respectively, to final demand. It is interesting to note that the petroleum industry itself is the second largest consumer of petroleum products (22% of net consumption).

Table 1.1: COMMERCIAL ENERGY CONSUMPTION AND COMPARATIVE INDICATORS 1978 - 1985

	1978	1979	1980	1981	1982	1983	1984	1985
Commercial Energy Consumption ('000 toe)	250.10	245.40	261.56	270.61	304.45	335.18	291.35	300.00
Growth Rate (%/yr)		-1.88	6.58	3.46	12.50	10.10	-13.08	2.97
Per Capita Consumption (kgoe)	163	154	159	158	171	182	152	151
Energy Intensity (kgoe per CFAF) a/	0.90	0.80	0.73	0.61	0.60	0.64	0.51	0.54
Energy Coefficient b/		-0.19	0.37	0.14	0.96	2.80	-1.52	-0.96

a/ Energy consumed per CFAF of GDP. GDP in 1980 CFAF.
b/ Ratio of growth of commercial energy consumption to GDP growth.

Source: Annex 1.

Table 1.2: CONGO ENERGY BALANCE, 1985
('000 TOE)

	Primary Energy						Petroleum Products									
	Fuelwood	Agric Residues	Hydro	Crude Oil	Charcoal	Electricity	Gasoline	Kerosene	Jet Fuel	Gas Oil	Fuel Oil	Avgas	LPG	Other	Tot. Pet. Products	TOTAL
Gross Supply																
Production	277.00	6.12	70.96	5,847.00											0.00	6,201.08
Imports						7.25		22.62		9.40		0.88	0.56		33.46	40.69
Primary Exports				(5,226.00)											0.00	(5,226.00)
Stock Changes							(4.18)	(0.66)		(2.10)	(8.69)		(0.03)		(15.65)	(15.65)
Tot. Avail. Supply	277.00	6.12	70.96	621.00	0.00	7.25	(4.18)	21.96		7.30	(8.69)	0.88	0.53		17.80	1,000.12
Conversion																
Refining				(598.72)			99.18	34.29		126.30	339.77		4.19	8.33	572.06	(26.67)
Charcoal Prod.	(25.33)				7.60											(17.73)
Thermal Gen.						0.13				(0.65)					(0.65)	(0.52)
Hydro Gen.			(70.96)			24.41										(46.55)
Autoproduction										0.00					0.00	0.00
Trans. and Dist. Losses						(4.76)										(4.76)
Stock Changes							(0.78)	(0.13)		1.25	(1.76)	(0.03)	(0.55)		(2.00)	(2.00)
Net Supply	251.67	6.12	0.00	22.28	7.60	27.01	94.22	56.13		134.19	329.32	0.84	4.17	8.33	587.21	901.88
Secondary Exports											(288.74)				(288.74)	(288.74)
Bunker Sales							(0.20)		(24.04)	(12.10)	(3.07)	(0.00)			(39.41)	(39.41)
Net Domestic Cons.	251.67	6.12	0.00	22.28	7.60	27.01	94.02	21.22	10.86	122.10	37.51	0.84	4.17	8.33	259.06	573.73
Household/Comm	243.67				7.60	9.90		21.22		2.69			3.37		27.29	288.45
Transport							93.79		10.86	66.69		0.84			132.19	132.19
Petroleum Ind.				22.28						28.98	21.08			8.33	58.40	80.68
Other Industry	8.00	6.12				14.01				12.72	16.43		0.80		29.95	58.08
Agriculture										7.21					7.21	7.21
Public/Civil Works						3.10	0.25			3.80					4.03	7.13

II. PETROLEUM EXPLORATION AND DEVELOPMENT

Issues

2.1 Petroleum has provided the stimulus behind economic growth and has dominated the economy since 1979 (para. 1.3-1.4), to the extent that all plans for public sector investment now are contingent upon the continued ability to generate oil reserves. The Government notes that, even though the petroleum sector has an important impact on the entire national economy, the contribution of petroleum to the national energy balance is relatively small, if traditional fuels (e.g. fuelwood) are taken into account. The State's objectives include the gradual reduction of petroleum consumption relative to national energy consumption and the promotion of hydroelectricity, as well as use of a crude oil better adapted to the local refinery's configuration. In this context, the authorities responsible for the sector consider crude oil, produced for exportation, to be primarily a "strategic material" for generating resources for investments. The weight of the oil sector in the economy during the next five years, will remain such that any changes in oil prices or production will have a much greater impact on economic stabilization than the effects of policy reforms or supply responses in other sectors of the economy. The present chapter therefore outlines an action program to ensure that oil revenues make the maximum possible contribution to the resources available during the adjustment period and for national development in the medium term.

2.2 As background to the action program, the chapter (a) briefly summarizes the results of a recent review of the Congo's petroleum resources, and (b) examines the impact of alternative future oil price paths on oil production and oil-related government revenues. On the basis of this analysis, the mission proposes:

(a) an action program to develop petroleum production and revenues in the short and medium term; and

(b) suggestions for exploration promotion to ensure continuation of petroleum development in the longer term.

Petroleum Reserves and Production

2.3 The Congo has two sedimentary basins (Map IBRD 20005), the Coastal Basin (28,000 km^2) and the interior Central Basin or Cuvette (100,000 km^2). The Coastal Basin consists of an onshore segment (7000 km^2) with little oil production to date, an offshore shelf area (0-200 m) of about 7,800 km^2 with abundant production, and a deep offshore section (200-300 m) with no discoveries or production. The Coastal Basin geological section is divided by an evaporite layer (salt)

into a pre-salt lower section and a post-salt upper section. The bulk of the present reserves lies in the post-salt section where exploratory drilling is easier and cheaper. As it is remote and difficult to access, the only study of the Central Basin has been a reconnaissance airmagnetometric survey.

2.4 In total, about 540 wells have been drilled in the Congo, and more than 60,000 line-km of airmag and 50,000 line-km of seismic have been acquired and interpreted. A small gas and oil discovery at Pointe Indienne in 1958 was followed by major oil discoveries by Elf Congo in 1969 (Emeraude) and by Agip Resources Congo (ARC) in 1971 (Loango). In all, there have been 40 wildcat wells over structural leads with oil and/or gas shows; of these possible discoveries only 12 have been delineated and nine put into production. Despite the considerable exploration effort already undertaken, in 1986 there was still significant potential for adding new reserves:

(a) There are 22 discoveries yet to be delineated -- seven to ten could eventually be commercial, with potential reserves of about 250 to 500 million barrels.

(b) Approximately 26 known structures still have not been drilled.

(c) There is a high probability of discovering additional structures below the salt layer in the Coastal Basin, including a possible major field.

2.5 Known hydrocarbon reserves are located entirely in the Coastal Basin; about 91% are offshore. The estimates of remaining producible reserves of oil (including condensates) and non-associated gas from developed, delineated and non-delineated discoveries (36 oil bearing and 17 free-gas-bearing structures) vary according to the rate of recovery 1/ and the reserves-to-production ratio. They range from 1065 million stock tank barrels (STB) at low recovery rates to more than 2000 million STB. For non-associated gas, the estimates are around 800 million STB and 1634 million STB respectively, as of January 1, 1986. These estimates are conservative, since no allowance is made for promising indication of additional reserves.

2.6 Exploration permits as of January 1, 1986 are listed in Table 2.1. Exploration blocks (and production permits) are shown on Map IBRD 20005. The two main exploration permits are Madingo with Agip Resources Congo as the titleholder, and Pointe Noire Grands Fonds (PNGF) with Elf Congo as the titleholder. These two companies have a cross-

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1/ In effect, the recovery rates of Congolese crudes are variable and/or low for some fields (4% at Emeraude, without injection). The rates for other fields vary from 15 to 27%, depending on the recovery technique.

interest (65/35) agreement for all their operations. Both permits expired in November 1987. Amoco and Conoco also have active exploration permits offshore.

2.7 Oil production in the Congo began on a small scale at Pointe Indienne in 1960; the large, offshore Emeraude field started production in 1972. The nine fields in production in February 1986 produced at a rate of 115,000 b/d. All producing fields are in the Coastal Basin.

Table 2.1: LIST OF PRODUCTION PERMITS, 1986

Name	Company (with % interest)	Area (km^2)	No. of fields	Production (Feb. 1986) (b/d)
Pointe Indienne	Elf Congo (100)	10.7	1	134
Emeraude	Elf (65), Agip (35)	331.0	1	22,065
Loango E	Agip (65), Elf (35)	50.6	1/2	21,351
Loango W	Elf (65), Agip (35)	65.1	1/2	
Likouala	Elf (65), Agip (35)	63.4	1	18,965
Sendji-Yanga	Elf (65), Agip (35)	170.0	2	52,718
Mengo a/	Elf (85), HC b/ (15)	24.0	1	228
Kundji a/	Elf (85), HC (15)	98.7	1	179
Bindi a/	Elf (85), HC (15)	100.0	1	45
Tchibouela	Elf (65), Agip (35)	135.0	1	-
Zatchi	Agip (65), Elf (35)	n.a.	1	-

a/ Production from these fields is not subject to royalty calculation since their balance sheet is highly negative.

b/ HC = HydroCongo

Source: MME and HC

Impact of Oil Price Decline

2.8 The growth of oil production and total government oil revenues since 1980 is presented in Table 2.2.

Table 2.2 TOTAL OIL PRODUCTION AND OIL REVENUE

	1980	1981	1982	1983	1984	1985
Production (million bbl)	18.6	23.1	33.2	36.9	33.5	41.3
Revenue (billion CFAF)	72.6	133.2	150.7	180.8	213.3	224.5

Source: MF, MME, IMF mission.

2.9 Government oil revenues comprise royalties, petroleum income tax and, in some cases, after-tax profit on government equity participation. Each field is governed by an Exploration Agreement ("Convention") that establishes the royalty (14.5-17.5%), the income tax rate (55-75%), and the Government's participation (at least 50%), either directly or through HydroCongo. Profits and the royalty are computed on the basis of a fiscal reference price that is defined by the legal texts linking the companies to the Government. Approximately 80% of the tax due each year is paid within that year.

2.10 The mission retained two scenarios to illustrate the sensitivity of future oil production and government oil revenues to the price of crude. In terms of the Congo's fiscal reference price, the scenarios are (in current US$/bbl):

	1986	1987	1988	1989	1990
LOW	14	14	15	16	16
HIGH	15	17	19	22	25

On the basis of these alternative price paths, the mission estimated production/development expenditures and corresponding production profiles for each of the major fields. The main assumption underlying the low scenario is a slippage in the implementation of the two-stage Tchibouela development (76,300 b/d in 1990). The high scenario takes into account: (a) additional field maintenance resulting in improved yields; (b) full development of Tchibouela; (c) staged development of Zatchi; and (d) initial production in 1989 of Tchendo -- a field for which delineation is almost complete (130,600 b/d in 1990).

2.11 This information was taken as the basis for estimating government oil revenues from all sources, field by field. The consolidated results are presented in Table 2.3. In nominal terms the total government take in 1990 varies between 18% and 71% of the 1985 cash total (225 billion CFAF). These results illustrate the enormous

multiplier effect of relatively small increases in oil prices--by stimulating increased output, and by taking the larger fields back above the breakeven point for petroleum income tax in particular.

Table 2.3: GOVERNMENT PETROLEUM INCOME, 1986 - 1990 a/ b/

	1986	1987	1988	1989	1990
Low Price Path					
(billion CFAF)	33.9	32.1	44.5	53.8	40.1
(million US$)	96.9	91.8	127.3	153.7	116.4
	(15%)	(14%)	(20%)	(24%)	(18%)
High Price Path					
(billion CFAF)	37.7	44.3	72.6	95.1	160.0
(million US$)	107.8	126.4	207.5	265.9	457.2
	(17%)	(20%)	(32%)	(41%)	(71%)

a/ Figures in parentheses indicate nominal total as a percentage of total government take in 1985 (225 billion CFAF, cash basis).

b/ Totals may not add due to rounding.

Source: Mission estimates.

2.12 Oil revenues accounted for 67% of total government revenues in 1985. Under most plausible oil price scenarios for 1986, total government revenues will be less than half the 1985 total. Even under the mission's more optimistic price scenario, the rate of recovery of government revenues will be slow and will be only partially complete by 1990. In such difficult circumstances, the Government should take all possible steps to:

(a) reduce production costs and improve revenue generation from existing fields;

(b) increase revenues by promoting rapid development of small, low-cost reserves, where viable; and

(c) promote continued exploration so that delineated fields and new discoveries are available for development as soon as prices recover.

Petroleum Development Strategy

2.13 The mission recommends the following action program to optimize government oil revenues in the short and medium term:

(a) improved monitoring of petroleum operations on existing fields;

(b) review of the legal and fiscal framework including suggested accommodation of current agreements; and

(c) feasibility studies for accelerated development of low-cost reserves.

Monitoring Petroleum Operations

2.14 The Government's most immediate concern should be to improve its understanding of operating and financial costs on existing fields. The object is to explore whether these costs could be reduced in the near future and the Government's return thereby increased. Improved monitoring of petroleum operations by the Government would also increase its ability to verify costs declared for future tax assessments and to evaluate the costs and benefits of direct equity participation in future developments.

2.15 The Ministry of Mines and Energy (MME) is responsible for supervising the petroleum sector in the Congo. In some functions it calls on the assistance of the Exploration and Production Directorate (DRP) of HydroCongo. Despite the large numbers of professional staff available, particularly in HydroCongo DRP, there is a shortage of staff with the necessary skills to monitor oil company operations and to audit the accounts of HydroCongo's joint ventures. The mission recommends that the Government call in external expertise to assist with the following tasks:

(a) advise MME on the best arrangements to systematically monitor petroleum operations;

(b) provide on-the-job training for the senior professional MME staff selected for this function;

(c) advise MME, as the need arises, on specific monitoring issues requiring inputs from technical specialists;

(d) train HydroCongo DRP staff to audit the accounts of joint ventures.

Improving the Legal and Fiscal Framework

2.16 In the medium term, it may be possible to improve the profile of government oil revenues without reducing the incentives for exploration and development. At the time of the Energy Assessment Mission (April 1986), the Government already had prepared terms of reference for a study to review the development strategy for the Congo's petroleum reserves. The technical analysis is to be based on the recent study of reserves; the financial and economic analysis is expected to lead to proposals for improvements in the present contractual and fiscal framework. The options to be considered should include a change from concession to production sharing agreements on any other valid scheme for future developments.

2.17 In the short term, it may also be possible to negotiate adjustments of existing contracts with current operators. The study should examine various tradeoffs between royalty rates, amortization schedules, and treatment of financial charges.

Feasibility Study for Developing Reserves

2.18 The Government should investigate the feasibility of developing one or more of the oil fields located onshore near Pointe Noire, in the Loeme permit area of the Coastal Basin. The Kundji and Bindi fields, for example, have sizeable accumulations of light oil at depths of around 4000 ft. If further development of these small fields is shown to be viable, they could be brought into production in a very short time and thereby make a small (in the order of 10% of current production) but rapid contribution to the Congo's petroleum production and government revenues.

2.19 A second possibility to be investigated is liquids extraction from the Litchendjili gas field. This field is about 15 km offshore and may be suitable for condensate stripping using gas reinjection for pressure maintenance. If these conditions are confirmed, close to 50 million bbl of condensate could be recovered over a 10-12 year period. Limited use of the dry gas for power generation could also be considered (para 4.42-4.45).

2.20 The mission recommends that the feasibility of these options be assessed as soon as possible. The necessary studies could be undertaken by HydroCongo's current engineering advisers.

Petroleum Exploration Promotion

2.21 Recent exploration history indicates that the Congo has significant potential (relative to exploration and development areas in the northern hemisphere) for discovering and proving-up additional relatively low-cost reserves in existing producing areas (para. 2.5).

The Congo's immediate concern should be to exploit this comparative advantage to enhance exploration for additional reserves during the period of depressed prices. This level of exploration is essential to ensure that delineated fields and new discoveries are available for development as prices recover over the medium to longer term.

2.22 The mission assembled the following envelope of projections for total exploration expenditure over the period 1986-90 (in million US$): 2/

	1986	1987	1988	1989	1990
BASE CASE	65	70	70	80	100
IMPROVED PROMOTION	65	90	110	120	120

The difference between the two projections depends partly on the outcome of current work programs; the balance will be determined by the effectiveness of the Government's exploration promotion efforts between now and late 1988. In half the increment over the three years 1988-90 is attributed to successful promotion, the benefits amount to about US$100 million of additional exploration. The cost of strengthening and accelerating the Government's present promotion program is in the order of US$1 million. Until recently, the Congo's strategy for promoting free acreage has not been very active for the onshore Coastal Basin. In the difficult and unexplored Central Basin (Cuvette) it has been unsuccessful.

Coastal Basin

2.23 Offshore Relinquishments. Elf and Agip resumed exploratory drilling in early 1987, four to six wells (estimated at US$40 million), to drill a few untested structures before their initial PNGF and Madingo permits run out in November 1987. At that time, the companies had to relinquish all acreage other than their declared production permits. The freed acreage would be available to any interested oil company, including Elf Congo and/or Agip.

2/ These projections are not directly linked to the mission's 1986-1990 oil price scenarios, since exploration decisions are governed by a longer term view of oil reserves than decisions about oil development and production.

2.24 MME has started work on a promotion report dealing with offshore acreage and, in particular the Elf and Agip relinquishments in November 1987. A promotion meeting is planned for the fall of 1988.

2.25 Other Offshore Exploration. Amoco has made a farm-in agreement replacing Citgo and Braspetro in the Marine 1 permit. According to its 1986 work program, Amoco will conduct a joint offshore airmag with HydroCongo and Conoco, after which it will drill two wells (one with pre-salt objectives) in order to qualify for another exploration extension. Conoco is the other company active only in exploration, and has the only permit issued so far under the new petroleum law (Marine 2). After it participated in the joint offshore airmag in late 1986, Conoco then was committed to drill one or two wells into the pre-salt section.

2.26 If a discovery is made by either Amoco or Conoco, this will be followed by delineation drilling (perhaps four wells). If, however, both Amoco's wells and Conoco's well are dry, these companies probably will not seek to renew their rights when they expire. The free acreage then would become part of MME's overall promotion of the Coastal Basin in 1988. Ideally, the preparation of the promotion should include seismic reprocessing of significant Coastal Basin lines. However, this expenditure (approximately US$650,000) may have to be deferred until budget conditions improve.

2.27 Onshore -- Kayes Permit. MME currently is completing a promotion report for the onshore Kayes area and has plans to organize a promotion meeting. This effort should be coordinated with the other promotion activities, if at all possible.

Central Basin (Onshore)

2.28 MME's promotion in the Central Basin has been sporadic, individually targeted, based on a rather weak airmag interpretation, and lacking well-defined legal and fiscal terms. The mission recommends (a) reinterpretation of the 1980 airmag survey, and (b) external assistance for the preparation of a promotion report and organization of a promotion meeting.

Recommendations 3/

2.29 The mission recommends the following action program for petroleum exploration and development:

3/ These have been accepted by the Government and the principal recommendations have been incorporated in a Second Technical Assistance Project financed by the World Bank. The project will be implemented during 1987 and 1988.

(a) technical assistance and training to develop MME's ability to monitor petroleum operations and HydroCongo DRP's ability to audit the accounts of joint ventures (US$150,000);

(b) technical assistance to review petroleum development strategy, including possible improvements to the legal and fiscal framework (US$140,000);

(c) feasibility studies for development of onshore oil fields (US$40,000) and recycling of the offshore Litchendjili gas-condensate field (US$50,000)

(d) exploration promotion in the Coastal Basin -- free offshore acreage (US$0.6-1.2 million) 4/ and the Kayes onshore permit (US$100,000) -- including finalization of reports and organization of a promotion meeting;

(e) exploration promotion in the Central Basin (Cuvette), including reinterpretation of the 1980 airmag survey (US$135,000), finalization of the promotion report and organization of a promotion meeting (US$100,000).

4/ Upper estimate includes seismic reprocessing.

III. PETROLEUM PRODUCT SUPPLY AND DISTRIBUTION

Issues

3.1 The supply and distribution of petroleum products are the responsibility of two parastatal monopolies--CORAF and HydroCongo. Under the present institutional arrangements, there are no incentives for supplying petroleum products efficiently and at least cost. This chapter presents options for improving these arrangements and for redefining the product price structure to better reflect the economic costs of supply. The broad issues addressed are:

(a) The short-term marginal cost of supply from the refinery cannot compete with the cost of imported products, due to a number of technical, marketing, and economic/financial factors.

(b) HydroCongo's inland distribution of petroleum products is characterized by excessively high costs, attributable to the parastatal's poor financial discipline and overstaffing.

(c) This results in a number of distortions in the pricing structure, which are exacerbated by ill-defined or underutilized criteria for the application of subsidization and fiscal policies.

Organization

3.2 The supply and distribution of petroleum products is overseen by the Ministry of Mines and Energy (MME), which supervises the two parastatals operating in the sector, HydroCongo and CORAF. The Société Nationale de Recherches et d'Exploitation Pétrolières (HydroCongo) was created in 1974. It is an almost fully integrated national oil company and holds the monopoly for petroleum product distribution throughout the Congo. Specifically, HydroCongo has been entrusted with the tasks of (a) meeting the domestic demand for petroleum products and ensuring supply, and (b) managing efficient distribution operations. HydroCongo operates as a commercial concern, subject to public interest constraints related to national policy imposed by the MME.

3.3 The Compagnie Congolaise de Raffinage (CORAF) is a subsidiary of HydroCongo (60%) and the Société Nationale Elf-Aquitaine (40%). CORAF's statutes define its vocation as a refining company and monopoly supplier of finished products to HydroCongo. The MME's operating agreement with CORAF permits the import of products for meeting the local demand to make up for shortfalls in the refinery's production. The refining facilities operated by CORAF (para. 3.4) are entirely owned by the Government.

3.4 Refining Facilities. The Congolese refinery was designed in the early 1970s and the first trial commissioning was in 1976. A number of serious deficiencies were found in the design and construction at start-up, however, and claims were brought against the original construction consortium. HydroCongo directed subsequent repair work to bring the refinery on-stream in December 1982.

3.5 The characteristics of the refinery configuration and its offsite facilities at the beginning of 1986 are presented in Table 3.1. Conversion of one of the old strippers to a vacuum unit was completed in July 1986. This brought the feedstock capacity of the hydrocracker up to 12 tons/hr. Total processing capacity was reduced under the new configuration to 800,000 tons/yr.

Table 3.1: CORAF REFINERY CHARACTERISTICS

Facilities	Capacity
Processing units (Ton/hour)	
Atmospheric distillation	126 (Total)
Catalytic reformer	10
Overhead hydrotreater	19
"Mild hydrocracker"	12
Offsite facilities and storage	
Power generation (MW) (current needs : 2.8 MW)	4 x 3.2
Crude oil storage (m^3)	70,000
Product storage (m^3)	145,000

Source: CORAF.

3.6 In 1986, the refinery treated about 600,000 tons/yr of the locally-produced Djéno crude (28.4° API). Annex 2 shows CORAF's annual production pattern since 1982. Approximately 250,000 tons of finished products were supplied to the local market and over 300,000 tons of excess fuel oil were exported (para. 3.13). This costly mismatch between the refinery's production pattern and local product requirements will be avoided when the refinery uses another, lighter crude as feedstock (para. 3.11).

Competitivity of Local Refining with Product Imports

3.7 The mission compared the total annual costs associated with refining versus those of importing under fourth quarter 1985 and third quarter 1986 economic conditions. The refining costs for processing indigenous Djéno crude and imported Nigerian Bonny Light were considered for these two periods. The mission also estimated refining costs for the two crudes under a scenario of improved refinery management and operations, the details of which are discussed in Annex 4.

Table 3.2: COSTS OF LOCAL REFINING VERSUS IMPORTS a/
(thousand US$)

	Present Management/ Operating Conditions		Improved Operations and Reduced Costs	
Crude Type b/	Djéno	Bonny Light c/	Djéno	Bonny Light c/
Fourth Quarter 1985				
Refining Costs	90,223	84,815	80,133	74,725
Import Costs	75,371	75,371	75,371	75,371
Gain/(loss) in refining	(14,852)	(9,444)	(4,762)	646
Third Quarter 1986				
Refining Costs d/	47,884	52,389	35,711	40,216
Import Costs	39,898	39,898	39,898	39,898
Gain/(loss) in refining	(7,986)	(12,491)	4,187	(318)

a/ All assumptions and detailed calculations presented in Annex 4.

b/ Crude used on local refining option. The reference price for Djéno is as quoted to the mission during its visit.

c/ Bonny Light crude is used in the calculations for indicative purposes, in order to estimate the relative costs of processing a crude which is better adapted to the local demand profile.

d/ Operation of the new distillation tower was not considered in the calculations of the relative refining costs of processing Bonny Light in 1986; it would reduce costs, without altering the conclusions of the analysis.

e/ The Government revised the calculations for 1986 on the basis of modified hypotheses for the prices of crude and imported products. In each case, larger losses resulted. The revised figures are presented in Annex 4.

Source: Mission estimates.

3.8 The analysis shows that:

(a) Under the technical configuration and economic conditions for the period under consideration, local refining is not competitive with product imports. It costs the economy as much as US$10.3 million more to refine the products locally rather than to import them.

(b) No matter the economic conditions, CORAF's refining operations could only be marginally economic if large reductions are taken in operating costs (including financial charges).

3.9 In interpreting the mission's analysis, it is important to make the distinction between the profitability of CORAF's operations and the economic losses to the Congolese economy due to its product supply arrangements. Because ex-refinery prices are determined on a cost-plus basis (para. 3.21-3.22), CORAF does indeed make a profit on its operations. However, there are certain economic losses borne by the Government due to the fact that the CORAF refinery is its only supply source, and it purchases products from this source at a cost considerably higher than that at which it could import products: according to the detailed analysis in Annex 4, that cost is currently at least US$8 million annually ($10.3 million according to the Government's own calculations), assuming third quarter 1986 economic conditions. Given the many steps which could be taken to reduce refining costs and make CORAF's operations more efficient (para. 3.10-3.14; Annex 4), a national subsidy at such levels cannot be justified, even by social objectives. Furthermore, the current system for setting ex-refinery prices offers no incentive to CORAF for reducing its costs. A more appropriate formula for setting ex-refinery prices is one of the mission's recommendations (para. 3.25).

Factors Contributing to High Refining Costs

3.10 Low Capacity Utilization. The domestic Congolese market is the only market supplied by the refinery. Due to limited demand in this market, the refinery is run at only 60% of its optimal processing capacity (800,000 tons/yr) when processing Djéno crude. If a lighter crude was processed, throughput would be even lower (320,000 tons). The possibilities for substantially increasing throughput in the short- to medium-term are limited: local demand is expected to stagnate, and there is little potential for increased sales to external markets. In addition, the mission's analysis indicate that even with an increase in throughput, the competitivity of local refining relative to product imports will not necessarily be enhanced due to CORAF's high fixed operating costs.

3.11 Unsuitability of Local Djéno Crude. The locally-produced Djéno crude is relatively heavy, with a high fuel oil content. Even with the recent addition of conversion facilities, fuel oil yield represents more than 50% of the crude throughput. The local market for fuel oil being

very limited, well over 300,000 tons are exported annually to industrialized countries under unfavorable financial terms (para. 3.13). According to the mission's analyses in Annex 4, 320,000 tons of a crude similar to Bonny Light processed to meet the local product demand would yield 71,000 tons of fuel oil, of which only 48,000 tons would have to be exported. The refinery intends to import Palanca crude starting in 1988; the fuel oil yield should thus be reduced.

3.12 High Energy Consumption. Although major technical deficiencies were corrected before the refinery was brought on stream (para. 3.3), the refinery design still does not provide for sufficient energy recovery. Energy efficiency (fuel consumption and hydrocarbon losses) is relatively poor, reaching 5.8% of crude processed in 1985, as compared with a standard of 4.0% in similar facilities. The low efficiency is caused mainly by poor heater design and inadequate process heat recovery. The newly rehabilitated heat exchange system of the crude distillation unit (para. 3.5) will only reduce energy consumption by 0.4% of crude processed. In late 1985, CORAF was also considering a project of heat recovery from furnace flues. The economic viability of such a project is less certain due to lower crude prices.

3.13 Uneconomic Export of Surplus Fuel Oil. Under current marketing terms, the surplus fuel oil is sold for considerably less than the international market value. Fuel oil is marketed through a long term contract with a trader. The export price is based on NWE FOB (Rotterdam) prices with a premium for its low sulphur content (0.3%), but also includes a penalty for its high viscosity (630 CS 50° C). These terms could be improved by instituting a system of periodic tendering for the export contract. The mission estimates that between $5 and $10 more per ton could be obtained by opening fuel oil exports to competitive bidding under modified marketing terms. This credit for improved marketing of excess fuel oil is included in the mission's detailed analysis (Annex 4).

3.14 Economic and Financial Factors. Under current institutional and operational conditions, there are no incentives for reducing costs. The refinery is under no obligation to supply products at least cost and has no competition for supplying the local market. Apart from the cost of crude, which is supplied at the FOB export price, the refinery operating costs (at US$24.3 million) are unusually high, even in comparison with operating costs of similar hydroskimming refineries in Africa (US$6-10 million). These charges include: (a) variable costs for utilities, chemicals, and catalysts; (b) fixed costs for personnel, maintenance, overhead, and technical assistance expenses; and (c) financial charges on credit to HydroCongo and interest charges on working capital. All of these charges amounted to about US$40.5/ton of processed crude in 1985/86; 25% of this amount is attributable to technical assistance. The Government has already begun to implement measures which will lead to a substantial reduction in the refinery operating costs, as indicated in Annex 4. Many of these actions, including reductions in personnel costs, are being monitored under a

Public Enterprise Sector Adjustment Operation financed by the World Bank. Refinery operations may prove economically viable, once other cost cutting measures such as processing more suitable light crude, improved product pattern, energy conservation, etc. are implemented.

Conclusions

3.15 There is no question that action must be taken to modify the system for supplying finished products, given the high cost to the economy of the present system (para. 3.9). The Government should adopt a least cost supply solution to bring the economic costs of product supply in line with the opportunity costs of supplying products from alternate sources. This solution should be based on sound economic criteria: products should be supplied to the country at or near import parity, whether they are refined locally or imported. The mission identified a series of options which are based on the establishment of an appropriate ex-refinery price that reflects this economic criteria, and which will allow the Government to achieve the objective of least cost product supply. These options and a suitable formula for ex-refinery prices are presented in the action plan in para. 3.25-3.26.

Petroleum Product Distribution

3.16 The costs of inland distribution operations managed by HydroCongo are very high and account for a significant proportion of the total economic cost of supplying petroleum products (Table 3.3; Annex 6). In April 1986, for example, gas oil transport and other distribution costs as a proportion of the import parity price ranged from 71% on the coast (Pointe Noire), to 86% after 520 km of rail transport to Brazzaville, to 197% after river transport to Ouesso, a remote inland location 1475 km from the coast. Even allowing for the logistical difficulties of transport in the Congo, these costs appear high relative to neighboring countries.

3.17 The main causes of the excess distribution costs are the disproportionate increases in HydroCongo personnel and financial costs since 1974, when HydroCongo took over the assets of the oil companies active in product marketing. Similar problems are found throughout the public enterprise sector in the Congo and reflect the ambiguity of parastatal objectives and the lack of financial discipline associated with soaring government revenues during the early 1980s. These problems have been targeted under the Pulbic Enterprise Sector Operation Adjustment.

3.18 HydroCongo has received a large amount of specialized technical assistance in recent years, and the actions required for financial rehabilitation of the enterprise are well defined. In principle, HydroCongo has been implementing a rehabilitation plan since 1982; in practice many of the main objectives have not yet been achieved. The mission therefore recommends that:

(a) the main recommendations arising from earlier technical assistance be implemented as soon as possible; the major items include: (i) separate the Direction of Research and Production (DRP) from HydroCongo's marketing functions, granting it autonomy in its budget, cost accounting, and operations; (ii) reduce HydroCongo's manpower to a level more adapted to its work requirements; (iii) provide technical assistance to the Direction of Finance to develop mechanisms for increasing the creditworthiness of both HydroCongo's marketing operations and the DRP; and (iv) provide technical assistance to develop HydroCongo's abilities to make full audits (technical and accounting) of joint venture expenditures; and

(b) reduce the cost of petroleum product distribution by: (i) restricting HydroCongo's role to that of a wholesaler and reducing its manpower to suit this new role; and (ii) selling or subcontracting HydroCongo's functions in product transportation and its retail outlets.

3.19 At the time of the energy assessment mission, HydroCongo:

(a) owned and operated all major depots;

(b) entrusted its rail tank wagons to the Agence Transcongolaise de Communications (ATC)--the transport parastatal--for product transport from Pointe Noire to Brazzaville;

(c) owned and operated two of the six 200 m^3 barges used for product transport upstream of Brazzaville;

(d) owned and operated a 500 m^3 fleet of road tankers for dry season bulk transport and for final dispatching to large consumers and filling stations; and

(e) owned and operated a number of filling stations.

3.20 The main scope for moving some of these functions outside the public enterprise sector lies in:

(a) subcontracting bulk transport and final delivery by road to private companies, preferably with competitive bidding on a regular basis;

(b) selling HydroCongo's remaining interest in retail outlets;

(c) selling HydroCongo's two barges or renting them to ATC.

All of these measures are being considered by HydroCongo. The mission recommends that they be evaluated and implemented as soon as possible.

Petroleum Products Price Structure

3.21 Petroleum product prices are set by the Government on the basis of a cost structure prepared by HydroCongo. The prices are characterized by uniform national prices and cross-subsidization among products to the benefit of kerosene and bunker sales. Ex-refinery prices are computed on a cost basis to take into account the cost of crude oil and all actual refining expenses. A theoretical selling price is established based on ex-refinery prices, with the addition of taxes, distribution costs (including HydroCongo's operating expenses, financial charges and wholesale margin), and the retail margin. The final retail price is then adjusted according to the requirements for subsidization. Table 3.3 compares the official retail price with the estimates of the economic costs of delivering products to various locations throughout the Congo; a breakdown of the elements of the retail price is presented in Table 3.4.

3.22 The mission found in its analysis of the current pricing structure that:

(a) Ex-refinery prices are quite distorted and very high in comparison to import parity (para. 3.7-3.9; Table 3.5) and do not accurately reflect the actual costs of refining individual products.

(b) Distribution costs are very high relative to neighboring countries (para. 3.16) and account for a significant proportion of the retail price. Although these costs are not itemized under the current pricing system, it appears that they can be attributed largely to poor financial discipline and overstaffing at HydroCongo (para. 3.17).

(c) Product transport costs vary widely by location and product, and it is the Government's policy to subsidize product distribution to remote locations through use of a uniform retail price. However, since HydroCongo does not itemize its expenses, there is no systematic methodology for allocating these costs in the calculation of the collective distribution costs for each product.

(d) The Government makes little use of fiscal policy to generate revenues from petroleum product sales: taxes range from only 1.5% of the price of gasoline to less than 0.2% for gas oil.

(e) The combination of poor cost accounting by HydroCongo and underutilization of fiscal policy means that any rent arising from fluctuations in the major items which comprise the economic costs of supply (crude prices, transport and distribution costs) is absorbed entirely by HydroCongo and/or CORAF.

Table 3.3: PETROLEUM PRODUCT PRICES AND COSTS BY GEOGRAPHIC LOCATION
April 1986
(CFAF/liter)

Product	Official Retail Price	Pointe Noire	Brazzaville		Oyo		Ouesso	
		Economic Cost a/	Transport Differential b/	Economic Cost a/	Transport Differential b/	Economic Cost a/	Transport Differential b/	Economic Cost a/
Butane c/	320	347	23	411	74	514	107	552
Gasoline	295	87.5	12	102.5	29	147.5	40	157.5
Kerosene	170	94.3	13	104.3	31	154.3	42	164.3
Gas Oil	195	95.9	13	103.9	32	155.9	44	165.9
Fuel Oil	115 d/	80.9	15	96.9	--	--	--	--

a/ CIF import prices, plus estimated distribution costs relevant to Hydro Congo operations, including transport costs.
b/ From Pointe Noire, excluding turnover taxes.
c/ CFAF/kg.
d/ Wholesale price.

Source: HydroCongo, Mission estimates.

Table 3.4: PETROLEUM PRODUCTS PRICE STRUCTURE: MID 1986
(CFAF/liter)

Product	Ex-refinery price	Taxes	Distribution costs a/	Total cost	Compensation (subsidization)	Retail price (official)
Gasoline	131.0	4.3	61.3	196.6	98.4	295
Kerosene	136.0	0.3	58.4	194.7	(24.7)	170
Gas oil	132.2	0.3	60.3	192.8	2.2	195
Butane b/	61.5	0.1	225.1	286.7	33.3	320
Jet Fuel	136.0	0.3	50.6	186.9	(33.9)	153

a/ Including taxes on transport.
b/ CFAF/kg.

Source: CORAF.

Table 3.5: PRODUCT PRICES - EX CORAF VERSUS IMPORTS
(Average 1985)

	Gasoline	Kero/Jet	Gas Oil	Fuel Oil	Butane
Ex CORAF a/					
CFAF/ton	185,708	180,723	166,390	86,523	86,523
$/ton b/	413	402	370	192	192
Imports ($/ton)					
Ex Rotterdam	293	289	266	193	625
Ex Italy	291	286	259	186	625
Ratio CORAF/Import	1.40	1.40	1.40	1.0	0.29

a/ Djéno crude price = US$26.04/bbl.
b/ 1985 (average) US$1 = 450 CFAF.

Source: Mission estimates.

3.23 The mission's recommendations for the supply and distribution system, including ex-refinery prices based on import parity (para. 3.15-3.25) and elimination of HydroCongo's distribution and marketing monopoly, should help ease the distortions in the pricing structure. In addition to these changes, it is imperative that HydroCongo take immediate action to set up an analytical cost accounting system for each product, with separate identification of each cost item from purchase through to final demand. This is a prerequisite for greater transparency in the actual costs of product supply. This information then should be used to:

(a) build up new product price structures for each major point of delivery with provisions for periodic adjustments; and

(b) define a matrix of taxes and government subsidies to account for differentials between costs and consumer prices at each location.

The latter point is especially important: the Government must clearly define its subsidization policies to strike a balance between the revenue requirements of product distribution and desired price levels for retail prices. At the same time, the Government should make constructive use of fiscal policy to serve as both a revenue generation mechanism and an incentive to lower cost product supply and distribution.

3.24 A specific problem arises in the case of LPG. Total consumption in 1985 was about 4000 tons, well below the 6000 tons/year that could be produced when processing Djéno crude. For this reason, CORAF has been selling LPG at the same price per ton as fuel oil. The import parity cost of LPG in small volumes (less than 10,000 tons/year) has been in the order of three to four times the CORAF selling price since the refinery came on stream in December 1982. Despite recurring shortages of LPG cylinders, the LPG market grew at around 9% annually over the same period. If this growth rate is maintained, LPG consumption will reach the 6000 tons/year limit in four to five years. Incremental consumption would then have to be supplied by imports at an extremely high cost. The mission recommends that import parity pricing of LPG be phased in as soon as possible to restrain demand growth and ensure that LPG in only consumed by those who are able to pay the full marginal cost of supply. This strategy is compatible with the Government's other development objectives, since (a) LPG consumption is concentrated among higher income households (para. 5.9), and (b) slower growth of LPG consumption will have practically no impact on deforestation (para. 5.2-5.5).

Recommendations

Refining/Product Supply

3.25 The mission recommends the following action program for petroleum supply and distribution. As a first step to reduce the costs of supplying refined products, ex-refinery prices should be set to reflect the costs of importing products. A suitable formula could be:

(a) Average of mid-Platts Oilgram quotations for cargos CIF NWE for each product during the period;

(b) Plus a freight and insurance factor of US$10-15/ton (this brings the price to import parity for the countries of West Africa from Dakar to Luanda);

(c) Plus US$8/ton terminalling and maintenance cost and operator profit;

(d) Plus US$1.50/ton port cost;

(e) Plus a capital recovery factor for any investments required to allow efficient handling of products.

The Government then should consider three options for its product supply arrangements:

(a) CORAF would be required to deliver products to HydroCongo at this price. This implies that CORAF will have to implement measures to reduce substantially its operating costs, if its operations are to remain financially profitable. The operating agreement would have to be modified accordingly. The Government has taken steps to promote this solution through improving CORAF's management and operations.

(b) Alternately, or in the case that CORAF cannot or is not willing to meet this requirement, the Government should lease or sell its refining facilities to an independent operator. HydroCongo, or another appropriately defined unit (para. 3.26 (a)), would be required to supply refined products through periodic international tenders. CORAF could participate in the bidding and conceivably could constitute all or part of the period supply contract, if it could deliver products at the stipulated ex-refinery price. Contractual arrangements with the refiner should be made according to standard industry practices and should also reflect conditions specific to the Congolese product supply system, including a requirement for handling and storage of imports at Pointe Noire for an agreed throughput charge on occasions when other suppliers win the period supply contract.

(c) Alternately, or if none of the conditions of options (a) and (b) can be met, it would be more economic for the Government to import petroleum products as long as local refining remains uncompetitive due to international market conditions and refining costs. In this case, the Government should review and revise its storage requirements, and adapt the existing capacity accordingly.

3.26 In all cases, a procurement system will have to be established for imports of crude or products. The mission recommends that:

(a) appropriate institutional arrangements for petroleum procurement be developed for inviting competitive quotations;

(b) the MME's ability to monitor the efficiency of refining and/or procurement, distribution and marketing be strengthened through reinforcement of existing units or, if more appropriate, the creation of a new unit within the MME. This unit should coordinate its activities with the Ministry of Finance and the Central Bank for budgeting;

(c) Under supervision of the unit, HydroCongo be responsible for negotiating and implementating contractual arrangements for product supply.

Appropriate technical assistance and training in commercial negotiations, procurement activities and petroleum intelligence for both MME and HydroCongo will be needed.

Product Distribution

3.27 The main recommendations arising from earlier technical assistance to HydroCongo for financial rehabilitation should be implemented as soon as possible. In addition,

(a) HydroCongo should sell or subcontract as many functions as possible (para. 3.18-3.20), and its role should be restricted to a product wholesaler. Regional depots and holding stocks will continue to be owned and operated by HydroCongo. HydroCongo will monitor retail distribution and implement government marketing policies.

(b) HydroCongo should set up an analytical cost accounting system and proper management information systems; cost information should be used to set up new petroleum price structures.

Product Prices

3.28 On the basis of the ex-refinery prices and HydroCongo's cost accounting system, the Government should define a new price structure for each major point of delivery adjusted periodically, which reflects the economic costs of supply. The Government should make constructive use of fiscal policy to generate revenues and avoid windfall profits to supply and distribution companies. Clearly articulated subsidization and fiscal policy should be used to define a matrix of taxes and subsidies, to be applied to the pricing structure and to account for differentials between costs and consumer prices at each location. In the case of LPG, the mission recommends that import parity pricing be phased in as soon as possible. This type of measure corresponds to the Government's own objective of using pricing policies to stimulate and develop the use of local energy resources other than oil.

IV. POWER SUBSECTOR STRATEGY

Issues

4.1 The present chapter outlines an action program to address the three main areas of immediate concern in the electric power subsector:

(a) the need to strengthen the national power utility (SNE) as part of a program to give the power subsector an unambiguous and commercially efficient organizational structure;

(b) the need to mobilize additional financial resources from consumers and private investors to avoid cuts in essential expenditure on maintenance, rehabilitation and increased capacity reserves; and

(c) the need to concentrate all power investment expenditure until 1990 on plant rehabilitation and other measures to restore reliable electricity supply to consumers in the main urban load centers.

4.2 At the Government's request, the mission also briefly reviewed two issues of medium to long term strategy:

(a) the need to develop a rural energy strategy and to define the role of rural electrification in that strategy; and

(b) the need to evaluate the possibility of using natural gas for baseload electricity generation in the longer term.

Electricity Demand and Supply

4.3 The following sections briefly summarize electricity demand and supply patterns in the Congo. Annex 5 contains additional background information on: (a) SNE and private autogenerator plant; (b) load growth scenarios to 1995 with corresponding energy and capacity balances on the SNE interconnected system; and (c) an estimate of the marginal cost of generation.

4.4 Consumption of electricity is concentrated in the two main urban centers. Total estimated electricity sales in 1985 were 315 GWh, of which Brazzaville accounted for 151 GWh (48 %), and Pointe Noire 133 GWh (42 %). Business, government and parastatals, and households are the three main groups of consumers. About half of total sales are at low voltage. The statistics available on electricity sales and generation are incomplete, unreliable and distorted by restrictions in power supply.

They are of limited value for forecasting future demand or for identifying unbilled sales and losses in the transmission and distribution systems. 6/

4.5 The SNE operates a public supply system consisting of two independent networks -- Brazzaville and Pointe Noire-Loudima-Bouenza-N'Kayi -- and 15 small isolated load centers (Map IBRD 18242). The Brazzaville load (38 MW in 1985) is served by a small run-of-river hydro plant (Djoué, 12-15 MW), and a 225 kV interconnection with the Inga hydro plant in Zaïre; approximately 2 MW of the thermal capacity is available as reserve. The main components of the Pointe Noire/southwest system (40 MW total load in 1985) are the Moukoukoulou hydro plant (74 MW installed, about 23 MW firm), 110 kV transmission to Loudima and nearby towns, and nearly 150 km of 225 kV tranmission from Loudima to Pointe Noire. The Brazzaville and Pointe Noire/southwest systems are in the process of being linked by a 225 kV transmission line, and the resulting interconnected system is expected to be operational by late 1988.

4.6 The distribution systems in Brazzaville and Pointe Noire operate at 30 kV and 6.6 kV. Both distribution systems are in very poor condition due to saturation and insufficient maintenance. Distribution outages are a more frequent cause of nonsupply to consumers than failure of either generation or transmission. Poor reliability of supply has compelled many consumers to maintain their own private capacity, either for baseload generation or as backup during outages in the public supply system. In 1983 estimated total installed autogeneration capacity was 12 MW in Brazzaville, 35 MW in Pointe Noire and 5-10 MW in the rest of the country.

Organization and Finance

4.7 While rehabilitation of the physical assets of the power system is urgently required, it is equally important to reform the organizational and financial structure of the subsector to ensure its future operations. The operating agency in the subsector (SNE) needs to control sufficient financial and human resources to sustain adequate maintenance, adopt sound operating procedures, and possess sufficient capacity margins. This can only be achieved by (a) rebuilding SNE into a commercially viable enterprise with some degree of financial and managerial autonomy, and (b) mobilizing additional financial resources from consumers (through tariff increases) and private investors--through direct participation in electricity supply.

6/ SNE projections for 1985 were based on distribution losses equal to 20-25% of sales, of which approximately one third was believed to be unbilled sales.

Differentiating Commercial and Administrative Functions

4.8 According to the 1967 legislation under which it was established, SNE is responsible for all aspects of public electricity supply, subject only to the usual requirements of shareholder control, i.e. the "tutelle" (supervision) of the Government. In practice, in recent years the Ministry of Mines and Energy (MME) has taken over the planning, financing and execution of all new major generation and transmission projects. Under these circumstances, the present 'de facto' role of SNE is: (a) to maintain and operate the generation and transmission facilities handed over to it by MME, and (b) to plan, finance, execute and operate its own electricity distribution systems.

4.9 The organization of the electric power subsector in the Congo should be improved in the following areas:

(a) A mechanism should be developed to ensure that the total investment program for public electricity supply--MME's program for generation and transmission, plus SNE's program for distribution--is the least cost means of meeting public demand. This requires integrated planning of operations and investments, preferably by an autonomous commercial organization with clear financial objectives.

(b) There is a need for a financial mechanism to ensure that the full cost of generation, transmission and distribution is reflected in the final cost of electricity to the consumer. The simplest way to achieve this would be: (i) to make SNE responsible for all future debt contracted for investments in electricity supply; (ii) to remove all Government budget support to SNE other than equity injections negotiated as part of the financing of the least cost investment plan; and (iii) to require SNE to operate commercially, i.e., to pay duties, taxes and dividends at the same rates as the Congolese private sector.

(c) The "contrat de programme" between the Government and SNE should be finalized for 1988 and renegotiated annually thereafter. If necessary, the Government would directly finance the non-commercial activities imposed on SNE within this framework, such as electrification of secondary centers.

Strengthening SNE

4.10 The present arrangements are regarded as transitional by both MME and SNE. Both parties recognize the need for SNE to be strengthened to take complete responsibility for public sector commercial electricity supply. The next step is for the Government and SNE to agree as soon as possible on the scope and financing of an action program to restructure SNE and a timetable for its execution. External financial support will be required.

4.11 The main components of the program would be:

(a) A review to straighten out the relationship between SNE and the Government; and preparation of relevant legal texts.

(b) A review to clarify the relationship between SNE and its customers, and between SNE and other electricity producers; and preparation of standard texts and contractual conditions regulating SNE's electricity sales and purchases.

(c) Continued technical assistance to improve customer management and related aspects of financial management.

(d) Progressive implementation of the recommendations of the 1983 organizational review; establishment of a manpower planning system -- definition of skill requirements, inventory of existing personnel, development of a staff training plan with special emphasis on technical training of skilled operators.

(e) Establishment of an integrated system planning group for generation, transmission and distribution; establishment of a planning database covering sales (including major customers), generation (including autogeneration), and supply costs; followed by substantial on-the-job training as part of the preparation of a 15-20 year system development plan.

Resource Mobilization

4.12 Even before the decline in oil prices in late 1985, recurrent expenditure and investment in the power subsector were limited by the availability of finance, namely SNE's net cash generation and the Government's investment resources. As a result, SNE was able to finance only a part of essential expenditures needed for periodic maintenance, equipment rehabilitation and installation of standby capacity. In the present economic environment, there is a severe risk that these essential functions will decline to a dangerously low level unless additional financial resources are mobilized from some source other than the Government. While some of the measures needed to promote improved medium term cash generation are already planned or being implemented, these should be complemented: (a) by an immediate tariff increase, and (b) by modifying SNE's monopoly powers so that autogenerators can supply electricity to SNE.

4.13 Electricity Tariffs. Electricity tariffs have not changed since 1976 in most of the country, and since 1982 in the area served by the Moukoukoulou hydro plant. In mid 1985 it was estimated that a rate increase of 25-30% was required to balance the operating budget. A larger increase would have been required for SNE to contribute to its investment program. The tariff structure is quite complex and composed of a series of declining blocks within each voltage category, adjusted according to regional differentials. The basis for these differentials

presumably is tied to the status of the generating and distribution systems in 1976. Furthermore, the structure requires the use of two meters per customer. Tariffs bear little relation to the marginal costs of supply associated with the present and planned regional allocation of generating capacity, transmission and distribution infrastructure.

4.14 SNE's tariffs were reviewed by EDF in 1982 with the aim of simplifying the tariff structure and increasing rates to bring them more into line with marginal costs. However, SNE has been reluctant to increase any rates without first improving the reliability of its delivery systems. This position is untenable in the present crisis. The following measures are required: (a) electricity rates should be raised by 30-50% as soon as possible; (b) the EDF study should be updated on the basis of a least cost system development plan once SNE's financial objectives have been defined (para. 4.9(b) and 4.11) and (c) an institutional mechanism should be introduced to ensure regular review and update of electricity tariffs in line with changes in economic and financial costs.

4.15 Medium Term Cash Generation. In the medium term there is significant potential to mobilize additional resources through improved revenue collection (para. 4.11), reduction of technical losses in the distribution systems (para. 4.21), and increased sales. From the moment the Moukoukoulou hydro plant is connected to Brazzaville (probably in late 1988), SNE's variable operating costs will fall to a very low proportion of total costs. A high proportion of revenue from additional electricity sales will therefore flow through into net cash generation. Timely completion of two investments is essential if increased sales are to contribute to SNE's financial recovery--first the Moukoukoulou-Brazzaville interconnection, and second the distribution rehabilitation program. Unsatisfactory quality of supply appears to be the main constraint on increased sales.

4.16 Private Suppliers of Electricity. At present SNE has a monopoly on public electricity supply; private electricity supply is confined to autogeneration, either as a baseload alternative to SNE supply or as backup. No particular role is envisaged for private sales of electricity in the expansion of the electricity system. There are several possibilities for increasing the contribution of private energy suppliers and SNE's monopoly powers should be modified to allow these options to considered. The objective is to retain the economies of scale associated with a strong integrated national power utility, but at the same time to take advantage of capacity or energy contributions from private suppliers in the specific circumstances where they have a comparative advantage. Examples are given in the following sections; these include:

(a) autogenerator backup for SNE, as part of an interim package to improve security of electricity supply in Pointe Noire (para. 4.29); and

(b) in the longer term, private baseload supply to SNE if supplies of natural gas become available (para. 4.40) at a low enough cost to undercut the "base case" expansion plan--electrical energy imports plus 100% capacity backup (Annex 5).

Rehabilitation/Reliability of Supply

4.17 Additional baseload energy plant is not immediately required for the SNE interconnected network (Annex 5). In the period until 1990, electricity expenditure (investment, investigations and training) should be entirely devoted to (a) obtaining the greatest economic benefit from existing productive assets, and (b) achieving acceptable reliability at all levels of the existing supply system.

4.18 SNE's most important single asset is the Moukoukoulou hydro plant (4 x 18.5 MW installed). In 1985 only about half its maximum energy output (400 GWh/yr) was absorbed by the SNE system. At a cost of about US$13 million (April 1986), completion and commissioning of the Loudima-Brazzaville transmission link therefore will bring two main benefits:

(a) Moukoukoulou's low cost surplus energy and power will be transferred to Brazzaville, thereby reducing the cost of electricity imports from Zaire.

(b) In the event of difficulties with SNE generation facilities, imported energy and power will be available not only to Brazzaville but also to Pointe Noire and other load centers in the southwest.

4.19 Delaying completion of the Loudima-Brazzaville line had been considered as a response to the recent economic crisis. The mission made a simplified comparison of the costs and benefits of allowing the completion of the line to slip by two years. The main costs of the delay would be the additional payments for imported electricity. The main benefits would be deferment of capital expenditure, net of contract suspension costs. Under most plausible assumptions the costs of the delay would exceed the benefits by at least US$5 million. 7/ The mission therefore recommends that timely completion of the transmission line, installation of telecommunication equipment and creation of a central system control center (para. 4.26) receive the highest possible priority in the power subsector investment budget.

7/ Present value in 1986, assuming 1986 selling price from Zaire and 10% discount rate.

4.20 In the absence of a more complete planning database, other expenditure priorities should be set in accordance with the potential impact on improved reliability. In order of severity the most immediate bottlenecks are:

(a) the condition of distribution networks in Brazzaville and Pointe Noire;

(b) the vulnerability of Pointe Noire to outages on the transmission line linking it to the Moukoukoulou hydro plant;

(c) the absence of an operating strategy for the new Pointe Noire-Loudima-Brazzaville interconnected system; and

(d) the deteriorating condition of the Moukoukoulou hydro plant.

These problems are briefly described below, along with the mission's recommendations.

Urban Distribution Bottlenecks

4.21 The distribution networks in Brazzaville and Pointe Noire are both saturated and worn out. Operations, maintenance and repairs are also handicapped by a variety of voltages installed at different periods. For these reasons SNE has embarked on a program of rehabilitation and conversion to a standard voltage of 20 kV. Aside from improved reliability, the adoption of 20 kV will increase the networks' transit capacity by a factor of three to five, thereby allowing them to absorb between 10 and 20 years of load growth. SNE load forecasts also include a reduction of distribution losses to 13% by 1990. In Pointe Noire the rehabilitation includes a short extension of the incoming 220 kV transmission line to a substation on the other side of the 20 kV network. This second point of injection will improve the reliability of supply in the event of minor distribution incidents.

4.22 The total cost of the program is about US$15 million. Implementation began in 1985 with financing from the Caisse Centrale (CCCE). Disbursement has been slowed down as part of the Congo's adjustment to the fall in oil prices and work is now expected to be completed in about 1990. The mission recommends that the rehabilitation program remain in the core program for public sector investment and to be executed according to an accelerated schedule.

Transmission/Backup at Pointe Noire

4.23 SNE currently cannot provide firm backup to Pointe Noire during outages on the single 225 kV transmission line (300 km long) linking it to the rest of the interconnected system. There will continue to be a need for back-up as long as there is only a single line (Annex 5). The following investigations and follow-up are urgently required:

(a) Steps to improve the reliability of the Loudima-Pointe Noire line; and adoption of the preventive maintenance program.

(b) A detailed inventory of private autogenerators in the Pointe Noire area; analysis of their reliability requirements and the scope for integrating their plant into SNE's backup capacity (para. 4.29-4.32); negotiation of special contracts governing electricity supply to and from major autoproducers.

(c) Definition of reliability criteria for SNE supply in Pointe Noire; analysis to determine the least cost combination of investments in transmission reinforcement, thermal backup capacity and from major autoproducers.

(d) In the event that additional thermal capacity is required for Pointe Noire, analysis of the option of baseloading the thermal plant using natural gas.

(e) A study of the option to link Inga and Pointe Noire via a 220 kV line (using the material available for Brazzaville-N'go, if necessary).

4.24 SNE should aim to complete the necessary investigations as soon as possible. Ideally the investigations should be part of more comprehensive study to develop a 10-15 year system expansion plan. However, certain feasibility studies of hydro sites, such as the Bouenza control dam, should be undertaken first.

System Operations Strategy

4.25 Once the Loudima-Brazzaville 225 kV link begins operating in mid-1988, SNE will have responsibility for an interconnected network which is more complex than the present two separate grids. The full benefits of this system will not be realized unless there are adequate arrangements for system operations, installation of required telecommunication equipment, and development of a central system control center. Additional work is required to ensure the existence or adequacy of: (a) protection systems; (b) a load shedding plan to cope with drops in frequency; (c) arrangements to maintain stable links with Zaire; and (d) a voltage control plan for different situations.

4.26 The recommendations arising from this investigation should be embodied in a proposal for the creation of a central system control center. The center would have to be compatible with the local control centers that are planned for the Brazzaville and Pointe Noire distribution networks; it would also have to be able to meet the system's control needs up to 1995 by means of relatively simple extensions. An essential part of the proposal would be to define:

(a) the systems, methods, procedures and operating instructions for the central control center;

(b) technical assistance needed to help SNE build, commission and operate the center; and

(c) a medium term training plan for the SNE staff involved in system operations and maintenance.

Rehabilitation of Existing Hydro Plant

4.27 The full output of the Djoué hydro plant is absorbed by the Brazzaville network. After completion of transmission from Loudima to Brazzaville, the bulk of the energy and power capability of the Moukoukoulou hydro plant will be absorbed by the interconnected system. Under these conditions it is important that the full power output of both hydro plants be available. The rehabilitation required at Djoué is reasonably well defined and SNE has budgeted about US$3.2 million to complete the work program over the period 1986-89. Serious problems have been identified at Moukoukoulou and shoudl be remedied immediately.

4.28 Moukoukoulou's effective capacity is at present reduced by the need for repairs on one of its 4 x 18.5 MW sets. Extensive work is needed on ancillary equipment and on preventing leaks developing around the outlet valves. In addition the station is suffering from the effects of cavitation at low loads. Much of the station's recording, communications and voltage regulation equipment is also obsolete. At the time of the mission, consultants had been hired to make a preliminary report on these problems and SNE had tentatively budgeted about US$ 3 million for rehabilitation work in 1986 and 1987. Completion of the recommended rehabilitation work and regular maintenance thereafter should be given the highest possible priority in SNE's budget.

Autogenerator Backup for SNE

4.29 The power subsector strategy recommended by the mission includes installation of thermal backup capacity in Pointe Noire as soon as possible (para. 4.23-4.24). The need for backup capacity will continue after the completion of the Pointe Noire-Brazzaville interconnected system in mid-1987, since the Pointe Noire network will remain vulnerable to outages on the single 225 kV line linking it via Loudima to the main sources of generation. Given the present difficulties of financing new SNE capacity at Pointe Noire, the possible contribution of autogenerators in Pointe Noire should be evaluated as a means of reducing (a) the extent of total blackouts during the period until SNE installs adequate thermal backup at Pointe Noire, and (b) the total amount of backup capacity to be installed by SNE.

4.30 The two main groups of captive plant in the Pointe Noire area are at the Elf Congo crude oil export terminal at Djéno and at the CORAF refinery. In both cases there appears to be excess capacity potentially available as backup to the SNE system. In 1985, Elf Congo purchased 15 GWh from SNE and operated a 5 MW gas turbine fueled by natural gas as baseload to generate about 36 GWh; 2 x 3.6 MW diesels (running on crude

oil) and 4 x 1 MW diesels (running on gas oil) were available to supply the remaining requirements (about 21 GWh) and as backup for periods of nonsupply from SNE. Under some circumstances Elf Congo's diesel capacity would be sufficient to cover an SNE outage and at the same time supply power to other consumers in the Pointe Noire area. CORAF maintains 4 x 3.2 MW of diesel capacity; this plant runs on heavy fuel oil and supplies a baseload of about 2.8 MW.

4.31 Evaluation of autogenerator backup should proceed by the following steps:

(a) assess more precisely the available surplus capacity;

(b) evaluate the additional investments and operating procedures required to allow the two autogenerators to inject their surplus power into the SNE grid;

(c) compare the marginal cost of operating the autogenerator's plant during a power outage with the variable costs to SNE of operating a gas turbine or other backup; and

(d) discuss with Elf Congo and CORAF suitable legal and contractual frameworks for supply to SNE before the commissioning of SNE's new thermal backup.

4.32 Preliminary indications are that the SNE may be able to offer US$50-75/kW/yr for the right to call on autogenerator capacity during transmission outages. If such an offer were attractive to both parties, this stopgap measure would allow SNE to defer the installation of some of the capacity that is immediately required at Pointe Noire.

Rural Electrification

4.33 The term "rural electrification" is used here to mean small load centers in the same size range as SNE's existing secondary centers. The Government's stated objective is to improve the quality and quantity of electricity supplied in existing secondary centers and to extend electricity supply to other, generally smaller, centers. These objectives should be re-examined in the context of the Government's national development strategy and the role of rural energy supplies in that strategy. Two of the relevant national development objectives are, first, to integrate isolated communities into the mainstream of the Congolese economy, and second, to promote a better balance of economic activity between rural and urban areas.

Rural Energy Supplies

4.34 Possible rural energy problems in the Congo include:

(a) frequent disruptions of the supply of transport fuels;

(b) need for pumping energy for water supplies;

(c) need for hot water and small-scale refrigeration units in health centers;

(d) need for electricity in key economic activities; and

(e) the high cost of household fuels--fuelwood, charcoal, kerosene, LPG--and the poor reliability of supplies of kerosene and LPG in particular.

4.35 Only some of the energy problems cited above can be solved by electrification of rural areas. The mission suggests the following guidelines for developing a rural electrification program:

(a) The Government agency responsible for energy policy (MME) should pay as much attention to improving rural supplies of petroleum products and biomass as to rural electrification.

(b) MME should re-examine the institutional options for promoting rural electrification and, in particular, the role assigned to SNE for investments and taking charge of financing deficits.

(c) Where direct government investment is required, the level of expenditure should reflect its low priority relative to basic infrastructure and social services.

Technical Options

4.36 Most of the technical solutions for meeting rural electricity needs have been tested in the Congo. Choices have to be made on a case by case basis between:

(a) transmission links from existing distribution centers to the main interconnected system;

(b) a central generation unit (diesel, micro/minihydro, or wood-fired) and distribution system; and

(c) decentralized systems such as photovoltaics, either (i) without battery backup, for low head, low volume water pumping, or (ii) with full battery backup, for small refrigerators in isolated health centers.

4.37 The centerpiece of the Government's present rural electrification strategy is the extension of the main interconnected network to the secondary centers north of Brazzaville--from Djambala to Makoua. The distances involved are such that a transmission system of approximately the same size as the Pointe Noire-Loudima-Brazzaville network would be required. The limited amount of information available on potential load growth (i.e., population densities, incomes, etc.) and costs suggests that this strategy would not be justified by the level of demand for several decades.

4.38 During the period until 1990, the Government should develop a more detailed strategy for the next decade. MME should compile a comprehensive database and at the same time analyze:

(a) load characteristics in existing secondary centers;

(b) population density and potential demand for electricity in all rural locations;

(c) micro/mini-hydro resources--streamflow data, development costs, distance from load centers, transmission costs, need for diesel backup;

(d) availability of wood and wood waste (sawmill or logging residues--Chapter V) for power generation--(i) vegetation density, (ii) wood location and ownership, (iii) cutting, delivery and handling costs, (iv) moisture content and combustion characteristics, and (v) capital and operating costs of available wood-fired generating plant; and

(e) results of photovoltaic demonstration projects in the Congo.

4.39 The rural electrification strategy that emerges from this analysis should result in:

(a) short 110/35 kV extensions of the existing system to the secondary centers within economic connecting distance from the Pointe Noire-Brazzaville interconnected system; and

(b) interconnecting links between secondary centers to establish small isolated networks, where economically justified.

Natural Gas for Power Generation

4.40 It is likely that the least cost expansion plan for the interconnected system will include backup gas turbine capacity in Pointe Noire. It will not be economic to operate this plant, other than during capacity shortfalls or emergencies unless the variable operating cost (principally fuel) is lower than the cost of electrical energy imports

from Zaire. This costs approximately 10 CFAF/kWh 8/--9 CFAF/kWh plus transmission losses. This ceiling translates to approximately US$83/ton for gas-oil or US$2.0/MSCF for natural gas.

4.41 In April 1986 (with crude at approximately US$13.5/bbl) the economic cost of gas-oil was estimated at US$190/ton (imported) or US$450/ton (ex-CORAF). The economic cost of natural gas delivered to a power plant near Pointe Noire is not known. Given the limited reserves remaining in the small onshore gas field at Pointe Indienne, this cost would be heavily dependent on the cost of replacement gas. The gas available in the untreated crude oil arriving at the Djéno terminal is already committed to meeting oil industry requirements for generating power and to supplement the crude used as fuel in the water removal process. Replacement gas would therefore have to come from development of new fields such as the nearby offshore gas fields.

4.42 Condensate production and power generation are the only two gas uses that are likely to justify a new field development. Table 4.1 summarizes the possible gas consumption for power generation in 1995. At the maximum demand price of US$2.0/MSCF, the gas sales revenues would be in the range US$3-15 million/yr. Condensate sales would therefore have to provide the bulk of the revenues required for development of a new field. 9/ A preliminary investigation of the role of power generation in gas development should be undertaken as soon as possible, preferably as an integral part of the strategy for improved power supply reliability at Pointe Noire (para. 4.23-4.24).

4.43 The development of gas-fired power generation would create an opportunity for a major institutional innovation in the power subsector, that is, private baseload supply to SNE. If supplies of natural gas become available for power generation at a sufficiently low cost, a choice could then be made between two options:

(a) gas-fired power generation by SNE on the basis of a take-or-pay gas contract between SNE and the gas producer; or

(b) gas-fired power generation by a private company on the basis of a take-or-pay power contract between the company and SNE.

8/ The marginal cost may be lower than 10 CFAF/kWh since Zaire is offering power at a lower price to uses; this may include incremental supplies to existing users.

9/ Mission estimates indicate that the Litchendjili field could produce condensate revenues of $50 - 60 million/yr at $15/bbl. If these estimates were confirmed, joint condensate and gas sales (to SNE) could justify a field development of up to $250-300 million.

The second option should be examined as early as possible in the process of evaluating natural gas as a baseload option for the SNE interconnected system.

Table 4.1: POSSIBLE GAS CONSUMPTION FOR POWER GENERATION, 1995 a/

Demand Scenario	Energy Demand	Hydro Generation b/	Energy Deficit	Natural Gas Equivalent c/
	(GWh)	(GWh)	(GWh)	(billion SCF)
Low	634	520	114	1.6
High	1,071	520	551	7.7

a/ Summarized from Annex 7.
b/ Full output from Moukoukoulou.
c/ Assuming natural gas with calorific value of 1000 BTU/SCF is used in gas turbines with heat rate of 3500 kcal/kWh.

Source: Mission estimates.

Recommendations

4.44 The mission recommends the following strategy and action program for the power subsector. 10/

Organization

4.45 The Government and SNE should agree as soon as possible on the scope, financing and timing of an action program to strengthen SNE and differentiate its role; the medium term objective is for SNE to take complete responsibility for public sector commercial electricity supply.

Resource Mobilization

4.46 The present measures to improve SNE's net cash generation in the medium term should be complemented by:

10/ Since the Energy Assessment mission, two donors have expressed interest in financing the highest priority items: (a) the World Bank, through its proposed Second Technical Assistance Project, and (b) the UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), using funds to be provided by the French Government.

(a) in the short term, an immediate tariff increase of at least 30%; and

(b) in the longer term, an increased role for private electricity supply in those parts of the market where it is shown to have a comparative advantage.

Priority Investments

4.47 Two projects should receive absolute priority in the power subsector investment budget:

(a) completion and commissioning of the Loudima-Brazzaville transmission link and a central control center; and

(b) completion of rehabilitation and conversion to 20 kV of the Brazzaville and Pointe Noire distribution networks.

4.48 Other priority investments will be defined by the investigations listed below.

Investigations

4.49 Immediate. Investigations and detailed design should be launched and/or completed as soon as possible in three key areas:

(a) definition of the least cost arrangements for ensuring adequate security of supply in Pointe Noire;

(b) design of (i) a network operating strategy for the new Brazzaville-Pointe Noire interconnected system, (ii) a central system control center for the interconnected system, and (iii) a technical assistance program and training plan for SNE staff involved in system operations; and

(c) detailed design of a rehabilitation program for the Djoué and Moukoukoulou hydro stations.

4.50 Medium-Term. Additional investigations are required to define policy and investment strategy in two key areas:

(a) A medium-term (1990-2000) strategy is required for rural electrification. Major investment projects (hydro and transmission) should be deferred indefinitely, and public sector participation should be redefined (i) after consideration of other rural energy objectives--reliable supply of petroleum products, more efficient use of biomass, etc., and (ii) as an appropriately small part of the overall rural development budget.

(b) The prospects for using natural gas from a future gas-condensate development should be evaluated as a possible alternative to (i) increased electricity imports from Zaire, and (ii) future hydro development such as Imboulou.

(c) The feasibility of a 220 kV link between Inga and Pointe Noire should be studied.

V. WOOD FUELS AND HOUSEHOLD ENERGY

Issues

5.1 The mission identified the following major issues concerning the rational exploitation and consumption of wood as an energy resource. They include:

(a) deforestation around Brazzaville, its relation to wood fuel demand and impact on wood fuel prices;

(b) household energy strategies for managing wood fuel demand;

(c) use of existing wood plantations for energy (charcoal) production; and

(d) efficient use of surplus wood residues from commercial and industrial forestry operations.

Deforestation in Brazzaville

Wood Fuel Demand and Area Deforestation

5.2 Although there is no official documentation of the phenomenon, the forests around Brazzaville have become less dense, and in some cases have disappeared entirely. A striking example of this pattern is the Patte d'Oie forest, which originally covered 300 ha between the city and the airport. Now, only 51 ha of lightly forested area remain. The depletion of other forests in the region is less dramatic, but has been noted both in official and informal circles.

5.3 A 1975 survey of household energy (para. 5.9), based on the assumption that wood fuel demand was the major cause of local deforestation, recommended the development of peri-urban plantations to supply wood fuels to Brazzaville. The technical feasibility of a 15,000 ha plantation was studied and confirmed in 1982. The CCCE, main potential donor for the project, recently has commissioned a second study, with emphasis on project design to integrate the plantation into the rural/agricultural systems. The final project originally was to be implemented by the "Projet Bois de Chauffe", an ad hoc team of 24 set up within the Congolese Forestry Office (CFO) specifically for this project. The CCCE indicated at the time of the mission, however, that the Unité d'Afforestation Industrielle du Congo (UAIC), which to date has had extensive and successful experience with large plantations (para. 5.17), would be responsible for both the feasibility study and project implementation.

5.4 No evidence has been gathered in the interim to determine the actual contribution of Brazzaville's wood fuel demand to deforestation. The mission's own estimates would indicate that the direct contribution, for the moment, is minimal: current annual consumption is well below the sustainable production of natural forests. Rather, prevailing agricultural land use patterns, especially the slash-and-burn technique widely used to prepare land for planting, appear to represent a greater threat to natural forests. As more and more of the forest area is cleared for agricultural uses, however, projected wood fuel demand may eventually exceed sustainable production of remaining forests, thus accelerating the deforestation caused by agriculture.

5.5 The mission believes that a large-scale peri-urban plantation project would be premature at this point, when the extent and causes of deforestation, especially as they relate to wood fuel demand, have not been established. If, as the mission's initial estimates suggest, deforestation can more directly be attributed to agricultural practices, a large-scale plantation project will not relieve the pressure on the natural forests, and thus its impact deforestation is likely to be marginal. No further outlays should be made for peri-urban plantations until the necessity of these and other projects directly linking wood fuel strategy to deforestation is determined within the context of a global analysis of: (a) competing uses for land and wood resources; (b) supply and distribution systems for wood fuels; (c) wood fuel demand; and (d) current and projected resource availability.

Impact on Wood Fuel Prices

5.6 The retail prices of commercial wood fuels, found almost exclusively in urban areas, are set by the market. Retail prices observed in Brazzaville are high relative to other West African countries. Charcoal prices are exceptionally high, which may account for its limited consumption (para. 1.6). As little is known about the charcoal industry, it is not certain what special considerations may be reflected by this price.

5.7 Retail prices tend to underestimate economic costs, as the cost of the resource itself is rarely included in the price. Authorities are concerned by the relatively high supply costs for wood fuels because they are perceived as a measure of the extent of area deforestation, which in turn is reflected in the burden of energy costs to consumers (Table 5.4). The costs of transport and distribution alone account for up to 80 % of both the retail price and the economic costs of wood fuels (Table 5.1). The perceived impact of deforestation may be overstated, however, as poor road conditions are also a major factor in transport and distribution costs.

Table 5.1: COMPONENTS OF WOOD FUEL PRICES
(CFAF/kg)

Component	Firewood		Charcoal	
	Price	Econ. Cost	Price	Econ. Cost a/
Resource b/	--	3	--	20
Production c/	6	6	28	28
Transport	9	9	15	15 d/
Distribution	15	15	117	37 e/
TOTAL	30	33	160	100

a/ Costs of production at Pointe Noire used as a proxy value.
b/ Resource costs normally are not accounted for in retail prices.
c/ For firewood, refers to the observed retail price at the roadside, which comprises primarily cutting costs. For economic costs of charcoal, represents estimated carbonization costs.
d/ Transport to Brazzaville from Pointe Noire.
e/ Based on experience in neighboring countries.

Source: Mission estimates.

5.8 There is little scope for sucessfully reorganizing the existing transport and distribution system to effect a reduction in these costs. The alternatives are either to reduce supply costs by producing wood at locations closer to the market, or to reduce the costs paid by consumers by improving the utilization efficiency. The schemes under consideration to achieve the former, notably peri-urban energy plantations for Brazzaville (para. 5.3), do not reduce significantly costs: transport costs would decrease by, at best, one-third; and the addition of resource costs would bring the total supply cost to at least 30 CFAF/kg, equivalent to current retail prices. The related cost of useful energy to the consumer remains the same. Increased efficiency of wood fuel consumption, on the other hand, translates into a lower overall demand in households. With adequate training, consumers using improved stove technologies could decrease the quantity of wood fuels consumed, while incurring limited additional investment costs. The relevant cost per unit of useful energy would be reduced proportionately. Thus, this option would appear to be the most effective solution. It is discussed as part of the household energy strategy presented below.

Table 5.2: HOUSEHOLD ENERGY CONSUMPTION OF PRIMARY COOKING FUELS

Income	Average Household Size	Number b/	Electricity a/ Percent using	Firewood Percent using	Firewood Annual Consumption	Charcoal Percent using	Charcoal Annual Consumption	Kerosene Percent using	Kerosene Annual Consumption	LPG Percent using	LPG Annual Consumption
(kCFAF/month)	(persons)		(%)	(%)	(kg/cap/yr)	(%)	(kg/cap/yr)	(%)	(kg/cap/yr)	(%)	(kg/cap/yr)
less than 40	6.6	16	25	55	334	0	0	25	45.8	30	4.2
40 to 60	8.2	20	40	60	325	20	60.8	15	67.3	55	10.2
60 to 80	6.2	17	47	53	278	24	18.5	47	36.3	59	11.4
80 to 100	6.6	13	85	38	137	69	21.4	85	31.1	77	20.6
100 to 120	7.2	16	88	44	97	75	18.9	69	15	94	19.4
more than 120	8.6	23	78	35	146	70	15.2	78	25.6	87	35

a/ Per capita consumption could not be estimated on the basis of information collected in the survey.
b/ Number of households in survey falling into the income category.

Source: Mission Household Survey.

Household Energy Strategy

Characteristics of Energy Utilization

5.9 Partial surveys conducted in 1975 in Brazzaville, and in 1983 at Pointe Noire, give a rough description of household energy use. The mission completed a preliminary survey of 125 households in Brazzaville to reconfirm and/or update observations of energy consumption patterns and found that:

(a) Households generally use more than one fuel to satisfy energy demand.

(b) Demand and the pattern of consumption are directly related to income, as shown in Table 5.2: Upper income households are three times more likely to have access to electricity and to use LPG and/or charcoal. However, the per capita consumption of charcoal is up to three times greater in lower income households which consume that fuel. Per capita consumption of firewood and kerosene is also quite high in the lower income households which consume them, supporting previous observations that these are the principal household fuels.

(c) In lower income households, the relative demand for fuels does not correspond directly with their ranking according to either the retail price or the economic cost per unit of useful energy (Table 5.3). This would indicate that other factors, such as equipment costs and ease of purchase, are more influential in the choice of fuel.

(d) Lower income households tend to use fuels which can be purchased in small quantities (firewood, kerosene sold in small bottles), with a relatively small outlay of cash at the time of purchase. However, because these purchases are more frequent, the total energy costs of these households are not significantly different from those with higher incomes. Thus, the proportion of the household budget spent on energy can be up to three times greater in the lower income households.

(e) The equipment (stoves, utensils) for fuels used by lower income households are less expensive, but have lower conversion efficiencies.

Interfuel Substitution

5.10 The rankings in Table 5.3 indicate the scope for substitution among cooking fuels. The mission's survey showed that in terms of the total consumption of useful energy in households, the ranking is almost identical to the ranking by price, except that the order of firewood (with traditional stoves) and LPG is reversed. This is probably a

reflection of the income bias in the survey, which had proportionately more upper income households than the actual population. Nevertheless, total consumption appears to follow price signals, which encourage utilization of kerosene in low-income groups and LPG (a much cleaner burning fuel) for higher incomes. In terms of economic costs, however, charcoal, if supplied from new sources (para. 5.15-5.23), would actually be favored over both firewood and LPG.

Table 5.3: COOKING FUELS IN BRAZZAVILLE - FINAL ENERGY PRICES/COSTS a/ c/

Rank	Retail Price		Economic Costs	
	Fuel	CFAF/kgoe	Fuel	CFAF/kgoe
1	Firewood (improved stove)	312	Firewood (improved stove)	344
2	Kerosene	482	Kerosene	409
3	Firewood (existing stove)	583	Charcoal (improved stove)	486
4	LPG	671	Charcoal (existing stove)	607
5	Charcoal	777	Firewood (existing stove)	641
6	Electricity	928	Electricity	b/
7	Charcoal (existing stove)	971	LPG	1,005
8	Firewood (open fire)	1,093	Firewood (open fire)	1,203

a/ Extracted from Annex 9, which contains all relevant calculations and notes.
b/ See note e/ of Annex 9.
c/ Implementation of import parity pricing for petroleum products will reduce the price of kerosene (but not change its ranking in the retail price list) and will make LPG more expensive than charcoal and electricity at their present prices.

Source: Mission estimates.

Energy Efficiency Improvement

5.11 Firewood is the most widely consumed fuel in Brazzaville. It is the primary energy source for low-income households, despite its high cost: when used in a "three-stone" stove (open fire), as is commonly the practice, it is one of the most expensive fuels in terms of both price and economic cost per unit of useful energy. The total energy costs of households with large per capita firewood consumption are much higher in proportion to household income (Table 5.4).

5.12 The use of improved stoves can drastically reduce the price and cost for firewood, and thus reduce the burden of energy costs on the household budget. The quantities of wood fuels consumed can be reduced by 40% to 55%. The mission's estimates indicate that both retail price and economic costs of firewood used in improved stoves are more competitive than those of kerosene. Charcoal is ranked third in terms of economic costs when burned in an improved stove (Table 5.2).

Table 5.4: HOUSEHOLD ENERGY COSTS
BY INCOME LEVEL

	Cooking Costs		Energy Costs		
			Cooking Costs		
Income	Total	As Percent of Income	Total	As Percent of Income	As Percent of Energy Costs
(kCFAF/month)	(kCFAF/yr)		(kCFAF/yr		
less than 40	79.5	18.7%	96.0	21.8%	82.8%
40 to 60	103.7	16.1%	136.9	21.4%	75.7%
60 to 80	74.4	8.5%	102.0	11.5%	72.9%
80 to 100	90.3	8.0%	114.7	10.2%	78.7%
100 to 120	78.1	5.8%	110.3	8.3%	70.8%
more than 120	108.8	5.4%	174.4	7.4%	62.4%

Source: Mission Household Survey.

5.13 Improved stoves have the additional advantage of decreasing the demand for firewood, since less primary energy is needed to produce the same amount of useful energy. Thus promotion of improved stoves would represent a promising strategy in Brazzaville, where there is concern about the link of wood fuel demand to area deforestation.

5.14 Considerations. Improvements to cookstove technology must be accompanied by an evaluation of local cooking habits to aid the design of equipment, including appropriate utensils. It is also necessary to assess the requirements for distributing the equipment and training women in its use.

Utilization of Existing Plantations

5.15 The Congo has between 40,000 and 50,000 ha of replanted forest area, both in the savannah and in the natural forests. Two plantations located in southern Congo are of interest for energy production: the Pointe Noire plantations and the Loudima plantations. Both were originally planted as feedstock for paper pulp projects which are no longer economically viable. Alternative uses for the wood, including energy

production, have been sought at both plantations. Given the transportation distances involved, charcoal production and distribution to urban/industrial centers appears to be the most viable energy utilization option. 11/

5.16 The UAIC manages a large, technically advanced eucalyptus plantation of over 23,000 ha adjacent to the city of Pointe Noire. Planting operations began in 1978 using a cloning technique perfected after 20 years of on-site experimentation by the CTFT. The cloning technique has yielded impressive results in terms of homogeneity of product quality and high productivity yields: nearly 30 m^3/ha/yr on most plots, with an average of 25 m^3/ha/yr for the entire plantation. These figures will be confirmed when the first industrial cuttings for electric poles are made in late 1986. Detailed production costs established by UAIC in 1983 showed total costs of 244,500 CFAF/ha. The mission estimated that 1986 production costs, taking into account hectares planted since 1983, have risen to 325,500 CFAF/ha (US$930/ha).

5.17 The mixed plantation at Loudima, comprised of 6000 ha of pine and eucalyptus, was established by the predecessor to the MFE, the Ministère des Eaux et Forêts and currently is maintained by the CFO. Productivity of the standing stock varies, ranging from 8.5 m^3/ha/yr for some of the older stands (18 yrs) to 21 m^3/ha/yr for the five-year age group. A feasibility study conducted by SODETEG (France) for charcoal production estimated the annual sustainable supply at between 84,000 and 109,000 m^3/yr. Production costs were not estimated, but should be higher than the Pointe Noire plantation due to poorer management and low resource inputs. Currently, no viable project for using this wood is under consideration.

Potential Charcoal Markets

5.18 Domestic Markets. Charcoal consumption in the Congo is limited and is unlikely to increase significantly in the short term. Utilization of charcoal in households is not widespread; demand in 1985 was only about 11,000 tons. Estimates of potential charcoal consumption in industry range between 25,000 and 34,000 tons. Given the competitiveness of petroleum products and the low investment capacity of most industries under current market conditions, the maximum total domestic demand for charcoal is expected to stay between 30,000 and 40,000 tons/yr in the short- to medium term. Export markets should represent more promising outlets for large-scale production.

11/ Although in the case of Pointe Noire, the plantation is close enough to the city that the by-products of cuttings are already collected free-of-charge for use as firewood by local residents.

5.19 Export Markets. The Kinshasa (Zaire) market, by its size (220,000 tons/yr) and location across the river from Brazzaville, is a prime target market. The Zaïre Energy Assessment 12/ reports that up to 40% of Kinshasa's demand will have to be supplied from other-than-traditional sources in the near future. The Congolese charcoal could be delivered to Kinshasa at a cost competitive with current wholesale prices (Table 5.5).

5.20 SODETEG (para. 5.17) analyzed the potential for exporting charcoal to other markets, including Senegal and Europe. Unless subsidized, transport costs would limit the competitiveness of Congolese charcoal exported to both markets.

Charcoal Production Potential

5.21 Large scale charcoal production appears feasible at both plantations. SODETEG estimates that 14,000 to 18,000 tons/yr could be produced at Loudima. In the case of Pointe Noire, annual production potential could range anywhere from 5,000 tons/yr, if only the wastes from electric pole production are used, to 126,000 tons/yr. The latter figure assumes that half the sustainable annual supply is recovered for charcoal production. In the long term, production from the wastes alone could top 60,000 tons/yr as electric pole production increases. In total, charcoal production from these two sources could start from an initial level of approximately 20,000 tons/yr and eventually top 200,000 tons/yr in the medium term.

Production Costs

5.22 The mission estimated the financial costs of charcoal production at Pointe Noire using Brazilian beehive kiln technology. Total estimated costs are presented in Table 5.5. As noted previously, transport costs to other markets (with the exception of Zaire) probably would have to be subsidized in order for Congolese charcoal to be competitive in those markets.

Further Considerations

5.23 Preliminary estimates would indicate that the plantations represent a considerable resource potential which could economically be tapped for charcoal production, primarily for export. The availability of lower cost charcoal supplies could also induce greater demand in local markets. Uncertainty remains, however, as to the extent of markets, transport options and optimal project design for economic production.

12/ "Zaire: Issues and Options in the Energy Sector", UNDP/World Bank, IBRD Report No. 5837-ZR.

Table 5.5: ESTIMATED UAIC CHARCOAL PRODUCTION COSTS
April 1986

Component	Unit cost (CFAF/kg)		Per Ton Equiv. (US$/ton)	
Wood (including drying)	17.3		49.4	
Cutting and Transport	7.7		22.0	
Carbonization	2.9		8.3	
Kiln Depreciation	2.2		6.3	
Bagging and Loading	1.3		3.7	
Overhead and Transport	4.9		14.0	
TOTAL a/	36.3	(19.0)	103.7	(54.3)

	Delivered Cost b/ (CFAF/kg)		Prices c/ (CFAF/kg)
Destination:			
Brazzaville	63.3	(45.8)	160
Kinshasa	68.3	(50.8)	85

a/ Figure in parentheses represent resource-free cost, that is costs under the assumption that residues are freely obtained as by products of main plantation activities, in this case, electric pole production; hence all production costs are charged off to the product. Otherwise, resource costs are calculated on the basis of average production costs (325,000 CFAF/ha) and average productivity (25 m^3/ha/yr).

b/ Figure in parentheses indicates resource-free delivery cost.

c/ Retail prices, equivalent to approximately 10 Z/kg for Zaire. Wholesale prices estimated to be 60% to 75% of these figures.

Source: Zaire Energy Arsessment, UAIC, mission estimates.

Other important points to be addressed when considering the design of large-scale charcoal production projects at either the Pointe Noire or the Loudima plantation are: (a) the place of charcoal production in the future management and utilization options of the plantations, which have yet to be decided; and (b) measures to overcome the lack of experience with charcoal production and carbonization techniques, so that decision makers can choose the most cost-effective technologies suitable for their respective exploitation and production conditions.

Utilization of Wood Residues

Resources

5.24 Wood residues are generated from three types of activities: industrial logging operations, timber cutting, and wood processing. Only 5% to 10% of the wood cut for industrial logging operations is actually of commercial value; the remainder is left on-site. This quantity rarely can be recovered economically. Of the wood cut for timber, unutilized wastes represent 1-1.4 times the volume of wood sent on for further processing. Just under 500,000 tons of residues are generated annually from these activities. An estimated 42,000 tons of residues are generated each year by wood industries, which include sawmills, furniture making and carpentry. Only residues generated from the latter two sources are of interest for energy utilization, however.

Utilization Options

5.25 Timber Cutting. Timber cutting operations are located in remote areas with negligible energy demand, so residues would have to be carbonized and transported to cities. A portable kiln technology, such as the Ghana kiln, would be most suited to the nomadic nature of these activities. Production may be viable if sales are limited to the local market; the already high transport costs would prohibit other options.

5.26 Wood Industries. Residues generated by sawmills have the greatest potential for recycling, either through carbonization or power generation. The carbonization activities would be similar to those for timber cutting, although shorter distances are involved and fixed kiln technology would be used. Using the residues for power generation could offset the fuel costs for diesel sets typically used by these industries, as most are not connected to the grid. A feasibility study of power generation conducted in the early 1980s for the sawmill SCIRIMA, near Pointe Noire, showed that a proposed power project could pay for itself in annual fuel savings in just over five years. The payback period now should be re-evaluated to account for decreased fuel prices.

5.27 Considerations. As the domestic market will be very limited in the short term, charcoal produced from wood residues may have to compete with overflow from the larger, export-oriented projects (para. 5.19-5.21). Consequently, the projects' viability will depend on the overall strategy adopted for charcoal production and export.

Recommendations

5.28 The mission recommends the following action program for addressing the issues in the wood fuel subsector.

5.29 For short-term, high priority action:

(a) A national charcoal production and marketing strategy should be investigated and developed, aimed primarily at export markets and based on the utilization of (i) existing plantations and, possibly, (ii) wood residues. An initial feasibility should be conducted at the Pointe Noire plantations in two phases: Phase I (US$75,000) will (i) determine resource availability and logistics of charcoal production under various plantation utilization scenarios, (ii) identify and quantify potential export markets, transport options and organization, and (iii) select appropriate technology. Phase II (US$75,000) will consist of training, logistical testing and engineering design for development of a longer term project strategy. If results are favorable, especially in Phase I, the methodology should be reapplied to encompass all production options.

(b) A program of demand management centered on utilization of improved stoves and energy substitution should be inititated, jointly with a wood supply/demand survey in Brazzaville (US$450,000, including wood supply/demand component). The project should include: (i) the selection, testing and design of improved stove models; (ii) the identification of cost-efficient production strategies; and (iii) the design of a program of marketing, education and training.

(c) All plans for peri-urban energy plantations should be abandoned until the systems of wood supply and utilization in Brazzaville are examined fully. See the complementary recommended action below.

5.30 For short-term, medium priority action:

(a) A thorough survey of wood resources, wood supply and distribution for competing uses, and wood fuel demand is needed. The primary objectives of the inventory are to ascertain: (i) which resources are used to satisfy demand for energy and non-energy uses and their current availability; (ii) the delivery system and costs of wood supply; (iii) the magnitude of wood fuel demand; (iv) the nature of the relationship between wood fuel demand, competing uses for land and wood resources, and depletion of area forests; and (v) the economic viability and cost-effectiveness of plantation projects versus the alternatives offered through better land-use management and demand management (US$150,000).

(b) Strategies for improved management of the natural forest should be developed which incorporate the findings in the survey recommended above.

5.31 The following strategies should be considered for development in the medium term:

(a) investigate the feasibility of expanding domestic charcoal markets in conjuction with (i) introducing improved stoves and (ii) developing the production potential of wood residues; and

(b) re-evaluate the feasibility of power generation using wood residues at sawmills; study the feasibility of charcoal production and transport to local markets.

Annex I
Page 1 of 2

CONGO: COMMERCIAL ENERGY CONSUMPTION
('000 TOE)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
PETROLEUM PRODUCTS ('000 tons)												
LPG	2.30	1.76	2.12	2.00	1.73	2.33	2.32	2.47	3.04	3.12	3.43	3.94
TOE equivalent	2.43	1.87	2.24	2.12	1.84	2.47	2.45	2.62	3.22	3.31	3.63	4.17
Growth rate (%) a/		-23.31	20.19	-5.43	-13.52	34.56	-0.69	6.82	22.96	2.66	9.70	14.86
Avgas	1.36	1.41	1.82	1.28	2.23	1.16	1.13	0.92	1.09	1.00	0.95	0.82
TOE equivalent	1.41	1.46	1.89	1.32	2.31	1.20	1.17	0.95	1.13	1.03	0.98	0.85
Growth rate (%) a/		3.67	28.99	-29.78	74.33	-48.03	-2.16	-18.89	18.39	-8.18	-5.31	-13.11
Jet A1	21.92	20.35	19.34	24.22	26.32	32.87	34.01	33.01	38.94	39.56	34.84	34.22
TOE equivalent	22.36	20.76	19.73	24.70	26.84	33.53	34.69	33.67	39.72	40.36	35.53	34.91
Growth rate (%) a/		-7.15	-4.96	25.21	8.66	24.91	3.47	-2.93	17.95	1.61	-11.95	-1.77
Gasoline	22.05	25.82	24.67	38.36	38.82	37.25	38.50	41.75	48.56	53.76	53.95	52.70
TOE equivalent	22.69	26.57	25.39	39.47	39.94	38.33	39.61	42.96	49.96	55.32	55.51	54.23
Growth rate (%) a/		17.09	-4.43	55.47	1.20	-4.04	3.34	8.45	16.31	10.72	0.35	-2.32
Kerosene	11.42	12.23	17.20	17.94	17.48	15.58	15.70	15.18	16.96	19.92	21.08	21.07
TOE equivalent	11.50	12.37	17.40	18.16	17.69	15.76	15.89	15.36	17.16	20.16	21.33	21.33
Growth rate (%) a/		7.11	40.64	4.31	-2.55	-10.90	0.80	-3.31	11.68	17.48	5.80	-0.01
Gas Oil	83.59	91.12	136.60	101.16	127.68	121.25	138.62	144.75	157.32	142.10	128.34	132.88
TOE equivalent	83.59	91.12	136.60	101.16	127.68	121.25	138.62	144.75	157.32	142.10	128.34	132.88
Growth rate (%) a/		9.01	49.91	-25.94	26.22	-5.04	14.33	4.42	8.69	-9.68	-9.68	3.54
Fuel Oil	36.66	32.43	33.37	36.13	22.63	20.86	15.73	15.55	17.44	49.69	17.92	20.51
TOE equivalent	35.53	31.43	32.34	35.01	21.93	20.21	15.24	15.07	16.89	48.15	17.36	19.87
Growth rate (%) a/		-11.54	2.90	8.27	-37.37	-7.85	-24.58	-1.14	12.12	184.99	-63.93	14.43
TOTAL	179.30	185.13	235.13	221.09	236.89	231.29	246.00	253.63	283.34	309.15	260.50	266.14
TOE equivalent	179.50	185.58	235.59	221.95	238.23	232.75	247.68	255.38	285.41	310.42	262.69	268.23
Growth rate (%) a/		3.25	27.01	-5.97	7.14	-2.36	6.36	3.10	11.71	9.11	-15.74	2.16
ELECTRICITY (GWh)												
Total to Internal System				124.30	138.00	147.10	161.40	177.10	221.40	287.90	333.22	369.47
TOE equivalent	0.00	0.00	0.00	10.69	11.87	12.65	13.88	15.23	19.04	24.76	28.66	31.77
Growth rate (%) b/					11.02	6.59	9.72	9.73	25.01	30.04	15.74	10.88
TOTAL COMM CONS ('000 TOE)	179.50	185.58	235.59	232.64	250.10	245.40	261.56	270.61	304.45	335.18	291.35	300.00
percent change		3.38	26.95	-1.25	7.51	-1.88	6.58	3.46	12.50	10.10	-13.08	2.97

Average Annual Growth

YEARS	75-78	78-81	79-82	80-83	81-84	82-85	78-85	79-83
Electricity		9.27	12.76	18.62	20.13	20.42	14.84	16.22
Petroleum Products	7.86	3.56	4.70	7.57	2.05	1.81	2.69	5.58
Total Commercial Consumption		3.92	5.17	8.16	3.25	3.12	3.52	6.15

COMMERCIAL ENERGY CONSUMPTION
AND COMPARATIVE INDICATORS
1978-1985

	1978	1979	1980	1981	1982	1983	1984	1985
Comm. Energy Consumption ('000 TOE)	250.10	245.40	261.56	270.61	304.45	335.18	291.35	300.00
Comm. Energy Growth		-1.88	6.58	3.46	12.50	10.10	-13.08	2.97
Per Capita Consumption (kgoe)	0.16	0.15	0.16	0.16	0.17	0.18	0.15	0.15
Electricity Consumption ('000 TOE)	11.87	12.65	13.88	15.23	19.04	24.76	28.66	31.77
Per Capita	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Petroleum Consumption ('000 TOE)	238.23	232.75	247.68	255.38	285.41	310.42	262.69	268.23
Per Capita	0.16	0.15	0.15	0.15	0.16	0.17	0.14	0.14
Energy Intensity (kgoe per CFAF) b/	0.90	0.80	0.73	0.61	0.60	0.64	0.51	0.54
Energy Coefficient c/		-0.19	0.37	0.14	0.96	2.80	-1.52	-0.96
GDP (billion 1980 CFAF)	278.51	306.12	360.40	446.95	504.97	523.17	568.18	550.60
Real GDP Growth Rate (%/yr)		9.91	17.73	24.01	12.98	3.60	8.60	-3.09
Population d/ ('000 people)	1530.96	1588.83	1648.88	1711.21	1775.90	1843.02	1912.50	1984.79

a/ Preliminary estimates.
b/ GDP in 1980 CFAF.
c/ Ratio of GDP growth to growth of commercial energy.
d/ Growth 3.78%/yr, base 1974=1319.8 ending 1984 census=1912.5

Annex 2

CORAF PRODUCTION: 1982-1985
('000 tons)

	1982/83	1984	1985	Percent (1985)
Crude oil processed	661.61	545.82	598.72	100.0
Production				
LPG	3.29	2.82	3.95	0.7
Gasoline	57.30	52.49	57.51	9.6
Kero/Jet fuel	17.74	26.64	33.62	5.6
White spirit	-	-	0.26	-
Gas oil	140.18	113.24	125.05	20.9
Fuel oil 1500 RI	19.19	14.68	21.95	3.7
Fuel oil 630 Cs	388.22	303.15	313.16	52.3
Intermediate products	-5.11	2.86	8.24	1.4
Fuel consumption and losses	40.80	29.94	34.98	5.8

Source: Mission estimates.

Annex 3

COMPUTATION OF EX-REFINERY PRICES a/ b/
('000 CFAF)

	('000 CFAF)
Crude Cost	43,161,681
Manufacturing Expenses	8,770,438
Investment Expenses	625,000
Capital Charges	2,756,230
Stock Changes	246,304
Total Charges	55,519,653
Export Fuel Oil	-16,094,000
Financial Receipts	-825,000
Local Sales Receipts	38,600,613

	Import price (CFAF/ton)	($/ton)	Computed Ex-refinery Price (CFAF/ton)
Butane	250,000	(625)	61,516
Gasoline	120,800	(302)	174,632
Kero/Jet Fuel	117,600	(294)	170,006
Gas-Oil	107,600	(269)	155,550
Fuel Oil	72,800	(182)	61,516
Average	111,010		152,031

a/ January 1, 1986.
b/ Ex-refinery prices are computed as follows:

- Gasoline, kero/jet fuel and gas-oil prices are proportional to corresponding import prices (FOB Rotterdam plus $25 per ton).
- Price of fuel oil (local market 1,500 RI) is computed from price of fuel oil 1% S (93.2%) and price of kerosene (6.8%).
- Price of butane is equal to price of fuel oil.
- Exchange rate on January 1, 1986: US$1 = 400 CFAF.

Source: CORAF.

COMPARISON OF REFINING AND IMPORT ECONOMICS

Table 1: CRUDE REFINING VERSUS IMPORT OF FINISHED PRODUCT: 4th QUARTER 1985

(Thousand US$)

	Base Case Djéno	Base Case Bonny	Improved Case a/ Djéno	Improved Case a/ Bonny
Refining Option				
Crude import, minus Fuel export, plud Port charges	68,933	64,421	68,933	64,421
Refining expenses	21,290	20,394	11,200	10,304
Sub-Total	90,223	84,815	80,133	74,725
Import Option				
Cost of product b/	75,371	75,371	75,371	75,371
Gain/(Loss) in refining	(14,852)	(9,444)	(4,762)	646

a/ Reduced operating costs, as specified on Table 4.
b/ NWE FOB prices, plus freight, insurance and ocean losses.

Table 2: CRUDE REFINING VERSUS IMPORT OF FINISHED PRODUCT: 3rd quarter 1986

(Thousand US$)

	Base Case Djéno	Base Case Bonny	Improved Case a/ Djéno	Improved Case a/ Bonny
Refining Option				
Crude import, minus Fuel export, plus Port charges	23,553	28,833	23,553	28,833
Refining expenses	24,331	23,556	12,158	11,383
Sub-Total	47,884	52,389	35,711	40,216
Import Option				
Cost of product b/	39,898	39,898	39,898	39,898
Gain/(Loss) in refining c/	(7,986)	(12,491)	4,187	(318)

a/ Reduced operating costs, as specified on Table 4.

b/ NWE FOB prices, plus freight, insurance and ocean losses.

c/ Taking into account the modifications to the hypothesis for crude and product prices as suggested by the Government (footnote 3, Table 3), even greater losses will result in each case:

Base Case - Djéno: (10,266)
Base Case - Bonny: (12,590)
Improved Case - Djéno: (1,907)
Improved Case - Bonny: (2,600)

HYPOTHESIS FOR CALCULATIONS: TABLE 1 AND 2

i. Product demand assumed for 1986 is as follows:

Butane	3,800 tons
Gasoline	51,300 tons
Kero/Jet	44,800 tons
Gas oil	131,000 tons
Fuel oil	23,000 tons

ii. Refinery production from DJENO and Nigeria BONNY/LIGHT is estimated as follows:

Product	Type of Crude			
	DJENO (28.4° API)		BONNY (36° API)	
	(% wt)	(tons)	(% wt)	(tons)
Butane	0.7	3,800	1.2	3,800
Gasoline	9.0	51,300	16.0	51,300
Kero/Jet	7.9	44,800	14.0	44,800
Gas oil	23.0	131,000	40.9	131,000
Fuel oil (local)	3.9	23,000	7.2	23,000
Fuel oil (export)	50.1	285,500	14.6	48,800
Refinery fuel plus losses	5.4	30,600	5.4	17,300
TOTAL	100.0	570,000	100.0	320,000

(These estimates do not include output while the distillation tower, which has been in service since July 1986, is operating.)

iii. CRUDE PRICES

Average prices for DJENO in fourth quarter 1985 and third quarter of 1986 are as follows:

4th Q 1985	$ 26.15 per bbl
3rd Q 1986	$ 9.85 per bbl

Average spot prices as per PIW sources for BONNY LIGHT during the same period are as follows:

4th Q 1985	$ 28.9 per bbl
3rd Q 1986	$ 12.5 per bbl

No freight is considered for DJENO crude.
In the mission's calculations, freight cost for BONNY LIGHT is estimated on the basis of WS 110 for 30,000 DWT vessels plus insurance and ocean losses at the rate of 0.7% of FOB plus freight. The calculations made by the Government (footnote c, Table 2) are estimated on the basis of $0.50/bbl for freight and insurance and $1.616/ton for port taxes.

iv. PRODUCT PRICES

Product prices as per NW Europe FOB prices plus freight in 20,000 DWT vessels at WS 160 plus insurance and ocean losses at the rate of 0.7% on FOB plus freight.

The estimated product prices are as per Table 3.

v. OPERATING COST OF THE REFINERY (Table 4)

They include:
Variable costs (purchased utilities, catalysts and chemicals).
Fixed costs (salaries, maintenance, technical assistance, administrative overheads).
Financing costs (cost of credit to HC, amount payable to ELF for advancing WC in 1983 and credit expenses on crude oil).
Exchange rate 1985: US$1 = 400 CFAF
1986: US$1 = 350 CFAF

vi. OPERATING EXPENSES FOR PRODUCT IMPORT

They include salaries, maintenance, administrative overhead losses and cost of providing additional facilities (see Table 3).

vii. COST OF PROVIDING SOME ADDITIONAL FACILITIES

For importing BONNY LIGHT crude additional investments of approximately US$200,000 will be required. Corresponding expenses are included in the costs of BONNY LIGHT cases.

viii. REDUCTION IN OPERATING COSTS

While processing BONNY LIGHT vis-a-vis DJENO crude, a reduction in operating costs of between US$506,000/yr and US$1,031,000 is also taken into account.

ix. In the improved cases, the various operating costs are assumed to be reduced as shown in Table 4. The main reductions are for technical assistance, social benefit costs, maintenance and financial expenses.

Table 3: PRODUCT PRICES

NW EUROPE FOB ($/t)

	4th Q 85	3rd Q 86
Gasoline	277.6	156.8
Jet/Kerosene	286.4	128.7
Gas oil	258.6	112.5
1% Fuel oil c/	149.6	71.2
3.5% Fuel oil c/	141.1	60.2
0.3% Fuel oil	152.0	74.3
Local Fuel oil a/	158.9	75.1
Export Fuel oil b/ c/	144.9	71.4

a/ 93.2% Fuel oil 1% S plus 6.8% Jet Fuel
b/ 95% Export Fuel plus 5% Jet Fuel = 100% Fuel 0.3% S
c/ The Government recalculated the costs of refining versus imports for 3rd quarter 1986 on the basis of the following corrected figures: 1% Fuel - $69.9/ton
3.5% Fuel - $61.3/ton
Export Fuel - $50.9/ton
The resulting estimates are presented in footnote c of Table 1.

Table 4: REFINERY OPERATING COSTS (1986)

Thousand US$/year a/

	Current		Improved management c/	
VARIABLE COSTS		1,031		1,031
Power (external supply)	363			
Catalyst	127			
Chemicals	148			
T.E.L. + Additives	393			
OPERATING FIXED COSTS		17,939		9,367
Salaries (local personnel)	2,894		2,894	
Housing expenses	1,480			
Social expenses	1,993		1,473	
Technical assistance	6,394		2,000	
Maintenance (material)	920			
Maintenance (external services)	2,613		1,500	
Overhead	1,645		1,500	
FINANCIAL EXPENSES		5,361		1,760
Cost of credit to H.C.	2,700		-	
Interest on working capital	1,260 b/		1,260 b/	
Others	1,401		500	
TOTAL OPERATING COST		24,331		12,158

a/ US$1 = 365 CFAF.

b/ Amount payable to Elf until end 1988 for advancing working capital in 1983.

c/ These figures indicate target levels. They are based on operating costs observed in similar refining facilities in Africa and should be possible to achieve with efficient management and operations.

Table 5: OPERATING EXPENSES FOR PRODUCT IMPORT

		Thousand $
Personnel (100 people at 9000 $/y)		900
Maintenance (1 % of investment) a/		500
Overhead		100
Sub-Total		1500
		or about 6 $/ton
Additional facilities cost b/		100
Losses (0.5 % on product value)		
	in 1985	310
	in 1986	188
Total cost		
	in 1985	1910
	in 1986	1790

a/ Based on value of required existing facilities of $ 50 million.
b/ 20 % of estimated $ 0.5 million additional investment (piping).

SUGGESTED MEASURES FOR REDUCING OPERATING COSTS 1/

Technical Measures

The implementation of the first two suggested technical measures have been achieved or are already underway:

(a) The addition of the vacuum tower unit to increase feedstock to the hydrocracker (para. 3.2) will reduce fuel oil production from 312,000 tons/yr to 285,000 tons/yr. The continued economic benefits of the addition will depend largely on crude oil and fuel oil prices.

(b) The rehabilitation of the heat exchange unit (para. 3.11) should save about 2500 tons of fuel oil annually.

(c) Import of a lighter African crude to replace the Djéno crude is planned for late 1987/early 1988. The economic benefits could be substantial, as fuel oil production would be reduced. The costs of additional minor investments to facilitate transport of the imported crude from Pointe Noire are not considered in the mission's preliminary calculations.

Operational Mesures

(a) The primary reduction should occur on foreign technical assistance expenses. Based on observations of similar refining operations in other African countries, the mission estimates that expatriate personnel could be reduced to about 10, without affecting current operations. The Government had already reduced the number of expatriate staff by 14 in mid-1987.

(b) Social benefits for local personnel, particularly housing, medicine and transport, amounts to about US$ 3.4 million annually. Steps have been taken which should substantially reduce these costs. They affect lodging costs (a preventive maintenance policy, which requires workers recruited locally to pay their own rent) and transport costs (re-arranging working hours and ending transportation subsidies for workers families). Still, the Government should continue to identify measures which will reduce these costs to acceptable levels.

1/ Some initial areas identified by the mission which could help reduce costs to the target levels on Table 4.

(c) Financial expenses. Interest charges on working chapital borrowed in 1983 will end after 1988. Cost of credit to HydroCongo should be eliminated by avoiding credit facilities.

(d) The total maintenance cost of this simple refinery could be reduced to about US$1.5 million per year.

Electricity Demand and Supply

Load Growth

1. Recent trends in economic growth and energy consumption have been briefly presented in Chapter I. In addition to the underlying linkage with expanding incomes, the growth of electricity consumption has been accelerated by a promotional (declining block) tariff structure and the freezing of rates since 1976 for about half the total load and since 1982 for the rest.

2. Consumption of electricity is concentrated in the two main urban centers; in 1985 Brazzaville and Pointe Noire accounted for 90% of total sales (Table 1):

Table 1: CONGO - PATTERN OF ELECTRICITY CONSUMPTION, 1985

	Brazzaville	Pointe Noire	Bouenza/ Loubomo/N'Kayi	Secondary Centers	Total
Energy (GWh)					
LV	90	57	7.8	1.2	156
MV	61	76	22.3	--	159
Total	151	133	30.1	1.2	315
Average Consumption per LV Customer (kWh/month) a/	363	587	333	122	259

a/ Estimated on assumption that the number of low voltage supply contracts is approximately 1.6 times the number of customers.

3. The structure of electricity sales by economic sector is not known in any detail. Table 2 presents the estimated structure of sales by voltage level and tariff category in Brazzaville and Pointe Noire:

Table 2: CONGO - STRUCTURE OF SNE SALES IN BRAZZAVILLE AND POINTE NOIRE a/

	Brazzaville	Pointe Noire
Low Voltage	61	42
Households	19	16
Government	7	2
Public Lighting	2	--
Private Business	23	21
Parastatals	10	4
High Voltage	39	58
Private Business	19	47
Government		2
Parastatals	21	8
Total	100	100

a/ In percent of total sales; Brazzaville estimates are for 1981-82(average); Pointe Noire estimates are for 1985.

b/ Totals may not add up due to rounding.

4. The statistics available on past and present electricity consumption are unreliable and are distorted by restrictions in power supply; they are of limited value for forecasting future demand. The mission has used a wide envelope of load growth scenarios (Table 3) as the basis for projecting future energy and capacity balances for the interconnected system out to 1995.

Table 3: SUMMARY LOAD SCENARIOS FOR SNE INTERCONNECTED SYSTEM, 1990-95 a/

	1985 b/		1990				1995			
	GWh (actual)	MW (actual)	GWh (low)	GWh (high)	MW (low)	MW (high)	GWh (low)	GWh (high)	MW (low)	MW (high)
Total System c/	408	78	487	695	89	127	634	1071	115	194
Brazzaville	209	38	261	362	47	66	312	568	57	103
Pointe Noire	165	33	186	291	35	53	273	435	49	79
Bouenza/N'Kayi/Loubomo	34	7	40	42	7	8	49	68	9	12

a/ Loads include estimated unbilled consumption and technical losses.
b/ Brazzaville not connected to rest of SNE system in 1985.
c/ Total system peak demand will be less than shown because of non-coincidence between load center peaks.

5. A vigorous program of new connections is built into the forecasts until 1990. If SNE succeeds in improving the reliability of supply, load growth will tend to move into the upper part of the forecast range. The impact will be significant if the present autogenerators in Pointe Noire switch to the public supply system. However, this effect could be reduced or eliminated if SNE raises electricity tariffs to levels that ensure full recovery of economic and financial costs.

Generation and Transmission.

6. The public power supply system consists of two independent networks--Brazzaville and Pointe Noire-Loudima-Bouenza-N'Kayi--and 15 small isolated load centers (Map IBRD 18242). Total installed capacity in the isolated centers in 1985 was about 5.4 MVA; most centers have an installed capacity of between 0.2 and 0.4 MVA. Estimated generation in the isolated centers in 1985 was 1.5 GWh, or 0.4% of total energy supplied to SNE networks.

7. The Brazzaville system consists of:

(a) the Djoue run-of-river hydro plant adjacent to Brazzaville--15 MW installed capacity, 12.4 MW firm;

(b) a 225 kV interconnection with the Inga hydro plant in Zaire;

(c) a diesel plant in the center of Brazzaville--in early 1986 approximately 2 MW was available for standby duty.

8. The Pointe Noire/southwest system consists of:

(a) the Moukoukoulou hydro plant, located about half way between Pointe Noire and Brazzaville--74 MW (4 x 18.5 MW) installed, about 23 MW firm;

(b) 110 kV transmission from Moukoukoulou to Bouenza, N'Kayi and Loudima, with 35 kV lines to three other smaller towns;

(c) nearly 150 km of 225 kV transmission from Loudima to Pointe Noire;

(d) a diesel plant in Pointe Noire--for system planning purposes this capacity should be treated as unavailable.

9. The Brazzaville and Pointe Noire systems are in the process of being linked by a 225 kV transmission line from Loudima to Brazzaville. The resulting interconnected system is expected to be operational by late 1987. The main benefits of interconnection are:

(a) The Moukoukoulou hydro plant's low cost surplus energy and power can be transferred to Brazzaville, thereby reducing imports from Zaire.

(b) In the event of difficulties with SNE generation facilities, imported energy and power can be made available not only to Brazzaville but also to Pointe Noire and other load centers in the southwest.

10. The mission has used its two load growth scenarios (para 4) to project energy and capacity balances for the interconnected system out to 1995 (Tables 4 and 5). The projections represent a hypothetical "base case" in which:

(a) additional electrical energy requirements are met by imports;

(b) gas turbine capacity (or other low capital cost thermal plant) is installed in Pointe Noire to match total peak demand in Pointe Noire--as protection against a temporary outage on the transmission line from Loudima to Pointe Noire (a 22 hour outage occurred in late 1985);

(c) additional thermal capacity is installed in Brazzaville so that total firm capacity on the interconnected system matches total system peak demand--as protection against supply interruption from Zaire (only about 8 hours in 1985).

Table 4: SUMMARY ENERGY BALANCE
FOR SNE INTERCONNECTED SYSTEM, 1985 - 1995 (GWh)

	1985 actual a/	1990 (low)	1990 (high)	1995 (low)	1995 (high)
Energy Demand	408	487	695	634	1071
Hydro Generation b/	287	463	520	520	
Deficit/Imports	121	24	175	114	551

a/ Estimated; Brazzaville not connected to rest of SNE system in 1985.
b/ Assuming maximum energy output from Moukoukoulou is 240 GWh (wet season) plus 160 GWh (dry season) and from Djoue is 88 GWh/yr rising to 120 GWh/yr in 1990 after rehabilitation.

Table 5: SUMMARY CAPACITY BALANCE
FOR SNE INTERCONNECTED SYSTEM, 1990 - 95
(MW)

	1990		1995	
	(low)	(high)	(low)	(high)
System Peak Demand	89	127	115	194
Firm Hydro Capacity	38		38	
Pointe Noire Capacity	35	35	49	79
Brazzaville Reserve c/	16	36	28	77

a/ Moukoukoulou 23 MW plus Djoue 15 MW (after rehabilitation).
b/ Reserve capacity needed in Pointe Noire, equivalent to projected peak demand in Pointe Noire.
c/ Additional reserve capacity needed in Brazzaville if system is to have 100% protection against interruptions of supply from Zaire.

11. The marginal cost of generation associated with the base case expansion plan is approximately (a) the cost of imports from Zaire at 9 CFAF/kWh, plus (b) US$500/kW--the cost of installing gas turbines, including a small allowance for fixed O&M costs. No allowance is made for transmission and distribution costs and losses. This simple analysis indicates that new generation options should only be considered if they can provide the required level of reliability for less than about 4.0 US¢/kWh at system load factor.

Distribution.

12. The distribution systems in Brazzaville and Pointe Noire operate at 30 kV and 6.6 kV. Both distribution systems are in very poor condition due to saturation and inadequate maintenance. Distribution outages are a more frequent cause of nonsupply to consumers than failure at either the generation or transmission level. A program of rehabilitation and conversion to 20 kV is underway and this should result in a progressive improvement in reliability of supply over the next few years.

Private Capacity

13. Poor reliability of supply has compelled many consumers to maintain their own private capacity, either for baseload generation or as backup during SNE outages. In 1983 there was an estimated total installed autogeneration capacity of 12 MW in Brazzaville, 35 MW in Pointe Noire and 5-10 MW in the rest of the country. Private backup capacity will remain a necessity until the distribution systems are restored to a reasonable level of reliability (1989/90). In Pointe Noire, an additional requirement is the installation of sufficient SNE thermal capacity to cope with a Moukoukoulou-Pointe Noire transmission outage. In the interim there may be some scope for using the excess installed capacity of some autoproducers in Pointe Noire to supply other SNE customers during outages.

PETROLEUM PRODUCT TRANSPORT DIFFERENTIALS (from Pointe Noire)

	CFAF/kg a/	Km	Transport system	Relative Duration of Journey Compared with Rail to Brazzaville c/ (Rail = 1)
Loubomo	5.8	180	Rail	
Nkayi	8.3	260	Rail	
Loutete	10.5	330	Rail	
Mossendjo	13.0	410	Rail	
M'Binda	17.7	550	Rail	
Brazzaville	16.6	520	Rail	1
Mossaka	35.4	985	Rail + river	
Oyo	38.7	1 090	Rail + river	3.5 b/
Impfondo	50.0	1 382	Rail + river	5 b/
Ouesso	53.2	1 475	Rail + river	10 b/

a/ Excluding turnover tares
b/ From Brazzaville
c/ Outward journey

Source: ATC.

PETROLEUM PRODUCT PRICE STRUCTURE - EARLY 1986
(CFAF/ton)

	Gasoline	Kerosene	Gas-Oil (Internal)	Gas-Oil (Marine)	Fuel Oil (Internal)	Fuel Oil (Marine)	Jet A1	Butane
EX CORAF PRICE	174,632	170,006	155,550	155,550	61,516	61,516	170,006	61,516
TAXES	5,682	340	311	311	123	123	340	123
DISTRIBUTION COSTS								
Operation Expenses	56,978	50,298	49,119	39,295	39,295	31,436	47,154	157,180
Financial Charges	9,927	9,927	11,628	11,628	11,628	9,927	11,534	13,236
Hydro-Congo Margin	4,831	4,605	4,326	4,129	2,250	2,059	4,574	4,640
Retail Margin	10,000	8,125	5,882	-	-	-	-	50,000
Total Cost								
CFAF/ton	262,050	243,301	226,816	210,913	114,812	105,061	233,608	286,695
CFAF/l	197	195	193	179	115 a/	105 a/	187	287 a/
Retail Price								
CFAF/l	295	170	195	-	-	-	153	320 a/

a/ CFAF/kg.

Source: CORAF.

Annex 7

COMPARISON OF COOKING FUEL COSTS

	Unit	Energy Content	Yield	Retail Price	Price per unit useful energy	Economic Cost	Economic Cost per unit useful energy
		(kgoe/unit)	(%)	(F/unit)a/	(F/kgoe)a/	(F/unit)a/	(F/kgoe)a/
TRADITIONAL FUELS (Brazzaville Only)							
Firewood							
open fire	kg	0.343	8	30.0	1093	33.00	1203
existing stoves	kg	0.343	15	30.0	583	33.00	641
improved stoves	kg	0.343	28	30.0	312	33.00	344
Charcoal							
existing stoves	kg	0.6863	24	160.0	971	100.00b/	607
improved stoves	kg	0.6863	30	160.0	777	100.00b/	486
In Pointe Noire:							
existing stoves	kg	0.6863	24	n.a.	n.a.	50.00c/	304
improved stoves	kg	0.6863	30	n.a.	n.a.	50.00c/	243
COMMERCIAL FUELS (By Location)							
Kerosene							
Brazzaville	liter	1.007	35	170.0	482	144.10	409
Pointe Noire	liter	1.007	35	170.0	482	134.10	380
Ouesso	liter	1.007	35	170.0	482	204.10	579
LPG							
Brazzaville	kg	1.059	45	320.0	671	479.00	1005
Pointe Noire	kg	1.059	45	320.0	671	415.00	871
Ouesso	kg	1.059	45	320.0	671	620.00	1301
Electricity							
Brazzaville	kWh	0.0877	65	52.9d/	928	52.9e/	928e/
Pointe Noire	kWh	0.0877	65	59.6d/	1046	59.6e/	1046e/
Ouesso	kWh	0.0877	65	59.9d/	1051	59.9e/	1051e/

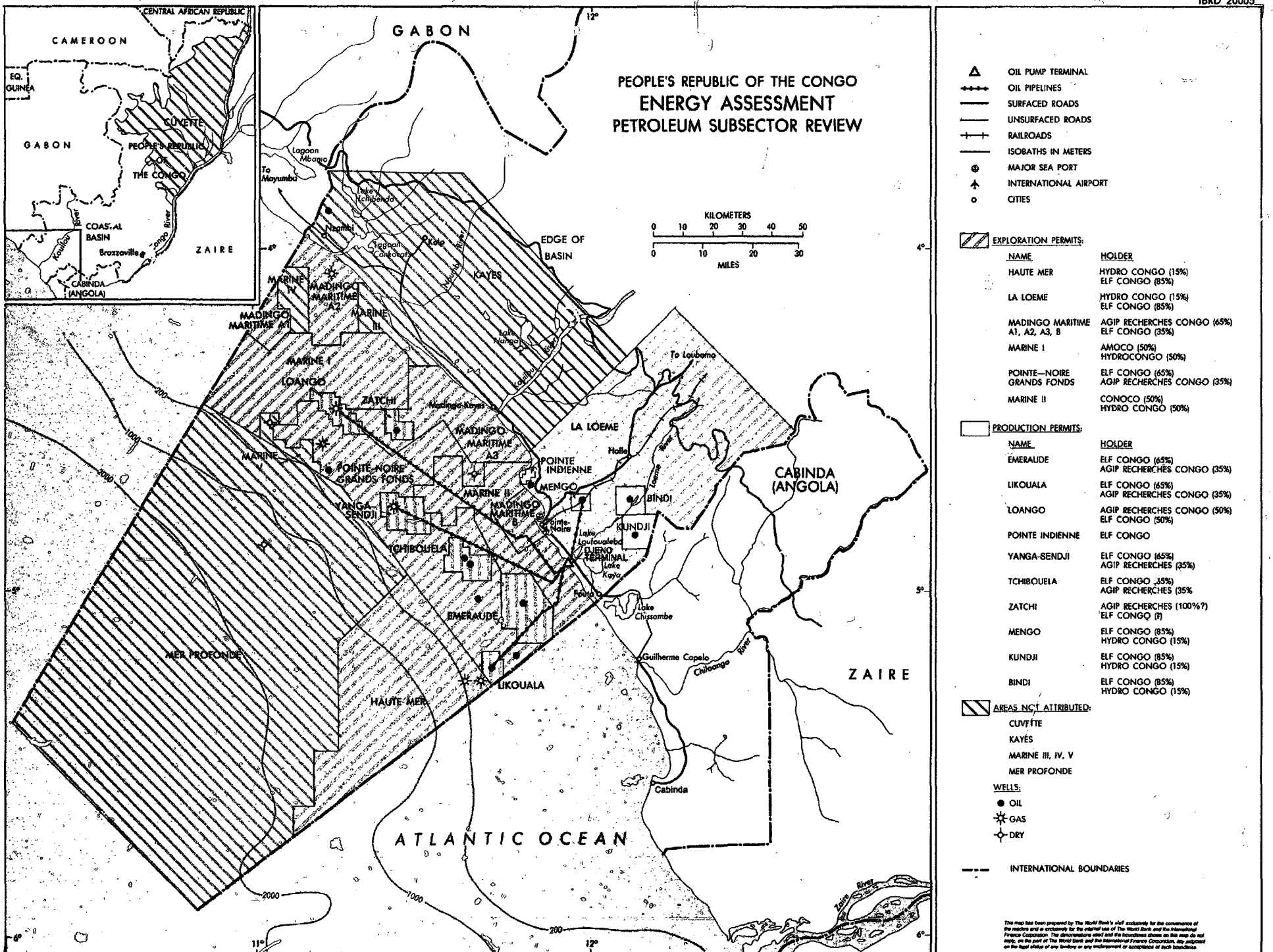
a/ F = CFAF

b/ Economic cost of charcoal produced at UAIC plantations in Pointe Noire and delivered to Brazzaville, plus estimated distribution costs. Used as proxy value for current costs of production in Brazzaville, which are not known.

c/ Economic cost of charcoal produced at UAIC plantations in Pointe Noire and delivered to the city, plus estimated distribution costs. Used as proxy value for current costs of production in Pointe Noire, which are not known.

d/ Low voltage tariff for lighting and domestic uses, 0 to 25 hours monthly utilization, before taxes.

e/ The mission's initial findings indicate that marginal costs of supply (economic costs of power supply) are higher than current tariffs. These costs could not be estimated at the time of the mission due to missing and incomplete data. Current tariffs are taken as a minimum proxy value for the marginal cost.



- OIL PUMP TERMINAL
- OIL PIPELINES
- SURFACED ROADS
- UNSURFACED ROADS
- RAILROADS
- ISOBATHS IN METERS
- MAJOR SEA PORT
- INTERNATIONAL AIRPORT
- CITIES

EXPLORATION PERMITS:

NAME	HOLDER
HAUTE MER	HYDRO CONGO (15%) ELF CONGO (85%)
LA LOEME	HYDRO CONGO (15%) ELF CONGO (85%)
MADINGO MARITIME A1, A2, A3, B	AGIP RECHERCHES CONGO (65%) ELF CONGO (35%)
MARINE I	AMOCO (50%) HYDROCONGO (50%)
POINTE—NOIRE GRANDS FONDS	ELF CONGO (65%) AGIP RECHERCHES CONGO (35%)
MARINE II	CONOCO (50%) HYDRO CONGO (50%)

PRODUCTION PERMITS:

NAME	HOLDER
EMERAUDE	ELF CONGO (65%) AGIP RECHERCHES CONGO (35%)
LIKOUALA	ELF CONGO (65%) AGIP RECHERCHES CONGO (35%)
LOANGO	AGIP RECHERCHES CONGO (50%) ELF CONGO (50%)
POINTE INDIENNE	ELF CONGO
YANGA-SENDJI	ELF CONGO (65%) AGIP RECHERCHES (35%)
TCHIBOUELA	ELF CONGO (65%) AGIP RECHERCHES (35%
ZATCHI	AGIP RECHERCHES (100%?) ELF CONGO (?)
MENGO	ELF CONGO (85%) HYDRO CONGO (15%)
KUNDJI	ELF CONGO (85%) HYDRO CONGO (15%)
BINDI	ELF CONGO (85%) HYDRO CONGO (15%)

AREAS NOT ATTRIBUTED:

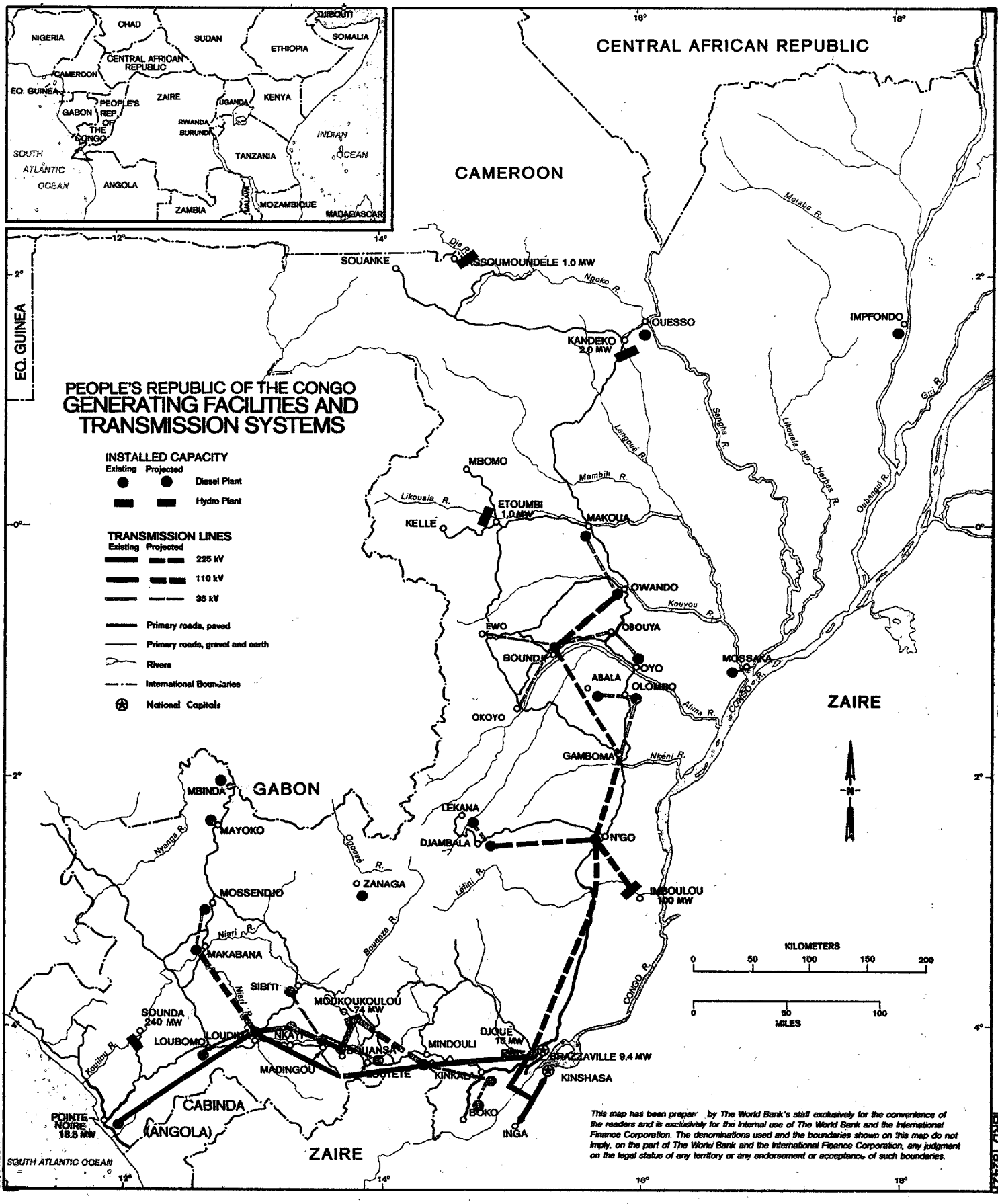
- CUVETTE
- KAYES
- MARINE III, IV, V
- MER PROFONDE

WELLS:

- OIL
- GAS
- DRY

INTERNATIONAL BOUNDARIES

SEPTEMBER 1986



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IBRD 18242R

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Somalia	December 1985	5796-SO
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