Report No. 7408-ANG

Angola: Issues and Options in the Energy Sector

May 1989

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

JOINT UNDP/WORLD BANK ENERGY SECTOR ASSESSMENT PROGRAM

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ANGOLA

ISSUES AND OPTIONS IN THE ENERGY SECTOR

MAY 1989

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 Government of Sweden, the UNDP and the World Bank, and the work has been carried out by the World Bank.

This Report was based in part on the findings of a mission which visited Angola in April/May 1987. The mission was led by Michel Del Buono (Senior Economist) and comprised of Messrs. W. Teplitz-Sembitsky (Consultant, Energy Economist and Deputy Mission Leader), J. Baptista (Power Engineer/Economist), S. Dalin (Power Engineer), M. Grimaud (Natural Gas Specialist), J. Lopes (Power Engineer/Household Energy Specialist), W. Matthews (Petroleum Specialist - Refining and Distribution), M. Paues (Researcher), R. Sergio (Utility/Financial Analyst), R. Soto (Petroleum Specialist - Exploration and Contracts), H. Warfvinge (Forestry Economist). Mr. R. Bates (Deputy Division Chief) joined the mission in its final stage and participated in the round-up meetings. Mr. Pedro V. Pinheiro reviewed the sections dealing with petroleum and product marketing procurement. The main authors of this Report are Messrs. Michel Del Buono and Witold Teplitz-Sembitsky. A preliminary version of this report was discussed with the Angolan Government in late September 1988 and in early February 1989 and was issued simultaneously in Portuguese and English.

ABSTRACT

Angola has sizeable hydrocarbon reserves, a large hydro potential and ample woodfuel resources. Its ability to export annually 12-14 million tons of crude oil has sustained the economy over the past dozen years of civil war. However, the war has significantly affected the energy sector. While the State oil company, SONANGOL, and the oil refinery in Luanda run well, the power sector has steadily deteriorated over the last decade, and the utilities have run into ever increasing cash deficits. Artificially low prices for both electricity and oil products are encouraging wasteful consumption, and not permitting recovery of costs, particularly for electric power. Some investment in natural gas is justifiable, to increase the supplies of LPG. With regard to traditional fuels, the Government's "hands off" policy should be continued in the current situation until a more active policy becomes possible with the return of security in the supply areas.

The proposals made in this report are designed to increase the efficiency of the energy sector, through a number of moderate investments in infrastructure, but also through changes in pricing policy, and overall improvements in sector management. The mission recommends that the focus for the electric power subsector should be on maintaining and upgrading the existing electric power infrastructure and improving the reliability of supply. The expensive Capanda project should be postponed. A power consulting firm has reevaluated the Capanda project and the Bank has agreed to review the resulting report. To keep the oil sector prospering and avert a precipitous drop in petroleum reserves and production, it is recommended that the Government continue strengthening SONANGOL and maintaining the competitiveness of contractual terms for foreign oil companies. SONANGOL should resume full responsibility for petroleum product trading to reduce the foreign exchange costs involved. Angola's LPG imports could be replaced by refractionating LPG obtained through the LPG recovery scheme in Cabinda. Domestic distribution of oil products should be assigned to an autonomous or semi-autonomous division of SONANGOL, which could, possibly, include private, foreign or domestic capital. In household energy, a return to peace would require the development of new strategies to ensure a less wasteful utilization and more competitive trading of the country's woodfuel resources, the demand for which is bound to increase if and when more reasonable prices are are set for petroleum derivatives.

ABBREVIATIONS AND ACRONYMS

AGIP	Italian State Oil Company (Part of ENI Group)
BEP	Belgian Engineering Promotion
BNA	Banco Nacional de Angola (the Central Bank)
BRASPETRO	International Affiliate of Petrobras, (State Oil Company of Brazil)
CABGOC	Cabinda Gulf Oil Company (Joint Venture between SONANGOL and Gulf-Chevron)
CELB	Companhia Eletrica do Lobito e Benguela
CEPSA	Oil refining company
CHEVRON	U.S. oil company
CIDA	Canadian International Development Agency
COMERINT	A consulting firm belonging to the ENI Group (Italy's State Hydrocarbons Holding Company)
CONOCO	U.S. oil company (Continental Oil Company)
DNACO	National Directorate for the Conservation of Nature
DNERFE	Department of New and Renewable Sources of Energy
EEC	European Economic Commission
EDEL	Empresa de Eletricidade de Luanda
ELF	French oil company
ENDIAMA	Empresa Nacional de Diamantes de Angola
ENE	Empresa Nacional de Eletricidade
ERR	Economic Rate of Return
ESMAP	Joint UNDP/World Bank Energy Sector Management Assistance Program
ESPA	Empresa de Servicios Petroliferos de Angola
E.T.C.	Dutch Foundation for Economic Research
FPA	Fina Petroleos de Angola
FURNAS	Furnas Centrais Eletricas, a Brazilian utility
GAMEK	Gabinete de Aproveitamento do Medio Kwanza (Office for the Harnessing of the Middle Kwanza)
GDI	Gross Domestic Investment
GDP	Gross Domestic Product
HEAC	Hidro Eletrica do Alto Catumbela
HFO	Heavy Fuel Oil
IBRD	International Bank for Reconstruction and Development
INP	Instituto Nacional de Petroleo
JPEA	Junta Provincial de Eletrificacao de Angola (utility of Southern Angola)
LFO	Light Fuel Oil
LPG	Liquefied Petroleum Gas
LRMC	Long Run Marginal Costs
LSFO	Low Sulfur Fuel Oil

ABBREVIATIONS AND ACRONYMS
(continued)

MEP	Ministerio de Energia e Petroleo (Ministry of Energy and Petroleum)
MPLA PT	Movimento Popular de Libertacao de Angola - Partido do Trabalho (the ruling party)
OGE	Orcamento Geral do Estado (General Budget)
PSA	Production Sharing Agreement
SADCC	Southern African Development Coordination Conference
SEF	Saneamento Economico e Financeiro (Program for Economic and Financial Restructuring)
SOFRELEC	French engineering firm
SONANGOL	Sociedade Nacional de Combustiveis de Angola (State oil company)
SONEFE	Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos (northern Angola utility)
TAU	Technical and Administrative Unit (Energy) of the SADCC
TEXACO	Texas Oil Corporation
TOTAL	French oil company
TPE	Technopromexport (Soviet engineering company)
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization

CURRENCY EQUIVALENTS

US$1 = 29.62 Kz (Kwanza) 1/
1 Kz = 3.38 US cents

ENERGY TERMS AND MEASUREMENTS

BCF	billion cubic feet
CIF	cost + insurance + freight
DWT	deadweight tons
FOB	free on board
ft/y	feet a year
GWh	Gigawatt hours
HV	high voltage
kcal	kilocalories
kcal/kg	kilocalories per kilogramme
kgoe	kilogram of oil equivalent
km	kilometer
km^2	square kilometers
kWh	kilowatt hours
kV	kilovolts
LV	low voltage
m^3	cubic meters
MAI	mean annual increment
MCF	thousand cubic feet
mcwb	moisture content, wet basis
MMBTU	millions of British Thermal Units
MMCF	millions of cubic feet
MMCFD	millions of cubic feet per day
MV	medium voltage
MW	megawatts
TCF	trillion cubic feet
t/d	tons a day
t/y	tons a year
toe	tons of oil equivalent

1/ Official exchange rate prevailing in Angola since 1975.

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SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

1. Angola is a large, potentially rich country with energy resources far in excess of its own needs. Development of some of these resources has already made a major contribution, if not to the development, at least to the maintenance of a society facing internal instability and external aggression. Angola's ability to export annually 12-14 million tons of crude oil, worth between US$1.5 and US$2 billion, has certainly helped the population to weather the last ten years with fewer hardships than otherwise. In short, petroleum production, intelligently managed, has financed the past unavoidable and considerable defense effort and the basic consumption needs of the urban population.

2. The objective of this report is to clarify, for the benefit of Angolan policymakers, some of the main issues which should be resolved in order to meet the energy needs of the country most economically and, subsequently, to develop energy as a leading sector in economic growth and development. Needless to say, many of the recommendations made can only bear fruit if and when a reasonable degree of peace returns to Angola. Therefore, a number of these, such as the recommendation to set power tariffs on the basis of Long Run Marginal Costs (LRMC), are meant to be implemented gradually. Others, such as the recommendation to set power tariffs to cover the financial costs of the utilities, can be implemented immediately. Implementing them would have an immediate favorable impact on the energy sector, on sector enterprises, and on the efficiency of resource allocation. 1/

3. Many of the problems addressed in this report are known to the Angolan staff working in the sector and to sector managers and technicians. The analysis and most of the recommendations presented herein have been discussed extensively with energy sector policymakers, managers, and staff. The recommendations rest mostly on economic, financial or technical principles and analysis. No attempt has been made to deal with the political dimensions of the issues, a matter with which the Angolan authorities have to deal, and which could be much more complicated than the application of analytical principles that the Energy Assessment has performed.

4. While the report presents some urgent problems facing Angolan policymakers, it is by no means a complete treatment of all issues in the energy sector. Rather, it provides an overview of the role of the energy sector in the Angolan economy and its main problems. It also describes the main features of the Angolan economy as the framework in which the energy sector functions, but does not attempt to provide an exhaustive

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1/ As of January 1, 1989, the MEP has proposed to increase electricity tariffs to an average of Kz 3/kWh, in line with the analysis of this report. This should be sufficient to cover, for the time being, the cash deficit of the utilities.

treatment of general economic issues 2/. Coverage of the petroleum and gas subsector is limited to issues such as pricing, taxation, and supervision of oil companies which the Angolan authorities suggested and which are some of the most pressing ones. The report does not give a detailed descriptive picture of the oil subsector. This is, in any case, well known both in Angola and abroad and is reported on systematically by the petroleum press. Analysis of the electric power subsector does, however, intend to cover all important issues. Through extensive analysis, the aim of this report is to outline a development strategy for the energy sector, indicating the broad directions which management of the sector ought to take. This is summarized below and developed somewhat more fully in paragraphs 1.41 to 1.51. The summary of sector strategy is followed by discussion of the three main issues that must be addressed immediately. The report's main recommendations are presented in the form of an action plan for development of the energy sector. This plan is outlined in matrix form in Table 1 at the conclusion of the summary.

Recommended Development Strategy for the Energy Sector

Oil Exploration and Production

5. In the short run, Angola has little choice but to develop and exploit its oil resources as fast as it can. Continuing and even increasing investments in exploration by international oil companies should be encouraged to prevent too rapid a drop in oil production in the mid-1990s, especially in view of the recent acceleration of oil output. In fact, if current (mid-1988) production levels are to be maintained indefinitely, Angola needs to reassess whether the current level of exploration expenditures is sufficient to avert a precipitous drop in reserves and, eventually, in production. To maintain incentives for exploration, the Government should not allow the competitiveness of contractual terms for the oil companies to fall significantly behind those of other countries. The Government also needs to continue strengthening the State-owned oil company, SONANGOL (Sociedade Nacional de Combustiveis de Angola), its effective instrument for promotion and control of oil activities. The best way to strengthen SONANGOL is to increase its managerial and financial autonomy as much as possible, while improving its capacity to analyze the economic and technical issues that arise in its activities. To strengthen SONANGOL's management and supervisory role, an incentive system should be developed that will enable SONANGOL to attract and retain specialized staff. To improve its capacity to analyze economic and technical issues, an improved management information system is needed.

2/ This is done in the UNDP/World Bank Report entitled, "Angola: An Introductory Economic Review".

Refining and Petroleum Product Supply

6. In refining and petroleum product supply, the present situation is broadly satisfactory. The FPA (Fina Petróleos de Angola) refinery in Luanda runs economically. As a result of its recent de-bottlenecking and life-prolongation, it should be able to supply most of Angola's needs for quite some time, especially if peace returns soon. Angola can continue to satisfy its excess demand via imports but should act to reduce wasteful or low-priority consumption through a substantial increase in prices and the elimination of redundant subsidies.3/ To reduce the foreign exchange costs of petroleum product import/export arrangements, SONANGOL should resume full responsibility for procurement of imports and cargo exports and seek cheaper supply sources. For the short-to-medium term, large investments in refinery capacity can probably be postponed because of the great uncertainties in forecasting demand. At a time when both the State and SONANGOL need to devote resources to petroleum exploration and production, purchasing most or all of the stock or assets of the refinery cannot be a high priority. However, if a share of refinery ownership can be obtained without great, net outlays of Angolan public resources in the framework of a reshuffling of assets and claims between SONANGOL, FINA and the Government, then such a transaction could take place.

7. Refinery and distribution operations need to be studied to improve upon the cost-plus system that is common to both. In refining, incentives toward greater efficiency could be built in and applied. One way to achieve this goal would be to have FPA share in any savings earned through improved productivity and be penalized for inefficiencies, e.g., by paying some share of them. To improve efficiency in distribution operations, rather than creating incentives and penalties, it might be easier to spin off distribution to a relatively autonomous affiliate of SONANGOL. Additional work would be needed to define the precise form of the incentive system. This is proposed as a subsequent ESMAP activity.

Natural Gas

8. In general, prospects for development of non-associated fields are not promising. Rather than exploiting these fields, it is better to leave the gas in the ground until economic uses can be found for it. No investments should be made in assessment or delineation of gas fields unless major economic uses for the gas have been identified. Of the associated gas currently produced, about 50% is being used productively. New lift and reinjection schemes and the expansion of existing ones are likely to increase the utilization rate to 70% by 1990. As regards the further use of associated gas, highest priority should be given to an LPG fractionation scheme in Cabinda which would replace LPG imports, and an

3/ In the absence of a reliable exchange rate, the report finds it difficult to make precise price recommendations. However, internal prices of petroleum derivatives are widely held to be negligible and in need of serious adjustment, if only to dispel the false idea that petroleum products are costless.

export-oriented LPG/condensates recovery program in Block 3. If the first project goes ahead, an LPG bottle rehabilitation plant would be required as well. SONANGOL's ability to study and supervise gas-related projects should also be strengthened by forming around the few people currently dealing with gas in SONANGOL, a small unit responsible for gas matters. While large petrochemical projects (such as ammonia urea) seem to have rather dim prospects, if foreign investors are prepared to take all risks, Angola could well accept such projects, provided a reasonable price were paid for the gas.

Electric Power

9. Angola's electric power subsector still operates reasonably well but has suffered from more than a decade of neglect, and the war has further contributed to this problem. Demand has stagnated, especially in industry, and households have become the main consumers of power. Given the great uncertainties in forecasting demand, a risk-averse stance with respect to investments would seem the preferable strategy. More specifically, this report suggests the following strategic guidelines:

(a) maintain a reasonable quality of service, without sizeable new investments;

(b) launch a rehabilitation program for existing dams, power plants, and transmission grids;

(c) strengthen key central management functions, such as system and financial planning and equipment standardization, but maintain a decentralized operations structure; and

(d) set the base for future growth by strengthening management, accounting, and finance and ensuring that the utilities have the managerial autonomy which they require for efficient operation.

Additions to capacity should be very low on the list of priorities until after the mid-1990s. The current centerpiece of investment in electric power, the Capanda project, should be postponed and re-examined in the mid-1990s when, hopefully, a better assessment of future demand would be possible.

Household Energy

10. For household use, the cities presently receive both traditional and commercial energy. A major problem is the dramatic under-valuation of commercial fuels such as Liquefied Petroleum Gas (LPG) and kerosene. With a more balanced pricing policy in the future and with the removal of inefficiencies and risks in the supply of firewood and charcoal, consumption patterns even in the cities might not so overwhelmingly favor commercial fuels. For the present, the Government

needs to make sure that supplies to the cities are maximized. The essentially correct policy of keeping "hands off" trade in traditional fuels should continue in the short run. However, with the return of peace, the situation should be reviewed with the aim of: (a) establishing policies to promote a more efficient and competitive trade in fuelwood and charcoal; and (b) economizing on domestic use of some of the commercial fuels, thus creating exportable surplus. This longer-term strategy is viable because the country's forestry/biomass resources are sufficient and sufficiently, broadly distributed to satisfy the needs of the population under normal situations. No large, urgent interventions in forestry are really necessary or possible at present. However, some useful actions are suggested in paragraphs 5.34 to 5.44.

Main Issues in the Energy Sector

11. There are a number of issues and problems in the Angolan energy sector. Many are analyzed and discussed in the body of this report. The most important ones, however, are highlighted in the paragraphs below. For ease of discussion, they are organized under three headings:

(a) investment programming in the electric power subsector;

(b) price policies and financial problems of sector enterprises; and

(c) management, qualified manpower, training, and technical assistance.

12. These issues are interrelated. They are probably of about equal importance in that they must all be resolved to allow improved efficiency and viable development of the sector. While there are some problems in the petroleum and gas subsector, none seem really grave or urgent, except for pricing of petroleum products, which is discussed in paragraphs 16 to 20.

Investment Programming in the Electric Power Subsector

13. Investment programming in the electric power subsector reflects an economy-wide weakness in project analysis and selection. It also reflects a weak institutional capability in the utilities and in the supervising ministries. As a result, real needs or problems are not identified and projects to satisfy or resolve them are not carried out. An extreme case of the above is the centering of the investment program of the electric power subsector on the Capanda dam. This project, which may end up costing more than US$2 billion, is being considered despite the fact that it does not resolve the subsector's problems. Generating capacity would be added that, even allowing for a high degree of uncertainty over demand, would not be needed for many years. Moreover, this additional capacity could not be used because transmission and

distribution facilities are limited as well as run-down, and could not handle increased supply. Furthermore, an enormous share of generating capacity (about 50%) would be concentrated in one distant region of the country at a time when insecurity makes transmission lines vulnerable. This investment at Capanda would create very little additional revenue for the utilities and thus could exacerbate rather than alleviate the financial problems of the sector. Given the commercial nature of the financing plan for this investment, carrying it out would greatly inflate the sector's external debt and even threaten availability of free foreign exchange if future oil output were offered as a guarantee. Recent loans obtained in an effort to fill a large gap in the financing plan (in excess of US$500 million) are at wholly inappropriate terms (7.5%, 2% insurance fee, two years grace, and 90 months amortization period).

14. In reality, the needs of the electric power subsector are quite different from those that a project such as Capanda would resolve. The subsector needs to catch up on major maintenance, which was neglected for more than a decade. It needs this for generating plants, transmission lines, and distribution grids. Given the uncertainties, firm forecasts are not possible, so that the subsector needs flexibility to respond to demand wherever in the country it might arise. To achieve flexibility, improvements and small additions to capacity are needed everywhere, in the Northern, Central, and Southern Systems.

15. A project to resolve these problems is essentially the mission's main investment proposal for the electric power subsector (paras. 4.90-4.95). Briefly put, the objective of the project recommended in this report is to rehabilitate power subsector facilities so that they are able to operate at or near their installed capacity, with some small additions in some places, such as Matala and Lomaum. Since present available capacity is only about 59% of installed capacity (i.e., 275 MW out of 470 MW) this rehabilitation project is a substantial one. It is also a much better risk-averse response to the problems of the power subsector, and the uncertainties it faces, than a lumpy investment such as Capanda. In brief, therefore, this report recommends investments in the power subsector of about US$200 million (including technical assistance) over the next five years, as opposed to present programs exceeding US$1 billion.

Pricing

16. Energy pricing is an area where immediate and radical policy changes are both imperative and feasible. Severe price distortions are an economy-wide phenomenon and must be addressed in an overall policy which seeks to revive the allocative role of markets. Under the prevailing regime, prices perform a passive, accounting function or serve as an inefficient redistributional mechanism. These prices do not provide signals to assist producers and consumers in their decisions about the rational use of scarce energy resources.

17. The relative price of energy in Angola has fallen precipitously in the last several years as a result of basically fixed nominal prices for petroleum products and fixed nominal electricity tariffs. Other prices have increased at rapid rates. As a result, energy prices, including tariffs, have become negligible in real terms, resulting in wasteful consumption on the demand side, and large financial deficits for energy supplying firms, in addition to sizeable subsidies paid or revenues forgone by the State budget. Since energy prices have become negligible, subsidies have become redundant, i.e., whether LPG is sold at Kz 15 per kg or Kz 25 (at a definite cost to the budget) is essentially immaterial at the present purchasing power of the Kwanza. Justification for these consumption subsidies is therefore non-existent. Similarly, crude oil for domestic refining costs the State budget approximately US$3 per barrel in subsidies, but results in no appreciable reduction in the cost of oil products to consumers. The pricing, taxation and subsidization system for oil products is described more fully in paragraphs 3.27 to 3.36.

18. Briefly put, this report suggests that oil products be sold at prices which reflect their opportunity costs at a suitable exchange rate. Products should also be taxed at roughly similar rates (because they are close substitutes). Automotive fuel prices should include a levy for road maintenance. In paragraphs 3.35 to 3.36 some calculations are made to determine illustrative prices for oil products. With more realistic exchange rates, and minding the revenue needs of the budget, this report calculates that prices of oil products would need to be increased three- to four-fold. As a result of these higher prices, excess low-priority consumption might be reduced somewhat, yielding a greater exportable surplus. Meanwhile, the Government would reap enough revenues to substantially reduce the current budget deficit. This would have a positive deflationary impact, even if public (defense) use of products were to be tax-exempt.

19. In the case of electric power, the immediate goal should be to restore the financial viability of the utilities. In the longer run, the aim of policy should be to base tariffs on Long Run Marginal Costs. In the meantime, electricity tariffs have become meaningless (the annual cost of electricity supply to a high income urban home is equivalent to a few cans of beer) and the financial position of the electric power utilities, untenable. In the immediate, this report suggests that electricity tariffs be increased three- to four-fold to urgently direct some resources to the utilities. This would relieve the budget from having to supply Kz 1 - 1.5 billion in subsidies each year. In the medium term, an appropriate goal could be that tariffs should cover all financial costs as well as a share (say 20%-25%) of a reasonable investment program, or more simply, obtain a modest return on assets (say 4% or 5%) in addition to covering all costs.

20. Price measures are meant to help improve efficiency, and not to substitute for it. Thus, they need to be accompanied by other supportive actions. For example, in oil refining and distribution, the cost-plus

system governing these activities gives no incentive to cut costs, as savings are automatically transferred to the budget, and losses are automatically covered by the budget. A formula tying reductions in costs of refining with compensation to FPA needs to be defined and implemented. This formula could be defined in a subsequent ESMAP-assisted task. Similarly, the distribution activities now carried out by SONANGOL could be carried out more efficiently in a separate enterprise, or a very autonomous affiliate of SONANGOL, and without the cost-plus arrangement currently in force. The easiest system could be a tax regime that apportions the benefits of greater efficiency between the budget and the enterprise. For the power utilities also, increased tariffs will not help unless they are accompanied by measures to strengthen billing, collections, and technical and financial management generally, including system planning and project selection under uncertainty.

Management, Manpower, Training, Technical Assistance

21. The shortage of skilled and trained manpower which Angola inherited, and which was exacerbated by the exodus of Portuguese settlers, still remains one of the most pressing problems to be resolved. Many of the shortcomings in the selection, preparation, and execution of basic policies to a large extent are attributable to the lack of qualified and experienced personnel. These constraints also apply to the energy sector though it appears that the energy subsectors, notably the oil enclave, are somewhat better off than the rest of the economy.

22. Not suprisingly, the petroleum subsector has been least affected by the country's shortage of managerial capabilities and technical skills. So far SONANGOL's high- and medium-level management positions have been staffed with comparatively experienced and competent personnel. In addition, SONANGOL has had access to, and has extensively used, the expertise of foreign oil companies and consulting firms, and there is little doubt that it should continue to do so in the future, while trying to reduce the cost by tapping potential sources of concessional technical assistance. However, other existing sources of know-how, such as on-the-job training programs provided by foreign oil companies, are biased towards technical and engineering skills. SONANGOL itself more urgently needs additional expertise in the areas of management, supervision, financial analysis and economics.

23. A unique feature of Angola's Petroleum Law is that all oil companies are required to assign US$0.15/bbl produced, to a training fund which is controlled by the Ministries of Finance, Education and the Ministry of Energy and Petroleum (the MEP, Ministerio de Energía e Petróleos). At current production rates, these payments amount to US$16.8 million per year (Kz 500 million). However, control over these funds is unclear. A more transparent mechanism should be established to make sure that the resources, which are paid in hard currencies, are channelled into areas with highest educational priorities.

24. In 1986, the power sector, excluding the Office for the Harnessing of the Middle Kwanza (GAMEK, Gabinete de Aproveitamento do Medio Kwanza) employed about 4,000 persons. About 100 of these were expatriates. While the know-how provided by the expatriate employees proved remarkably cheap (US$1,000 per man-month), it contributed little to improving the management and planning capabilities of the power utilities. With only 51 higher-level technicians and professionals (30 Angolans plus 21 expatriates), the power sector is extremely short of experienced and qualified manpower. Moreover, a disproportionate share of the higher-level staff is concentrated in the head office of the national electricity company (ENE, Empresa Nacional de Electricidade) in Luanda so that many of the operating utilities are left without any professional back-up. Given the formidable task of rehabilitating the basic infrastructure of the utilities and improving the sector's overall management capabilities, an additional and sizeable inflow of financial and human resources will be required. The technical assistance needed to improve the efficiency and financial viability of the power utilities would amount to 105 man-years (equivalent to US$10 million) over a three-year period. Much larger sums would need to be raised in order to finance the implementation of a minimum rehabilitation program centered on strengthening the operational capabilities of the power sector.

25. Compared to the immediate needs of the electricity subsector, external support to the country's forestry administration in the area of woodfuel resource management is not as pressing. Thus, priority for the assignment of qualified manpower, whether national or expatriate, should go towards strengthening operating companies in the various subsectors (power utilities, SONANGOL), the policy-making units of the MEP, and, eventually, the staff of the central power planning in a yet to be created decentralized national power company. Priority should be given to training efforts and technical assistance which:

(a) meet the manpower requirements of the power subsector; and

(b) keep the managerial capabilities of SONANGOL at their current high level (with small improvements where necessary, for example in examining issues of gas utilization).

Other Conclusions and Recommendations

26. The following sections of the Executive Summary more systematically enumerate the conclusions and recommendations of this study.

Oil and Gas

27. Angola depends on oil income economically and politically. General Government policies on oil development have been enlightened, and thus deservedly successful. A workable modus operandi was established between SONANGOL and the MEP (which has the overall policy and supervisory mandate over oil) in supervising oil activities in Angola. Even though its enabling legislation empowers it to explore for, produce, transport, refine and distribute oil, SONANGOL has two major practical tasks. The first is to encourage foreign investment in oil exploration and production and to negotiate advantageous contractual terms with interested oil companies. The second is to supervise and control foreign oil companies and to raise the funds required to meet its share of investment programs. Therefore, the performance of SONANGOL should be judged on its success in mobilizing and steering external resources into oil operations and in supervising and controlling foreign oil companies. For these reasons, for the time being SONANGOL should minimize its involvement in upstream operations and other extraneous activities unless these strengthen its supervisory role. Similarly, the domestic distribution and marketing operations of SONANGOL could be spun off into a relatively autonomous division or subsidiary, if not privatized. Although it is inescapable that SONANGOL remain under the political control of the State, it should be granted greater managerial and financial autonomy. SONANGOL's ability to raise the funds required to meet its financial obligations is crucial. Therefore, the Government should not routinely use oil as collateral except for oil operations. SONANGOL's ability to adequately control and supervise the activities of foreign oil companies can be improved by establishing a more efficient management information system. This could be done with ESMAP assistance. Training of qualified staff, in conjunction with the development of an incentive structure for skilled personnel, is an important task. However, a more efficient utilization of existing training opportunities and institutions should suffice, rather than the creation of new or specially designed programs. A suitable incentive system could play an important role in attracting and retaining managerial and highly specialized staff. Technical assistance would still be needed both to carry out complex tasks and to help train newer staff.

28. So far, the taxation system for the oil sector has worked well. Tax legislation has allowed the Government to capture windfall profits, while oil companies have been protected against a profit squeeze in periods of declining oil prices. It would therefore be counter-productive to make fundamental changes in the fiscal terms that apply to oil companies.

29. Part of the existing legislative framework was established in the 1950s and does not match the contractual approach and taxation system embodied in the more recent joint venture and production-sharing

agreements (PSAs). There are also differences in the contractual terms for joint venture and PSA operations. Although the Government is ready to deal with these problems pragmatically, it might be preferable to make small textual adjustments to the text of the legislation and contracts.

30. Significant quantities of associated gas (currently about 50% of total production) are used for gas lift and reinjection schemes. New lift and reinjection schemes are underway, and existing ones are being expanded. A target utilization rate of 70% is the goal for late 1990, up from the present 50% or so. This is a reasonable objective. No economic large-scale projects are presently known. Thus, prospects for the development of non-associated gas fields are dim. The only large-scale project capable of using sizeable quantities of natural gas is the proposed export-oriented ammonia/urea plant which would require about 50.6 MMCFD of gas. However, in view of the depressed international fertilizer market and given that gas supply costs are relatively high, Angola would not have a substantial comparative advantage even in a well-managed plant.

31. SONANGOL's ability to study and supervise even a limited number of gas-related projects should be strengthened by building a small unit responsible for gas matters, using as a nucleus the few people currently dealing with gas in SONANGOL. This unit should be in a position to monitor ongoing gas-related activities more thoroughly and to coordinate plans for future projects with related activities in other subsectors.

32. Highest priority should be given to two projects presently under consideration by SONANGOL: the LPG recovery scheme in Cabinda, and the export-oriented LPG/Condensates recovery program in Block 3. Other projects which deserve further investigation in the short term are: the planned LPG bottle rehabilitation plant, the proposed dual-fuel thermal power plant in the Soyo area, and the onshore plant for recovery of LPG at Malongo costing US$3-4 million (provided that demand will be adequate at the higher LPG prices which the report proposes).

33. Pricing of petroleum products at the refinery gate and to final consumers, and pricing of crude oil for domestic refining, are areas where substantial reforms could be implemented most easily. Many countries use oil prices as a fiscal mechanism to raise public revenues and to impress on the consumer the fact that oil is a scarce, costly and exhaustible resource. Both these aspects of oil pricing could fit well with the present economic situation of Angola. Yet, specific pricing recommendations are difficult to make in the macroeconomic policy environment of Angola. However, given the extreme overvaluation of the Kwanza, the standard economic prescription of using opportunity costs as the basis for pricing would only fully make sense <u>after</u> the value of the Kwanza has been adjusted downwards to some sort of equilibrium level (or to a level nearer to equilibrium than is currently the case). But since final petroleum product prices in Angola are below border prices even at the highly overvalued, present, official exchange rate, and the crude oil

for local refining is subsidized, these shortcomings would need to be corrected first. A series of step adjustments in prices would probably be easiest to apply. The steps could be as follows, using hypothetical exchange rates:

<u>Step One</u>: Eliminate all subsidies to crude and products including LPG, and immediately bring all prices to border levels at the official rate of exchange.

<u>Step Two</u>: Adjust all petroleum product prices to an exchange rate of, say, Kz 100/US$.

<u>Step Three</u>: By this time, the Program for Economic and Financial Reconstruction (SEF, Saneamento Económico e Financeiro) should be in progress and a more adequate exchange rate might be available to guide the MEP in the pricing of petroleum products. Should the exchange rate remain fixed in spite of notable domestic price increases, the MEP could use an index of inflation to keep real product prices stable.

34. The refining of indigenous crude in Luanda in a hydroskimmer is an economically viable product-supply strategy for Angola as compared to imports of products. The FPA refinery is a reasonably run and well-maintained facility. The Government seems intent on purchasing this refinery or a genuine controlling interest in it. This would seem a low-priority use of limited Angolan funds unless it is done in such a way as to minimize the drain on public resources. Furthermore, lack of incentive to reduce costs and possibly high use of expatriate labor are the most apparent contributors to high operating costs. The FPA refinery operates on a "cost-plus" refinery gate pricing arrangement which gives no particular incentive for cost minimization and optimization of operations. Therefore, efforts should be made to design and implement a pricing scheme which encourages the refinery to operate in a more efficient way--for example, through a tax scheme that would share productivity gains between the Government and FINA. This could be done in the context of an ESMAP activity.

<u>Electric Power</u>

35. Angola's power subsector, which still operates reasonably well, has suffered from more than a decade of neglect. By 1987 the firm capacity had deteriorated to 275 MW, which is less than 60% of total installed capacity. Transmission and distribution lines have hardly

received any maintenance since 1975. Though the present state of the utilities' accounts makes it almost impossible to assess their financial performance, there was little doubt that in 1987 the global cash deficit of the sector would approach the level of US$50 million (or about Kz 1.5 billion).

36. In order to safeguard a reasonable quality of service and to gradually restore the utilities' financial viability, strong measures are required immediately. Priority should be given to: improving the financial performance of the utilities; strengthening the utilities' operational and managerial capabilities, including accounting, billing, and collection systems; reorganizing the subsector to provide more internal managerial autonomy; and, most importantly, reorienting the investment program to favor rehabilitation of the existing physical infrastructure rather than expansion of capacity.

37. A significant and sustained improvement in operations, maintenance and management requires the influx of know-how and finance. Operational support for the Central and Southern Systems as well as advisory assistance to a proposed task force would require about 35 man-years of long-term consultants plus some short-term consultants at a total estimated cost of US$10 million.

38. The financial losses of the power sector are no longer sustainable. Therefore, cost recovery is a matter of utmost concern. To ensure cost recovery, there should be immediate increases in tariffs up to 400%. The utilities' billing and revenue collection procedures should also be improved. In the short term, tariffs need to be simplified and restructured to enable the utilities to meet simple financial targets. In the medium term the adjustments should be designed so as to bring the level and structure of the tariffs in line with Long Run Marginal Costs.

39. In the past, ENE--the national power company--was neither given the actual means nor the authority to assume the management of the subsector in a reasonably efficient way. Therefore, measures should be instituted to decentralize all operations and maintenance and part of the proposed rehabilitation activities to the Regional Directions, as this is closer to actual practice than the theoretical centralization implicit in the formal structure of ENE. At the central level, a small planning unit should be established and be responsible for strategic matters (demand studies, capacity planning, tariff studies, etc.). Such a unit is currently being established in the MEP.

Investment Priorities in Electric Power

40. In the short term, investment priorities must center on repair, rehabilitation, and resumed maintenance of existing facilities. Rehabilitation should proceed simultaneously on all three systems as both security and economics relegate interconnection of the systems to a fairly distant future. The medium-term goal should be to fully restore supply capabilities in line with installed capacities. The investment programs for the electric power subsector as a whole, excluding Capanda, totalled about US$100 million for 1987 and 1988, 75% of it in foreign exchange. A program of this size is beyond the financial and technical capabilities of the utilities. A scaling down of future investments is thus inevitable. A tentative priority investment program described in Chapter IV should be based on the following considerations: assign highest priority to rehabilitation of existing facilities; strive for improved reliability of supply to main cities, which are also the main industrial areas; improve supply to Luanda by addressing the main problems in generation, transmission, transformation, and distribution; postpone most small projects in isolated systems, mainly for lack of managerial/technical staff, even if equipment has been purchased; postpone new rural/village electrification until hydro supply conditions have been improved and tariffs readjusted; limit new connections in cities until tariffs are adjusted and (especially in Luanda) until billing and collection procedures are substantially improved; and plan a substantial amount of technical assistance to support ENE task forces in big rehabilitation projects such as Lomaum and the Southern System.

41. A minimal priority investment program in line with the above priorities and considerations was prepared by the mission in collaboration with the staff and managers of the utilities and the staff of MEP. Given the above priorities and constraints, the mission sees no useful role for additions to capacity of the scale being considered at Capanda. The priority investment program should be carried out over the next five years and would cost about US$200 million (Kz 6-7 billion). This seems to accord better with the financial and managerial/technical possibilities of the subsector. However, it would still be a heavy financial and management burden on the utilities.

42. A general recommendation, in addition to the considerations listed above, is to subject every substantial project (say, exceeding US$2 million) to economic and financial feasibility analysis.

Capanda

43. The Government's apparent decision to advance the construction of a dam and power plant at Capanda presents several major issues. Although the analysis done is preliminary and conclusions should be taken as tentative, several robust conclusions emerge. First, Capanda

represents a significant departure from the lowest cost expansion path, even if it has not been updated recently. Second, the huge capacity (4 x 130 MW) planned for Capanda will probably not be needed until well into the next century. Third, it is a project which, by itself, will not improve the reliability of service in the Northern System and will not mitigate the problems of the other two systems at all. Fourth, actual and expected low demand growth rates and the availability of substantial thermal reserve would allow the postponement of this irreversible major investment decision during this period of uncertainty and stringent financial conditions, at a very low risk, until the economic environment becomes more stable and a better perception of the potential medium- and long-term demand is possible. Fifth, making the investment in Capanda will add substantially to the public external debt burden (commercial financing). It may also undermine Angola's ability to finance the vital petroleum development program (on which its future export earnings depend) because part of Angola's future petroleum output has been earmarked as a repayment guarantee on some of the Brazilian financing for Capanda. Sixth, only about half of the financing required for the project is firmly in place. That is, out of a total cost optimistically estimated at about US$1.5 billion* about US$528 million has been secured on commercial terms from Banco do Brazil (and these funds will essentially run out by early 1989) for civil works, and about US$275 million have been firmly committed by the Soviet Union for electromechanical equipment only. Thus, only about US$800 million has been committed. For this reason, it might be preferable to stop work deliberately rather than wait until funds run out. An alternative and better justified project would be the rehabilitation of all existing systems and small-capacity additions. In any case, it is likely that the Government of Angola will be unable to raise funds to complete the project. Meanwhile, a consulting firm has been retained to reevaluate the Capanda Project, and the Government has requested World Bank comments on the resulting report.

44. In the final analysis, therefore, this report recommends that the existing least cost expansion plan be updated, based on the best available demand projection, so as to confirm the stage at which Capanda power should be developed. Alternative expansion sequences in the Northern System (with different timings for Capanda and complementary works in Cambambe) should be evaluated in full detail and in the context of the entire power subsector, with all economic and financial implications reassessed in a realistic framework of demand projections and updated costs. To assist in these tasks, this report includes Terms of Reference (see Annex 18) for the carrying out of a Power Subsector

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* This total cost figure is approximate but excludes the cost of a transmission line to Luanda and of transformers and substations. It also excludes physical and price contingencies. With all these elements, and assuming good cost control measures--which are not now in evidence--the overall cost might well exceed US$2.0 billion.

Investment Review which would further identify and start preparing the rehabilitation of the three power systems, review or carry out the economic financial analysis of major projects and study the feasibility and costs of stopping the work on Capanda dam, protecting the works already executed and finding uses for materials and equipment already procured.

Forestry, Woodfuels and Household Energy

45. While available statistics are few and unreliable, two recent studies and mission estimates have produced a picture of the situation of supply and demand for forestry and woodfuels in Angola which can be summarized as follows.

46. Most Angolans use firewood or charcoal for cooking and heating. In the cities, however, a significant minority use LPG. The aggregate consumption of firewood is in the order of 2.5 million tons/y and of charcoal about 0.5 million t/y, requiring a total removal of 6 million tons or about 10 million m^3 of wood. Angola possesses some 50 million hectares of dense forests and a further 55 million hectares of woodland and savanna. Together these forests are capable of producing much more wood on a sustained basis than is at present consumed in the country.

47. Out of Angola's nine million inhabitants, almost half live in areas with more or less pronounced fuelwood shortages, either on the dry coast or in inland cities. In the shortage areas, the group hardest hit is the periurban population. They have limited access to alternative fuels (more easily available in urban centers) and, unlike most rural people, they cannot gather their own fuelwood for free. They are, furthermore, penalized by high market prices for woodfuels: the cost per thousand useful kilocalories is only Kz 10 for LPG but 10 to 20 times as much for firewood and charcoal.

48. The institutional framework for energy forestry in Angola is weak. Exploitation of fuelwood is regulated by the National Directorate for the Conservation of Nature (DNACO), which issues cutting licenses. The DNACO, however, has no resources to ensure that the actual cutting conforms to the licenses issued.

49. The creation of new forests is not the best (cheapest) way to solve the fuelwood problem. This is primarily because the dry coastal strip of Angola, where most of the people experiencing fuelwood shortage live, is poorly suited for tree-growing.

50. This report proposes several sets of priority activities at the regional and national levels. Four are regional in character while two are national. The first regional set of activities covers the provinces

of Huila and Namibe, a region where the security situation is fairly good. It includes both city-oriented activities like the improvement of stoves and rural-based ones like improved supply systems for firewood and charcoal. The other three regional sets of activities all cover urban areas: one for Luanda; one for Benguela/Lobito; and one for Huambo township. For Luanda and Benguela/Lobito, it is proposed that emphasis be put on increased use of LPG as a domestic fuel. In Huambo township, improved stoves should be given first priority.

51. Two national activities should be carried out in support of the regional ones. One covers the development and introduction of improved stoves and the other concerns initial development work and trials in agroforestry. The activities listed, regional and national, have been grouped into four projects. They are the following:

(a) a pilot project in Huila-Namibe, to integrate the various components of energy forestry, including the development of agroforestry;

(b) improved cooking stoves, mainly for the urban and periurban populations in Luanda, Benguela, Lobito, and Huambo;

(c) an improved supply system for woodfuels, mainly for the cities of Luanda, Benguela, Lobito, and Huambo; and

(d) continuing, partial replacement of firewood and charcoal by LPG as a domestic fuel for the urban and periurban population on the coast, at least until more peaceful conditions improve supplies and lower the prices of woodfuels, and economic adjustment measures increase the prices of petroleum products (LPG, kerosene).

52. Table 1 presents in matrix form an overview of the various actions proposed in this report to enhance the development of Angola's energy sector. Each action is assigned a priority and a time frame for completion. The time frame is divided into short term (actions to be implemented immediately), medium term (actions to be implemented over two to three years), and long term (actions to be considered over a period longer than three years). Estimated costs are given for specific projects, where these are already known or have been calculated for the purposes of this report.

Table 1: ANGOLA : ACTION PLAN FOR THE DEVELOPMENT OF THE ENERGY SECTOR

Objective	Action	Cost	Priority	Time Frame a/
A. Electricity				
(1) Operational strengthening of utilities.	Increase technical assistance and training in preparation for rehabilitation program.		FIRST	ST - MT
(2) Reorientation of investment policy towards repair and maintenance of the sector's existing facilities.	Plan and execute a Power Sector Rehabilitation investment program.	US$200 million (of which US$10 million to technical assistance) between 1988-92.	FIRST	ST - LT
(3) Financial recovery of the power sector.	Raise tariffs 300-400% immediately. Design and implement gradually a more economically efficient tariff policy. Improved billing and revenue collection system.	-	FIRST	ST-MT
(4) Administrative and institutional reform of the power sector.	Except for system planning, decentralize operations and maintenance.	-	SECOND	ST
B. Crude Oil				
(1) Maintenance of level of investment required to prevent the crude oil production rate from declining.	Provide SONANGOL with a greater managerial and financial autonomy.	-	FIRST	MT - LT
(2) Strengthening of the supervisory role of SONANGOL.	Establish an improved management information system; provide an incentive system to attract and retain specialized staff.	-	SECOND	MT
(3) Improvement in the competitiveness of contractual terms for oil companies.	Standardize the fiscal treatment of oil companies; revise outmoded legislation.	-	THIRD	MT - LT

a/ ST = short-term; MT = medium-term; LT = long-term.

Objective	Action	Cost	Priority	Time Frame a/
C. Natural Gas				
(1) Reduced dependence on LPG imports.	LPG fractionating offshore Cabinda to supply 30,000 t/y to the domestic market.	US$2-3 million	FIRST	ST
(2) Increase in export revenues.	LPG/condensates recovery in Block 3.	to be determined	SECOND	MT - LT
(3) Improvements in the supply infrastructure for domestic LPG.	LPG bottle rehabilitation plant in Luanda.	US$5 million	SECOND	MT
(4) Improved power generation in isolated areas.	Dual fuel 15 MW thermal power plant in the Soyo area and rehabilitation of 10 MW gas-fired turbine in Cabinda.	US$20-25 million	SECOND/ THIRD	MT
(5) Increase in LPG supply to domestic market.	Onshore plant for LPG recovery at Malongo.	US$3-4 million	THIRD	ST - MT
D. Petroleum Products				
(1) Removal of distortions in petroleum product and crude oil prices.	a) Eliminate all direct subsidies and adjust refinery gate prices to higher levels.	-	FIRST	ST
	b) Increase the price level in accordance with adjustments in exchange rate.	-	FIRST	
(2) Increase in the efficiency of refinery operations.	Modify existing cost plus arrangement.	-		MT
(3) Reduction in the foreign exchange costs of petroleum product import/-export arrangements.	SONANGOL to resume full responsibility for procurement of imports and cargo exports (Low Sulfur Fuel Oil) and seek cheaper supply sources.	-	SECOND	ST - MT

a/ ST = short-term; MT = medium-term; LT = long-term.

Objective	Action	Cost	Priority	Time Frame a/
Petroleum Products (Continued)				
(4) Reduction in the cost of domestic petroleum product distribution.	SONANGOL to delegate the wholesale business to an autonomous affiliate. Transport and retail business to be privatized gradually	-	SECOND	ST - MT
E. **Woodfuels : Scenario : No Peace**				
Coastal Areas				
(1) Improved fuel substitution.	Increase the supply of Liquefied Petroleum Gas.	US$5 or 6 million	FIRST	MT
(2) Increase in end-use efficiency for fuelwood and charcoal.	Produce and disseminate improved stoves.	US$100,000	SECOND	MT - LT
(3) Improvements in the woodfuel supply infrastructure.	Develop selected measures designed to improve the organizational set-up, the operational efficiency and the feed stock extraction of charcoal production.	US$75,000	THIRD	MT - LT
Inland				
(4) Reduction of specific woodfuel consumption in urban concentrations.	Introduce improved stoves.	US$600,000	FIRST	ST - MT
(5) Improvements in the woodfuel supply system.	Develop selected measures designed to increase the use of resources with marginal ecological importance, to upgrade harvesting techniques and to maintain the sustainability of supply.	Included in cost above.	SECOND	LT

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a/ ST = short-term; MT = medium-term; LT = long-term.

Objective	Action	Cost	Priority	Time Frame a/
Woodfuels : Scenario : Peace				
Coastal Areas:				
(6) Improvements in the woodfuel supply system.	Develop selected measures designed to improve the organizational set-up, operational efficiency and feedstock extraction of charcoal production.	-	FIRST	MT - LT
(7) Increase in the scope for fuel substitution.	Increase the supply of LPG.	-	SECOND	MT
(8) Survey of woodfuel supply systems to Luanda.	Described in Chapter V.	US$200,000	SECOND	ST-MT
(9) Improvements in end-use efficiency.	Produce and disseminate improved stoves.	-	THIRD	ST - MT
Inland:				
(10) Improvements in the woodfuel supply system.	Develop selected measures designed to increase the use of resources with marginal ecological importance, to upgrade harvesting techniques and to maintain the sustainability of supply.	-	SECOND	ST - MT
(11) Improvements in end-use efficiency.	Introduce improved stoves.	-	FIRST	LT

a/ ST = short-term; MT = medium-term; LT = long-term.

I. ENERGY IN THE ECONOMY

General Economic Framework

1.1 The People's Republic of Angola is located on the west coast of Africa, with Namibia to the south, Zambia to the east, and Zaire and the Congo to the north. The country also includes the enclave of Cabinda, which is separated from the rest of Angola by a corridor of Zairian territory and the mouth of the Zaire River. Angola covers an area of 1.27 million km^2. Its land borders measure 5,070 km and it has an Atlantic coastline exceeding 1,600 km. The climate is tropical in the north, subtropical in the south, and temperate on the high plateau. In mid-1986, Angola's population was estimated at about 9 million (1970 census: 5.6 million), and the current rate of population growth is in the vicinity of 2.8%. While the overall population density is comparatively low, there has been significant migration to urban areas in recent years. At present, urban and periurban dwellers probably account for about 30% of the total population.

1.2 After independence in November 1975, Angola was left with a significant shortage of trained professionals and skilled workers of all types needed to undertake the formidable task of rebuilding the economy which had been damaged by the war and was collapsing after a mass exodus of the Portuguese settlers. However, the country also inherited: a well-developed transport infrastructure; a relatively diversified manufacturing sector (above all in consumer and intermediate goods); rich agricultural areas; a healthy mining sector; and (e) a sizeable enclave petroleum sector. After independence, the continuing civil war has seriously hampered economic development and remains the most serious obstacle to economic recovery. Economic policy since independence has been based on central planning and administrative controls. This economic system has had various adverse effects, including the emergence of a parallel market, severe price distortions, wasteful investment programs, undesirable effects on the distribution of real income, and a general lack of financial and fiscal discipline.1/

1.3 Angola can be classified as a lower middle-income petroleum exporter. With an estimated GDP per capita of US$485 (1986) 2/ it ranks slightly above the average of the SADCC (Southern African Development Coordination Conference) countries. However, compared to other African countries with average hydrocarbon endowments (Tunisia, Gabon, and the People's Republic of Congo), Angola's GDP per capita is low

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1/ For a comprehensive analysis of the Angolan economy, see the UNDP/World Bank report entitled, "Angola: An Introductory Economic Review", July 1988.

2/ All of these figures are subject to large errors, but they are quoted in this report as they are the only ones available.

(Table 1.1). Moreover, despite large and increasing oil revenues, the country's GDP fell in real terms between 1980 and 1985. Angola is similar to other African countries with medium-scale hydrocarbon endowments in the sense that oil provides the lion's share of Government revenue (53% in 1985) and accounts for a significant portion of GDP (30% in 1985). As a consequence, the dramatic drop in international oil prices in late 1985 had a disastrous impact on the Angolan economy.

Table 1.1: COMPARATIVE ECONOMIC INDICATORS, 1985

Country	GDP per capita (1985-86 US$)	Share of Petroelum in GDP	Share of Oil Income in Government Revenues
Angola	485	30%	53.1%
Congo	1,110	40%	66.6%
Gabon	3,350	45%	66.0%
Nigeria	800	23%	--

Source: Angolan authorities; World Development Report 1986; Mission estimates.

1.4 As indicated in Table 1.2, the post-independence development of the Angolan economy can be subdivided into three distinct periods. Between 1977 and 1981, real GDP grew at an average annual rate of 4.3%. This upswing, however, was short-lived and came to a sudden halt in 1981-82 when internal strife intensified and oil revenues dropped because of sagging international petroleum prices. As a result, between 1981 and 1983 real GDP fell at an average annual rate of 5.1%. A series of austerity measures were enacted while oil production continued to grow. These two events cushioned the fall in GDP in the period between 1983 and 1985, but the collapse of petroleum prices in late 1985 precipitated the sharp recession of 1986. The figures presented in Table 1.2 also underscore the dominant role played by the petroleum sector. Imports and Government expenditures both strongly depend on the country's petroleum exports. In 1985 these accounted for almost 96% of total merchandise exports.

Table 1.2: ANGOLA: KEY ECONOMIC INDICATORS a/
(Percent Annual Change)

Indicator	1986	1978-81	1981-83	1983-85	1986
	Absolute Amount (In US$ million)				
Real GDP	4,409	+4.3 b/	-5.1	-1.7	-8.7
Government expenditure	3,110	+30.7	-9.9	+14.7	-14.1
Energy exports	1,150	+25.5	+5.7	+10.9	-39.7
Merchandise imports	1,062	+19.6	-19.1	+18.2	-23.3

a/ Least square estimates for average annual rate of change (%) in the value of above variables.
b/ 1977-81.

Source: Mission estimates (Annex 1).

Petroleum and Public Finance

1.5 The most direct linkage between the petroleum sector's value-added (which accounts for about 30% of GDP) and the rest of the economy (the non-oil sectors) is the impact which oil revenues have on the Government budget and Government spending. Between 1980 and 1986 petroleum contributed on average about 63% of total tax income (or almost 52% of total Government revenues). In fact, in every year except 1986 the rise or fall in total Government revenues was almost completely attributable to a corresponding change in the level of tax receipts from the petroleum sector. The momentum of public spending proved hard to curb when oil revenues slowed down or declined. As a consequence, large budget deficits were incurred between 1979 and 1986 (totalling Kz 140 billion). This gives the impression that Government expenditure out of oil revenues was adjusted, but with significant lags.

1.6 The medium-term impact of oil revenues on GDP growth has been minimal because most of the revenue either financed current consumption (public, mainly defense, and private) or went into low-productivity public investment projects, some of which remain incomplete. Moreover, oil income allowed the country to maintain a highly overvalued exchange rate which undermined the competitiveness of domestic tradeables by making imports artificially cheap, put an upward pressure on the prices of non-tradeables, and thus tended to distort the structure of GDP.

International Trade and Balance of Payments

1.7 The most striking feature of Angola's foreign trade is the steady increase in both the size and relative importance of the petroleum sector. The share of crude oil in total exports has increased consistently, climbing from about 30% in 1973 to 74% in 1980, and to more than 90% in 1986. Except for 1986, when oil income fell sharply, and 1981-82, when a slight temporary decrease was registered, oil export earnings have grown every year since 1978. In contrast, income from other export commodities such as coffee and diamonds--which used to account for a sizeable share of export revenues--has dropped continuously, and is today almost negligible. Since 1978 the country has always incurred a deficit on current account since the trade surplus (goods, especially crude oil, and non-factor services) and net unrequited transfers never offset the substantial--and steadily increasing--deficit on factor services. However, since 1978 Angola has invariably achieved a surplus on its capital account. However, more than 80% of the inflows were accounted for by foreign loans, and the small amount of foreign direct investment went mostly into oil activities. During the liquidity crisis of 1985-86, Angola's short-term foreign indebtedness increased significantly mostly because of increasing payment arrears which are recorded as short-term capital inflows.

Policy Reforms 3/

1.8 In view of the country's steadily worsening economic situation, Government authorities are seeking to develop and implement a series of policy reforms, such as granting more managerial and financial autonomy to State firms, relaxing price controls, limiting access to credit, making capital more costly, and devaluing the Kwanza. The proposed Program for Economic and Financial Reconstruction (SEF, Plano de Saneamento Económico e Financeiro) contains different ideas and proposals, but the specific objectives, design, and timing of the reform are still under discussion. The measures proposed so far are expected to help eliminate the most harmful features of Angola's economic system, i.e., the lack of fiscal and monetary discipline, the distortions created by price controls, the excess supply of money, and the overvaluation of the Kwanza. Should oil prices recuperate even partially, the balance of payments constraint would be eased and rising oil revenues and manageable budget deficits should lead to a sustained recovery, especially in the context of a better incentive framework and a winding down of the war.

Energy Sector Overview

1.9 By African standards, Angola is richly endowed with energy resources. The country has sizeable oil and gas reserves, a large hydro potential, and ample woodfuel resources. Currently, the proven oil reserves amount to 1,418 million bbl (sufficient to maintain the 1986 production level for the next 12 years), while natural gas reserves are

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3/ These policies are described and analyzed in greater detail in "Angola: An Introductory Economic Review".

estimated at 5 TCF. With its substantial oil and gas reserves, Angola ranks second only to Nigeria as an oil producer among Sub-Saharan countries.

1.10 In 1986, the primary energy equivalent of Angola's total commercial energy production amounted to 17.7 million toe, or 1.96 toe per capita. Only a few African countries, e.g., Libya, Algeria, and South Africa, recorded significantly higher figures on a per capita basis. If woodfuels are included (about 2 million toe of primary energy), per capita production was almost 2.2 toe. However, since more than 70% of the primary commercial energy production leaves the country in the form of crude oil and LPG (liquefied petroleum gas) exports, while 95% of the natural gas jointly supplied with crude oil is flared or reinjected, the final per capita consumption of commercial energy proves to be moderate. In 1986 it was 103 kgoe. This compares to 602 kgoe for Gabon (1985 figures), 151 kgoe for the Congo (1985), 142 kgoe for Saô Tomé and Príncipe, and 24 kgoe for Mozambique (1984). If woodfuels are included, which accounted for 56% of the net domestic energy supply, final energy consumption for 1986 worked out to 297 kgoe. Accurate figures on the sectoral breakdown of final energy consumption are not available. However, in rough terms about 50% of petroleum products, which account for 95% of final commercial energy or 42% of total final energy consumption, are used in transport and for military purposes, whereas the lion's share of woodfuels goes to households. A summary of Angola's 1986 Energy Balance is given in Table 1.3.

Table 1.3: SUMMARY OF ANGOLA ENERGY BALANCE 1986
(in '000s toe)

	Woodfuels	Natural Gas	Crude Oil	Hydro	Electricity	Petroleum Products	Total
Total Production	2,074	3,418	14,102	173	-	-	19,765
Total Available Supply	2,074	3,241	1,498	173	-	-	7,080
Net supply available a/	1,180	-	-	-	49	1,443	2,672
Final consumption b/	1,180	-	-	-	49	879	2,108

a/ Adjusted for conversion losses and non-energy uses.

b/ Adjusted for secondary exports and bunker sales.

Source: Annex 3.

1.11 Table 1.4 summarizes the trends in commercial energy consumption. The figures indicate the extent to which final consumption of petroleum products and electricity have been decoupled from the overall performance of the economy, particularly in the 1980s. While real GDP declined, the consumption of petroleum products showed a sharp upward trend. Even in the aftermath of the oil price drop of 1985-86, domestic sales of petroleum derivatives continued to increase. On the other hand, the changes in electricity consumption appear to be more in line with GDP growth. Between 1977 and 1982, consumption rose in direct proportion to GDP, and then declined as the economic situation worsened. However, this is not evidence of causality. The drop in electricity consumption may well have been due to supply constraints. Since the share of low voltage consumers (households) in total consumption increased significantly in the 1980s to more than 50% (a trend reinforced by extremely low tariffs), it appears that electricity consumption was more or less determined by power generation (net of transmission and distribution losses). Similar arguments apply to petroleum products. Between 1980 and 1986, consumption grew most for LPG, kerosene, and jet fuels which are demand inelastic with respect to income and prices (household and military use). Thus, lack of correlation between commercial energy consumption and overall economic growth can be explained by the fact that official tariffs for power and prices of petroleum products had become insignificant and no longer served as rationing devices. Indeed, at negligible prices, consumption may prove perfectly elastic until it meets another constraint such as appliances or supply capacity.

Table 1.4: SUMMARY OF TRENDS IN COMMERCIAL ENERGY CONSUMPTION a/

Energy Type	1977-82	1982-85	1980-86	1986 Absolute
Electricity	+6.6	-5.5	-0.5	49 ('000s toe)
Petroleum products	--	+9.0	+6.6	915 ('000s toe)
Total commercial energy	--	--	+6.2	965 ('000s toe)
Total per capita consumption	--	--	+3.3	110 (kgoe)
GDP	+4.3	-1.9	-3.9	485 (US$)

a/ Least square estimates of average annual rates of change.

Source: Angolan authorities and mission estimates (Annex 3).

Petroleum Products

1.12 As can be seen from Table 1.5, Angola's structure of petroleum product demand is heavily biased towards middle distillates, which account for more than 75% of total domestic sales. Within middle distillates, gasoil plays a less important role than it does in other countries at the same level of economic development as Angola, indicating that demand is artificially low in road transport, industry and agriculture. On the other hand, kerosenes account for more than one quarter of the total domestic petroleum product sales. Agriculture accounts for only 2% of domestic sales of refined products, which is hardly surprising given the low level of commercial agricultural production and the fact that many rural areas are cut off from the country's transport and distribution infrastructure. Industrial demand depends on a small number of energy-intensive operations (refinery, extraction, cement) which account for about three-quarters of the country's boiler fuel consumption. The public sector accounts for more than 50% of the aviation fuels consumed in Angola. Household consumption of petroleum products--primarily gasoline, kerosene, and LPG--is strongly biased towards the urban centers. Thus, the regional and sectoral distribution of Angola's petroleum product consumption are highly distorted, i.e., they mirror the constraints imposed by both the civil war and the depressed state of the economy.

Table 1.5: DOMESTIC PETROLEUM PRODUCT SALES BY SECTOR, 1985 (in %)

	LPG/Kerosene	Gas/Oil	Jet Fuels	Gasoline	Fuel Oil	Share in Total Sales
Industry	3.8	26.2	10.3	1.7	52.2	20.6
Agriculture	0.7	3.1	-	0.5	6.8	2.2
Transport	0.2	27.1	47.1	0.8	39.3	28.8
Construction	0.2	4.8	-	0.6	0.1	2.1
Resale	77.2	20.4	-	42.2	-	19.6
Government	1.7	4.0	0.1	2.5	0.4	2.2
Defense & Security	3.1	10.1	42.0	49.8	0.3	21.1
Others	13.1	4.3	0.5	1.9	0.9	3.4
Share in Total Sales	8.2	42.6	26.7	10.7	11.8	100.0

Source: Annex 8.

Crude Oil

1.13 In contrast to the rest of the economy, Angola's petroleum sector recovered rapidly after independence. Crude oil production climbed from 94,000 bbl/d in 1975 to 164,000 in 1979. Owing to the disruption of exploration and development efforts during the second half of the 1970s, a temporary decline in crude oil production was inevitable; but the trend was quickly reversed in 1981-82, and by 1983 output had rebounded to its 1974 level. In fact, large investments undertaken in recent years have resulted in a continuous increase in oil production since 1982 (while the reserve-to-production rate was kept above 12 years), and this upward trend in output is likely to continue until the end of the 1990s. Except for 1986, output growth even offset the fall in international petroleum prices to the extent that between 1982 and 1985 nominal export revenues continued to increase (Table 1.6).

Table 1.6: TRENDS IN THE PERFORMANCE OF THE PETROLEUM SECTOR a/
(Percent Annual Changes)

	1975-79	1979-81	1981-85	1986
Crude Oil Production	+16.6	-11.7	+18.0	+21.0
	1978-80	1980-82	1982-85	1986
Export Revenues from Crude Oil	+59.0	-5.8	+15.3	-39.3
	1978-80	1980-82	1982-85	1986
Export Revenues as % of GDP	+38.7	-6.3	+4.8	-33.4
Deflated Export Revenue from Crude Oil	+32.0	-6.4	+10.7	-41.2

a/ Least square estimates of average annual rates of change.

Source: Annexes 1 and 4.

1.14 Table 1.7 provides some rough indicators as to the relative magnitude of the resources which were required to keep the petroleum sector prospering. Between 1982 and 1986 the petroleum sector claimed an average of about 85% of Angola's Gross Domestic Investment (GDI). During the same period foreign direct investments in the petroleum sector accounted for more than 70% of the medium- and long-term capital inflow, while a rising share of the petroleum revenues was spent to finance the factor services required by the petroleum sector. However, these figures do not mean that in the absence of the oil boom considerable resources would have been available for non-oil ventures. On the contrary, given the extremely low level of national savings and the limited scope for productive investments in the non-oil economy, sectors other than petroleum would neither have been able to attract nor to absorb this external capital.

Table 1.7: INDICATORS FOR PETROLEUM SECTOR CLAIMS ON RESOURCES
(In percentages)

	1982	1983	1984	1985	1986
Share of GDI in GDP	15.4	11.0	10.1	12.4	11.3
Investments in the petroleum sector as a share of GDI	83.2	88.2	76.8	87.2	86.6
Direct investments in the petroleum sector as a share of medium- to long-term capital inflow	69.3	84.4	61.5	63.7	87.5
Factor income a/ transferred abroad as a share of oil export revenues	11.3	11.1	11.3	12.1	16.8

a/ Attributable to the petroleum sector.

Source: Annexes 1 and 4 and mission estimates.

1.15 However, the overall performance of Angola's economy remained highly sensitive to changes in oil revenues. With rising oil revenues the petroleum sector increased its share in GDP, resulting in an oil-led growth of the economy. On the other hand, in periods of falling oil revenues (1980-82), the petroleum sector's contribution to the country's value-added tended to decline and, thus, to adversely affect GDP growth. Moreover, since 1982 when the growth of oil revenues reflected only increases in output, the foreign exchange costs associated with an increment in revenues tended to rise. As a consequence, an increasing share of the oil revenue had to be transferred abroad (16.8% in 1986) to pay for the factor services required for the development of new fields and for the additional costs of higher output (Table 1.7).

1.16 While this drawback is likely to lose importance with rising prices, another difficulty may arise in the near future. So far, the State-owned oil company, SONANGOL (Sociedade Nacional de Combustiveis de Angola) has had no problems raising the funds required to meet the financial obligations of its investment agreements with foreign oil companies. However, SONANGOL's total debt service outlays have steadily increased and in 1986 amounted to US$56.1 million, which is equal to roughly half of the company's average annual investment expenditures for exploration and development during the period 1980-86. Given the country's critical balance of payments situation it may well become more difficult to finance the exploration and development needed between now and 1990 to ensure that production continues to rise in the early 1990s. Thus, attention should focus on the question of how SONANGOL's financial position can be improved and to what extent the legal and fiscal framework needs to be modified to encourage new investments.

Natural Gas

1.17 Angola has only begun to exploit its natural gas reserves. To date, efforts have centered on the gas which is produced in association with oil at a rate of about 1.34 MCF/bbl. Some 50% of the associated gas is put to productive use, primarily for lift and reinjection, with the remainder being flared. There is little evidence that the picture will change considerably in the near future. Some associated gas is recovered for LPG production off the coast of Cabinda. The scheme has been operating since 1983. In 1986 output was 177,000 tons of LPG, of which 168,000 tons were exported to Brazil. Revenues amounted to US$21.3 million and contributed 1.8% of the country's earnings from energy exports (crude oil, 95%; petroleum products, 3.2%).

Electricity

1.18 Basically, Angola's power subsector consists of three systems. The largest one, in the north, currently accounts for about 80% of the country's electric power production. In 1986 the country's total installed capacity was estimated at 463 MW (62% hydro) of which 275 MW were firm. At that time, peak demand was about 150 MW. While total generation reached 754 GWh, consumption accounted for only 78% (590 GWh) of the energy generated. On a per capita basis, this works out at 66.3 kWh per annum, a consumption figure which is relatively low (in Mozambique, for instance, the 1984 per capita consumption of electricity was about 44 kWh, while Gabon--a country with a high degree of urbanization--recorded 756 kWh).

1.19 Since independence, the most pronounced decline in electricity demand has taken place in the industrial sector. In 1986, industrial consumption of electricity was only 200 GWh, (i.e., 17,000 toe, compared to more than 50,000 toe in 1974), while about 170,000 toe were used in the form of boiler fuels. The residential sector's electricity consumption has increased steadily since the mid-1970s. In fact, it has proved to be a stable component of the country's electricity demand. In the mid-1970s, electricity became essentially a free good, i.e., its demand was not limited in any way by the consumers' willingness or (income-dependent) ability to pay, but mostly by the utilities' ability to generate and distribute power. Thus, it would be difficult to estimate the effect on demand of the significant increases in tariffs required to restore financial viability to the utilities and to adjust the relative price of electricity to the costs of alternative sources of energy. At the current level of tariffs, for instance, the total revenues from electricity sales are just sufficient to finance the foreign debt service (denominated at the official rate of exchange) of the utilities.

Woodfuels

1.20 Woodfuels play a significant role in the country's energy balance. While fuelwood is the dominant source of energy in rural areas, most of which are cut off from the supply of commercial fuels and electricity, charcoal is consumed by urban households, which have little or no access to LPG and kerosene or are not connected to the grid. In 1986, total woodfuel consumption was probably 6-8 million tons of fuelwood, equivalent to 2 million toe of primary energy (including the fuelwood equivalent of charcoal) and accounted for 56% of Angola's final energy demand. While there is little doubt that the country's overall biomass resources are sufficient to meet aggregate woodfuel demand on a sustained basis, the rapid growth of cities and the supply constraints imposed by the civil war have led to regional and local imbalances and shortfalls, particularly in urban coastal areas. However, these imbalances do not affect each and every household. In a broad sense, there are two categories of urban households: the privileged households, which have access to the official supply of cheap commercial fuels and electricity (if measured in terms of the purchasing power of parallel market income, then LPG, kerosene, and electricity could be considered free goods), and underprivileged households, which have no choice but to buy on the parallel market where charcoal is the dominant fuel.

1.21 Currently, Government can do very little to improve the energy situation of rural households, and even less to increase the flow of woodfuels supplied to urban areas. In the present situation, Government intervention is likely to exacerbate the danger of disruptions in supply. The Government should therefore continue a "hands-off" policy which would avoid additional frictions until improving security would permit the establishment of more active policies related to supply and marketing. Some small, focused projects or measures could bring some relief, especially in coastal urban areas.

1.22 Among the activities proposed for the urban areas, priority is given to fuel substitution and to stove improvement, both falling within the purview of DNRFE (Department of New and Renewable Sources of Energy). The two rural-oriented groups of activities--the pilot project for Huila and Namibe and the development of agroforestry--would on the other hand require some support from DNACO (National Directorate for the Conservation of Nature). This would require some strengthening of the field representation of DNACO in the Southern Region.

Energy Demand Projections

1.23 Given the past and current distortions in energy consumption and production, it is difficult to forecast future energy demand in terms of historic trends, nor is it certain that demand will respond to changes in GDP or prices in a predictable way. Much depends on how long the civil strife continues and to what extent a return to peace will result in a gradual resumption of growth in the agricultural and manufacturing sectors. The hypothesis of peace in the early 1990s is the cornerstone of the most-favorable-base-case scenario. This scenario consists of an average annual rate of GDP growth of 2.5% for the period between 1990 and 1995, followed by a sustained upswing which would keep the growth rate above 5% during the second half of the 1990s.

1.24 On the energy demand side, it is assumed that until 1990 the growth of petroleum product consumption will slow down to about 2.5% per annum, while electricity sales are likely to recover, rising at an average annual rate of slightly more than 2%. During the first half of the 1990s, the return to peace will dampen petroleum product demand due to the significant decrease in military consumption. However, with the subsequent recovery of the agricultural and industrial sectors, the pattern of demand will not only shift to productive uses (transport, industry) but also rise at a rate (3%) exceeding that of the late 1980s. But even if the demand for petroleum derivatives continues to grow at 5% during the second half of the 1990s, demand would still not exceed the capacity of the Luanda refinery. Electricity consumption, on the other hand, is assumed to increase at an average annual rate of 6.5% (1990-95), followed by an even more pronounced growth of 11% in the late 1990s.

1.25 Table 1.8 provides a summary of the base case demand projections. As can be seen, the implicit elasticity of commercial energy demand, with respect to GDP, decreases from a high figure of 1.64 in the late-1980s to about 1.5 in the early-1990s (which is still high, reflecting a need to catch up). But further increases in consumption would eventually lead to an elasticity just above unity.

Table 1.8: COMMERCIAL ENERGY DEMAND PROJECTIONS

	Average Annual Rate of Increase (%)			Level of Demand (in '000s toe)		
	1987-90	1990-95	1995-2000	1990	1995	2000
Petroleum products	2.5	3.5	5	1,000	1,190	1,500
Electricity	2.5	6.5	11	67	92	155
Total Demand	2.5	3.7	5.3	1,067	1,282	1,655
GDP Elasticity	1.67	1.48	1.06	-	-	-

Source: Mission estimates.

Institutional Framework

1.26 The Ministry of Energy and Petroleum (MEP, Ministerio da Energia e Petróleo) has overall responsibility for establishing and implementing national policies in the energy sector. In the petroleum field, the MEP supervises the operations of SONANGOL, which in turn supervises the operations of the international oil companies and the refinery. The MEP also supervises the operations of the three power utilities--ENE (Empresa Nacional de Electricidade), SONEFE (Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos), and EDEL (Empresa de Electricidade de Luanda). Through the DNRFE (National Department of New and Renewable Sources of Energy) the MEP keeps abreast of developments in biomass and new and renewable sources of energy.

1.27 MEP is the result of a 1984 merger of the then separate ministries of Energy and Petroleum. Until 1987, the MEP had "central" departments which reported directly to the Minister (such as the Planning and Technical Departments) and "executive" departments (such as the National Department of [Oil] Transformation which supervised the refinery) which reported directly to one of the Vice-Ministers (for Energy or Petroleum). This organization perpetuated the split between Energy and Petroleum and is being abandoned, following the MEP's "Consultative Council" in November 1986. The new MEP will have only four National Departments, or "Gabinetes", one each for Planning, Technical, Legal, and Human Resources, and the Vice-Ministers will no longer have subsectoral responsibilities. Vice-Ministers will perform assignments at the request of the Minister (Annex 2 gives organization charts). This reorganization of the MEP entails a significant reduction in staff (from 360 to 200) and seems to be part of a Government-wide restructuring effort designed to cut administrative expenditures and to diminish sector ministry supervision over State enterprises. Supervision by sector Ministries of the routine management of State enterprises is to cease, and only the central Ministries (Planning and Finance/Central Bank) will have supervisory functions over the finances and management of State enterprises. This, of course, is to lead to greater autonomy in the management of State enterprises, which is one of the main components of the SEF.

1.28 In addition to the MEP, the Ministries of Finance and Planning and the Central Bank play a role in the control/supervision of State enterprises. The Ministry of Planning has the last word on sector investments, in the sense that only the Ministry of Planning can include such investments in the (annual or pluriannual) Plan. In fact, actual investments take place in a much more haphazard fashion and no institution seems to really control the process. The Ministry of Finance taxes and subsidizes energy sector enterprises widely. With the help of SONANGOL and the MEP, the Ministry of Finance oversees the financial operations of the international oil companies and assesses and collects the various taxes on oil operations (so-called "Special Regimes"). The Ministry of Finance also subsidizes the operations of the power utilities. Finally the Banco Nacional de Angola (BNA), the only real bank in Angola, has the final word on the allocation of foreign exchange. This is a difficult task, and it is not suprising that foreign exchange operations are slow, complex, and disrupt external procurement programs of the enterprises, whether for current operations or for investment.

SADCC - Energy Technical and Administrative Unit (TAU)

1.29 The Energy Technical and Administrative Unit (TAU) is an entity set up by the Angolan Government, or more specifically by the MEP, to discharge the responsibility for energy sector coordination which SADCC (the Southern Africa Development Coordinating Conference) assigned to Angola. The TAU reports to the Minister of Energy and Petroleum of Angola, as does any other department of the MEP, but its roles do not concern Angola specifically. According to SADCC documents, the main purpose of the Energy TAU is to develop a regional energy development, conservation and security plan.

1.30 In practice, the TAU has gone about its work by establishing a portfolio of regional energy projects which can be classified under three headings:

(a) national pilot projects, the results of which are expected to be applicable to other countries;

(b) projects which benefit more than one country (i.e., "regional" projects); and

(c) projects which support other regional projects.

Although the range and diversity of projects promoted by TAU is striking, the electricity subsector is dominant, taking up to 50% of TAU's time.

1.31 The Government of Angola provides most of the TAU's funds, personnel and physical facilities. About a dozen Angolan professionals work for TAU. In addition to sizeable contributions in kind (offices, office equipment, vehicle maintenance), the Angolan Government also provided Kz 32 million in 1986 and Kz 33 million in 1987 (i.e., a little over US$1 million per annum). In addition, the TAU has attracted considerable donor support, especially from Europe (Belgium, Norway, EEC) and also from Canada. Norway provided US$300,000-400,000 per year in 1986 and 1987 while the Canadian International Development Agency (CIDA) provided about US$100,000 in each of those years. Funding for expanded activities was under consideration in late 1987, especially by CIDA, while Norway was preparing a study to redefine its support policy toward TAU. The TAU and the Angolan MEP also requested ESMAP support to conduct an evaluation of the TAU's mandate and achievements. This evaluation is currently in preparation with its report due to be released in mid-1989.

Manpower, Technical Assistance, and Training

1.32 The shortage of qualified manpower has been a ubiquitous problem in Angola since independence. Most shortcomings in the execution of basic policies can be ascribed to the shortage of competent staff. Similarly, poor performance by State enterprises can partly be blamed on a lack of qualified personnel to properly plan, evaluate, execute, and operate public investments. In addition, qualified Angolan staff command very high wages in the service of international oil companies. While the civil service can hardly compete with oil majors, the problem of providing qualified staff with suitable incentives is a pressing one and has yet to be satisfactorily resolved.

1.33 Responses to this problem of staff shortage have varied among different organizations, as follows:

(a) the Central Government is making use of bilaterally-supplied expatriate experts (from the U.S.S.R., Cuba, Eastern Europe) and gets significant help from the U.N. system in addition to having first claim on the supply of qualified Angolans;

(b) the petroleum subsector has access to the qualified manpower of the international oil companies, uses high level consultants, and invests heavily in training for its own needs anl generally;

(c) the power subsector has essentially concentrated on day-to-day operations (with lower service standards) while using some expatriate assistance (from Cuba, the U.S.S.R., and Portugal). Activities that require much highly qualified manpower (planning, ta-iffs, demand studies) are simply deferred;

(d) in forestry, the level of upstream activities is at a virtual standstill with almost no foresters deployed while some forestry technicians are being trained in Cuba (mainly for logging and sawmilling, areas that have attracted external capital and technical assistance from Cuba and Italy); and

(e) in addition, a number of individual technical and professional personnel are hired and paid directly by the Government (the "Cooperantes") but with recent budget strictures this form of technical assistance, which is often used in administrative posts rather than in advising policymakers, is declining.

Training for the Petroleum Subsector

1.34 In the petroleum subsector, the effect of qualified manpower shortages has been mitigated by recourse to the expertise of the international petroleum companies and the acquisition of staff services from abroad. SONANGOL has effectively and advantageously used external consultants to supplement its capabilities in all aspects of its operations. There is little doubt that it should continue to do so. It might be possible, however, to reduce the cost of this option by turning to concessional sources of technical assistance, such as the United Nations Development Programme (UNDP), the European Economic Commission (EEC), the World Bank Group, or bilateral aid (Canada, Norway) for at least part of its needs.

1.35 The petroleum subsector contributes (by law) to the financing of nation-wide training programs. All petroleum companies are required to pay (US$0.15 per produced barrel) into a training fund which is controlled by the Ministries of Finance, Education, and the MEP. At current rates of production, (i.e., 400,000 bbl/d) this fund accounts for about US$21 million in hard currency.

1.36 Control over this fund appears to be diffused and no mechanism exists to ensure that the highest priorities in training are identified and then funded. In addition, the contribution is paid to the State budget in hard currency, but is not available in hard currency to potential users, who must follow normal, lengthy procedures to obtain needed foreign exchange. At times, pressing needs for foreign exchange may result in a total diversion of foreign exchange to these other needs, at the expense of training.

1.37 Other training programs for the petroleum industry include: on-the-job training with the petroleum companies; company-owned training centers (at Malongo for CABINDA GULF; at Soyo for TEXACO); and the Sumbe Petroleum Training Institute, which is supported by UNDP and Norway and managed by COMERINT, a consulting firm belonging to the ENI Group, Italy's State hydrocarbons holding company (this Institute also serves the needs of other SADCC countries). According to SONANGOL, training opportunities in the above programs favor engineers, technicians, and skilled laborers rather than managers, economists, or accountants and other financial staff. This presents a problem because SONANGOL itself needs mostly the latter type of qualified staff, including engineers, as it does not yet operate any oil field or other facilities. Expatriate staff resources are also used in the management and operation of support/logistical facilities such as the Kwanza Offshore Petroleum Operations Support Base in Soyo, at the mouth of the Zaire River.

Training for the Power Subsector

1.38 In 1986, the electric power utilities, excluding the Office for the Harnessing of the Middle Kwanza (GAMEK, Gabinete de Aproveitamento do Medio Kwanza) employed about 4000 4/ persons, of which about 100 were expatriates. The expatriate staff cost roughly Kz 3,200/man/month

4/ Of the Angolans, 30 are higher-level technical or professional staff, 200 are technicians, and 3,600 are skilled, semi-skilled, and unskilled workers. Of the 100 expatriates, 21 are higher-level technical/professional staff, 30 are higher-level technicians, and 50 are skilled workers.

(US$1,100/man/month). This relatively low figure reflects the fact that most of these expatriates originate from Cuba or Eastern Europe (where qualified manpower is plentiful) and that many are relatively low-level technicians or workers.

1.39 According to available information, higher-level manpower is extremely scarce and badly deployed. A disproportionate share of higher-level staff is concentrated in ENE's head office in Luanda while, for example, the Southern Grid does not have even one Angolan engineer or professional manager. The situation is similar in other utilities, with distribution companies--such as EDEL and CELB (Companhia Eléctrica do Lobito e Benguela)--usually worse off. In addition, expatriate staff tend to work in a vacuum because of the shortage of Angolan counterparts. No skills/knowledge can therefore be transferred.

1.40 A major investment in a training school for the electricity subsector is about to be made with financing through a FF 60 million (about US$11 million) loan from the Caisse Centrale de Cooperation Economique. This financing covers school construction and equipment, curriculum preparation, and an initial infusion of teaching staff to train future teachers, but not housing for the teachers. This could be a problem because the school will be located near Mabubas, far from any reasonable supply of housing.5/ In addition, most of the financing will go for state-of-the-art buildings and equipment. The new training institute's main objective is to upgrade the skills of the workers of power utilities. This priority fits well with this report's recommendations. However, it might have been possible to set up a more cost effective system for the same purpose.

1.41 A sizeable influx of financial and staff resources would be required to maintain the existing assets of the power subsector. The technical assistance needed for minimal improvements in power subsector efficiency would entail roughly 35 man-years of technical assistance. This level of technical assistance would have to be maintained for at least three years during which time trained Angolan staff could be hired and receive on-the-job-training from expatriate staff. A three-year power subsector rehabilitation project would thus require US$10 million for technical assistance in addition to the need to finance pressing imports of materials, supplies, and spares. Major rehabilitation investments would require much larger sums.

Angolan Development Strategy in the Energy Sector

1.42 The role of energy in the Angolan economy has been highlighted in earlier sections: energy exports provide Angola with resources to keep the economy and polity functioning. In fact, the abundance and rapid development of Angola's oil reserves can be said to have financed the political survival of Angola over the past decade.

5/ The location of the school is being reevaluated. It may, in fact, be built in Luanda. This would mitigate the housing problem.

Petroleum Development Strategy and Peace

1.43 Angola's choices in future development of its oil resources depend, at least in part, on the evolution of internal stability. If the civil war persists, then, realistically, Angola has no choice but to continue developing and exploiting its resources as fast as it can. This has been the policy over the last decade. If civil peace returns soon, paradoxically Angola could have more leeway in the speed of development of its oil resources. In the event of immediate peace, Angola's priority should be to carry out a structural economic reform to set the stage for a resumption of growth in agriculture and industry rather than to continue rapid expansion of oil exports. Energy would, in that situation, play its normal role of supporting growth rather than leading it.

1.44 While expenditures on petroleum exploration and development should be maintained--lead times are lengthy in the petroleum industry--the next burst of activity in petroleum should take place when Angola will be able to "sow" petroleum revenues most readily. That is, after substantial reforms permit (public and private) investment to become productive once more, and when qualified manpower supplies have increased through lower military needs, then there could be a higher output of Angolan training institutions and a better framework for the effective use of external technical assistance. In essence, the Government's first priority with the return of peace should be to give petroleum second priority.

SONANGOL

1.45 In the immediate, the Government should continue perfecting SONANGOL--the effective instrument it has slowly created to promote and control petroleum development--under general State guidance. SONANGOL needs continued slow growth in its capabilities in both oil and gas and increased financial and managerial autonomy. Economy-wide measures under consideration to increase the autonomy of State enterprises should be extended to SONANGOL as soon as possible, keeping in mind that SONANGOL is in a position to benefit from these measures immediately, as its management, staffing, structure, and mandate are functional and undisputed, while many other enterprises are not in such a position yet.

Refining and Product Supply

1.46 The present situation in refining and petroleum product supply is broadly satisfactory. At current relative world prices for crude oil and products, the FPA (Fina Petroleos de Luanda) refinery at Luanda appears to be economic. In addition, with recent de-bottlenecking and life prolongation, the refinery can supply most of Angola's needs for quite some time, especially if peace returns soon. Thus, Angola should continue satisfying its excess demand through imports while attempting to reduce wasteful or low priority consumption through a substantial increase in prices and the elimination of subsidies on kerosene, gasoil, and LPG. This would give prices a role in controlling demand and would restore a price structure more in line with economic costs (i.e., world market prices, CIF or FOB. Angola, depending on whether Angola is an importer or exporter of the given product). In view of the above, large new investments in expansion of refinery capacity should be postponed as they have low priority. Similarly, the expenditure of large sums to buy a majority or the totality of the stock (or assets) of the refinery cannot have much of a priority when both the State and SONANGOL are in a period of financial stringency (although if the transfer could be accomplished without the disbursement of large sums, as through a reordering of assets and liabilities between SONANGOL, FPA and the Government, then this would not cause any problem). An equivalent amount invested in petroleum exploration or field development would have a much higher economic return. Independently of who owns the refinery, an incentive framework designed to lower costs at the refinery seems to be Angola's best option to reduce the economic costs of supply of petroleum products in conjunction with the elimination of the subsidy on crude oil for domestic refining. A similar framework should be extended t SONANGOL's domestic distribution operations.

Power

1.47 With few exceptions, Angola's power infrastructure has suffered from more than a decade of active neglect. Fortunately, the demand for power stagnated during this period, with households the major active consumers of power. This allowed the utilities to maintain a reasonable level of service. Since power has become essentially free after the monetary inflation of the mid-1970s, consumption has been supply-constrained. While the quick return of peaceful conditions might make the agenda for the power subsector somewhat easier to implement, it will remain essentially unchanged over the better part of the next decade. Assuming that power is to be sold at a price covering economic costs of supply, household demand will probably not grow very fast, and increased demand will only come about through the reactivation of industry, which will take time.

1.48 The tasks facing Angolan authorities in power would therefore be: (i) maintenance of a reasonable level of service without sizeable new investments; (ii) launching of a rehabilitation program for existing dams, power plants, and transmission lines; (iii) reorganization of the sector in a more decentralized structure better able to improve efficiency; and (iv) setting the bases for future growth by improving management, accounting, and finances through a sizeable infusion of technical assistance, simultaneous with a major training effort and an increase in tariffs. Addition of new capacity should be very low on the list of priorities at least until the mid-1990s. Mission demand projections show that new capacity (above and beyond existing rehabilitable capacity) would probably not be needed until the latter part of the 1990s even under sanguine assumptions about the pace of the economic recovery (Annex 14).

Household Energy

1.49 The Government can do very little to improve the energy situation of rural households, especially at times of civil strife. The cities are presently receiving both commercial (LPG, kerosene, electricity) and traditional (fuelwood, charcoal) energy products. Major hardships would be caused by interruption of either source of energy. The Government should therefore continue its "hands off" policy to ensure that supplies of traditional fuels continue to reach the cities. This is not the time to crack down on wood/charcoal truckers or merchants, nor is it the time to try to enforce cutting regulations. Efforts at managing forests, charging user fees, ensuring a competitive supply system, and establishing reserves will be needed, but this should await the return of more normal conditions, especially in the countryside. In the meantime, some improvements in the distribution of kerosene (especially in suburban and rural areas) and LPG (mostly in urban areas) should be carried out.

1.50 Angola's forest resources are sufficient, and sufficiently broadly distributed, to satisfy the needs of the population in normal situations. After the return of peace, the supply of woodfuels to all potential users should be relatively easy to assure. The Government should, at that time, establish basic policies that promote competitive woodfuels markets. This would ensure the lowest possible prices to users, while legislation, management, and supervision of forests will ensure that the costs of reforestation (i.e., value of the trees themselves) are taken into account by the market.

1.51 Kerosene and LPG are excessively undervalued in relation to woodfuels. With more reasonable relative prices for commercial and traditional sources of energy, (i.e., with the removal of security risks and premia in the supply of woodfuels and the removal of subsidies to LPG and kerosene) it is not certain whether consumption patterns, even in the cities, would favor modern commercial fuels as much as they do now. This situation should be kept under review, and excessive consumption of modern fuels (which can be exported) should perhaps not be promoted as aggressively as has been done over the past several years. The proposed LPG fractionation project (offshore Cabinda) would add about 30,000 t/y of LPG to domestic supplies. This will eliminate high-priced LPG imports (about 10,000 tons costing US$2.5 million) yet permit a 60% increase in domestic consumption over a short period. By the time this increased supply reaches the market, prices should have been increased substantially, or the amount of Government subsidy would also have to increase.

II.A. CRUDE OIL: UPSTREAM ACTIVITIES

Summary and Recommendations

2.1 Angola depends on oil income economically and politically. All matters relating to oil are therefore of extreme concern. General Government policies on oil development have been enlightened, and thus deservedly successful. The State gave its oil enterprise, SONANGOL, the most important responsibilities in oil development by making it sole concessionaire for all hydrocarbons. A successful modus operandi was worked out between SONANGOL and the MEP in supervising oil activities in Angola. As the business arm of the Government in oil, SONANGOL will play a significant role in the development of Angola as a whole. Recommendations for SONANGOL are as follows:

(a) Although the legislation establishing SONANGOL empowered it to undertake virtually all activities related to oil (exploration, production, transport, refining, distribution), in addition to general supervisory responbilities, it really has two major tasks. The first is to encourage foreign investment in oil exploration and production under general Government guidance and in accordance with the existing legislation, and to negotiate advantageous contracts with internal oil companies. The second is to contract, supervise, and control foreign oil companies in exploring and developing the country's oil reserves and to raise the funds required to meet its share of investment programs. Therefore, the performance of SONANGOL should be judged on its success in mobilizing and steering external resources into oil operations and in supervising and controlling foreign oil companies rather than in terms of its performance as an operator or a project manager. For the same reason, SONANGOL should minimize its involvement in upstream operations and other extraneous activities unless these strengthen its supervisory role as the "trustee" of Angola's petroleum reserves. Similarly, the domestic distribution and marketing operations of SONANGOL could be spun-off into a relatively autonomous division or subsidiary, if not privatized;

(b) SONANGOL should be granted greater managerial and financial autonomy, particularly in the area of joint venture agreements, to improve its ability to carry out its responsibilities. Although it is inescapable that SONANGOL should remain under the political control of the State, it should not be unduly constrained by the short-run difficulties of the Ministries of Finance and Planning. SONANGOL should be allowed to retain a reasonable part of its after-tax cash flow;

(c) SONANGOL's ability to raise the funds required to meet its financial obligations will be highly sensitive to the overall financial health of the country. Therefore, the Government should not routinely use oil as collateral for external loans, as this could undermine the present creditworthiness and future profitability of SONANGOL;

(d) SONANGOL's ability to adequately control and supervise the activities of foreign oil companies can be improved through the establishment of a more efficient management information system. Emphasis should be given to procedures which systemize and "digest" the flood of information SONANGOL receives. Uniform accounting procedures should be established for all oil operations;

(e) Training of qualified staff, in conjunction with the development of an incentive structure for skilled personnel, is an important task. For technical staff, a more efficient utilization of existing training opportunities and institutions should suffice, rather than the creation of new or specially designed programs. For managerial and highly specialized technical staff, a suitable incentive system could play an important role in attracting and retaining such personnel. Technical assistance, however, would still be needed both to carry out complex tasks and to help train newer staff.

2.2 Even though the contractual terms for oil exploration and development are not particularly soft, many international oil companies have been attracted to Angola. The geology is highly prospective, the investment-cost-to-production ratio is low, and the operating costs are moderate. In addition, the Government and SONANGOL have shown a practical, business-minded attitude. While the State owns the hydrocarbon reserves, SONANGOL, as sole concessionnaire, has been doing most of the work required to attract companies and investments. The model contract has been conceived as a framework with room for negotiation. Thus, major changes in the legal framework are not needed.

2.3 So far, the taxation system has worked well. Government tax income from joint ventures was based more on net profits than on royalties. The progressivity of the tax legislation allowed the Government to capture windfall profits, while oil companies were protected against a profit squeeze in periods of declining oil prices. So, output rose steadily from 1981 to 1986 in spite of stagnating or declining international oil prices. It would be counterproductive to make fundamental changes in the fiscal terms which apply to oil companies. Minor modifications, however, may be useful.

2.4 Part of the existing legislative framework (especially civil and commercial laws) was established in the 1950s and, therefore, does not match the contractual approach and the taxation system embodied in the more recent joint venture and production-sharing agreements (PSAs). Moreover, differences in the contractual terms for joint venture and PSA operations (e.g., tax base) have led to an unequal fiscal treatment of production revenues. Although the Government is ready to deal with these problems pragmatically, it might be preferable to make small adjustments to the legislation and the contracts.

2.5 Some companies have requested softening of the contractual and fiscal terms for commercially unattractive discoveries. Urgent revenue needs and high rates of time preference probably argue in favor of careful, controlled development of those marginal fields. Nonetheless, the Government should be aware of the trade-off between the short term benefits (revenues) and the possibly higher (though uncertain) future revenues which it would forego by developing these fields now. In any case, the issue of permitting development of these marginal fields is not urgent and Angola should carefully weigh the pros and cons of modifying--strictly for this purpose--a fiscal framework that has been and is working well.

2.6 Balancing the maximizing of Government revenues with attracting foreign oil companies is a difficult task. The best strategy to maintain competitiveness (which Angola follows) is to give foreign oil companies a stable and well-defined contractual framework, leaving sufficient incentives to attract risk capital. Contractual arrangements should be reliable and flexible, rather than generally hard or liberal. Angola's framework for petroleum activities meets most of these criteria well.

Oil Exploration and Production History

2.7 Intermittent oil exploration in Angola began in 1910 and concentrated on the lower Congo and Kwanza basins, but the first discovery was not made until 1955 by a subsidiary of PETROFINA. Production from the Benfica field started in 1956, while PETRANGOL--the name under which PETROFINA was reorganized in 1957--continued its onshore exploration activities. A major breakthrough came in 1966, when GULF OIL (which had entered Cabinda in 1957 through its subsidiary, CABGOC) discovered the first offshore field (Malongo), the reserves of which proved substantially larger than the delineated onshore deposits. During the 1960s, several other international oil companies initiated exploration activities, but CABGOC's Cabinda finds remained Angola's most important source of oil. Total production rose to 49,000 bbl/d in 1969, and further increased to 163,000 bbl/d in 1973. Ninety percent of the output was exported; the remainder was used as a feedstock for the Luanda refinery which came on-stream in the late 1950s.

2.8 After independence, CABGOC--by far the largest producer--ceased its operations, and crude oil production collapsed. This was reversed when CABGOC returned to Angola in 1976. However, uncertainties about future Government policy towards oil tended to reduce the company's propensity to invest in the development of existing fields and the exploration of new prospects. As a consequence, oil output ceased growing in the late 1970s. The Government quickly responded to the new situation and implemented a series of measures to improve the institutional and incentive framework of the petroleum sector. The measures included:

(a) the establishment of SONANGOL (1976) as the business arm of the Government to coordinate and control petroleum activities;

(b) the enactment of the Petroleum Law (1978) which made SONANGOL the sole concessionaire for oil exploration and production in the country (see Annex 5);

(c) the renegotiation of CABGOC's and PETRANGOL's concessions (1978), giving SONANGOL a 51% share in the existing productive operations;

(d) the division of the continental shelf into 13 blocks (1978) to be offered to interested oil companies under terms of PSAs; and

(e) the creation of the MEP (Ministry of Petroleum) (1979).

The reorganization of the petroleum sector, the new legal and fiscal framework, the comparatively low operating costs prevailing in Angola, as well as favorable prospects for new discoveries attracted numerous international oil companies, which has led to substantial investments and to continuously increasing production since 1982. This activity has taken place despite the recent decline in international oil prices. In 1988, production reached 441,800 bbl/d, 157% above the 1974 level.

Oil Production and Investment

2.9 As of June 1987, 7 of the 13 blocks (of about 4,000 km^2 each) making up the country's offshore area (except Cabinda) had been awarded to oil companies. Table 2.1 summarizes production and investment activities in the different areas between 1980 and 1986.

Table 2.1: OIL PRODUCTION AND INVESTMENTS IN THE PETROLEUM SECTOR

	Total Production 1980-86		Total Production 1986		Total Investments 1980-86	
	(Million tons)	(%)	('000s bbl/d)	(%)	(Million US$)	(%)
Cabinda	45.0	69.8	190	67.4	816.4	30.0
Congo Onshore A	0.4	0.6	1	0.4	52.9	2.0
Congo Onshore B	11.3	17.5	32	11.3	189.1	6.9
Block 1	-	-	-	-	216.1	7.9
Block 2	2.7	4.2	6	2.1	493.0	18.1
Block 3	3.7	5.7	50	17.7	878.4	32.2
Block 4	-	-	-	-	78.0	2.9
Kwanza	1.4	2.2	3	1.1		
TOTAL	64.5	100	282	100	2,723.9	100

Source: Annex 4.

2.10 More than 60% of total investments (US$2.7 billion) undertaken between 1980 and 1986 went into Cabinda and Block 3. The largest share was accounted for by Block 3 which started production in 1985 and, by 1986, already contributed 17.7% of the country's total petroleum output. While investments in Block 3 concentrated on exploration (until 1983) and development (since 1985), investments at Cabinda focused on increasing production from proven reserves, rather than on discovering new deposits. In terms of investment outlays, Block 2 ranks third.

2.11 In spite of significant expenditures to explore and develop new fields, the performance of Block 2 has been disappointing until recently. Production fell from a peak of 13,000 bbl/d in 1982 to 6,000 bbl/d in 1986. Many of the new discoveries are considered marginal so that some companies called for a softening of fiscal and contractual terms to encourage further development. These claims, however, appear to be exaggerated. Government has already written off a considerable share of its (potential) revenues by allowing the companies to take more "Cost Oil" than stipulated in the contracts. In addition, more recent finds are reported to be more promising and may reverse the downward trend of the past. In fact, 1988 output increased to about 35,000 bbl/d.

2.12 Other problem areas are the onshore Congo and Kwanza basins. Of the nearly US$440 million spent on these areas between 1980 and 1986, almost US$150 million was used for the development of the onshore B area. Since 1982, however, the onshore B output has been stagnating (in the vicinity of 30,000 bbl/d) while total onshore production (including onshore Congo A and Kwanza) declined from 56,000 bbl/d in 1977 to 36,000 b/d in 1986. The investments made in Blocks 1 and 4 were exclusively for exploration, with results still in the future. Though almost US$200 million was spent for exploration in Block 1, only marginal discoveries were made. The companies involved have already asked for fiscal incentives to develop fields which, at present prices, are unprofitable. Exploration rights in Block 4 were awarded in 1984, but no significant discoveries have been made yet.

2.13 In 1987, some 16 foreign companies were engaged in Angola's petroleum industry and others were queuing to get in. Thus, the role to be played by SONANGOL as the sole oil concessionaire is becoming more important. SONANGOL's first joint venture was formed with CABGOC in 1978, giving SONANGOL a 51% share in the Cabinda offshore. CABGOC remained the operator, and the Association successfully embarked on a five-year investment program (1980-85) to develop production from proven deposits. CHEVRON, which took over GULF OIL in 1984, continued to invest in Cabinda, but dropped GULF's plans to reduce its share in some deeper areas.6/ In 1978, SONANGOL also obtained a 51% participation in the Congo/Kwanza onshore areas formerly held by PETRANGOL. When FPA succeeded PETRANGOL and became operator, it retained a 49% share in the

6/ However, for other reasons, CHEVRON-GULF reduced its overall share in the Cabinda Joint-Venture to 39.2% by farming out a 9.8% participating interest to AGIP.

onshore A areas and a 32% share in the onshore B area, while TEXACO kept the remaining 16.4%. As for new blocks, SONANGOL contracted several foreign companies into PSAs under the 1978 Petroleum Law. In Block 2 it acquired a 25% working interest in an association in which TEXACO is the operator, thus providing SONANGOL with a 25% share of production in addition to the share it gets as concessionaire. Since 1984 it has also kept a 20% interest (on a carried basis) in an association led by BRASPETRO (PETROBRAS) in Block 4. Also in Block 4, SONANGOL owns 51% of the mixed company Empresa de Servicios Petrolíferos de Angola (ESPA) which has operational responsibilities. SONANGOL does not hold any shares (interest) in Block 1 (AGIP is operator), Block 3 (ELF is operator), and Block 5 (which was awarded to a group of companies formed by CONOCO in 1986). It must, nonetheless, as concessionaire, supervise the activities of the operators.

Institutional and Fiscal Framework

2.14 As the agency responsible for the overall coordination and development of the energy sector and the implementation of national energy policies, the MEP also has responsibility over the policies and performance of the petroleum subsector. In particular, the Director General of SONANGOL reports directly to the Minister of Energy and Petroleum. The MEP receives (through SONANGOL) detailed information and itemized financial statements on all oil-related activities to control and coordinate ongoing operations. In performing these functions, it can resort to external assistance, be it from SONANGOL or foreign consultants.

2.15 The division of tasks between the MEP and SONANGOL is as follows:

The MEP is the only organ competent to decide on:

(a) the authorization to open blocks for bidding, the commencement of production (including the field-specific production levels), and the flaring of gas;

(b) the approval of development programs; and

(c) the determination of reference prices for tax purposes.

The MEP's oversight responsibilities are not meant to intrude into the day-to-day management of SONANGOL. So far, the division of labor between the MEP and SONANGOL has worked well. But there could be complications since the MEP's ability to supervise petroleum operations depends, to a large extent, on SONANGOL's ability to provide the necessary information in a timely fashion.

2.16 SONANGOL's responsibilities include:

(a) the collection and compilation of technical and geological data prior to distinct exploration activities;

(b) advisory assistance to the Government;

(c) the opening of blocks for bidding and the evaluation of proposed work programs;

(d) the negotiation of (production-sharing) contracts;

(e) comments and suggestions on exploration activities carried out by foreign companies (i.e., participation in Exploration Advisory Committees); and

(f) the approval and auditing of all activities which follow a commercial discovery.

The latter function is executed through SONANGOL's participation in so-called Operating Committees (staffed with two representatives of the contractor and two SONANGOL members, with SONANGOL appointing the voting chairman) which monitor, control, and regulate the technical and financial performance of the contractors. In addition to ex ante supervision and approval faculties, the production-sharing contract also empowers SONANGOL to undertake ex post auditing and evaluation of past activities, facilitated by reporting obligations on the part of the oil companies.

2.17 However, in contrast to SONANGOL's powerful position within the petroleum subsector, its financial latitude is strongly circumscribed. About 50% of its amortizations and 95% of its profits accrue to the Treasury, so that investment decisions are subject to the Budget reallocating funds to SONANGOL. 7/ Though in practice only the balance is transferred to and fro, this makes SONANGOL subject to the priorities of the Ministries of Finance and Planning and leaves little financial autonomy. SONANGOL's dependence on the fiscal/budget authorities has led it to rely on foreign oil companies to assist it in raising the funds required to meet its financial commitments. Skillful balancing of these two options has allowed SONANGOL to acquire the resources to finance large-scale investment programs (which, between 1980 and 1986 accounted for more than US$1 billion). By these means, SONANGOL succeeded in financing almost 25% of the total expenditures for exploration and development of the country's petroleum reserves over the seven-year period (Annex 4, Table 2). However, a higher degree of financial autonomy would help SONANGOL fulfill its obligations in the future

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7/ Changes to increase the autonomy of State enterprises are being considered under the SEF program of structural adjustment. If these changes were approved and enforced, SONANGOL would no longer have to transfer any of its depreciation allowance but would only be subject to a corporation profit tax.

development of the petroleum subsector, now that the State Budget is tight and the finances of the oil companies are less buoyant because of low world prices.

2.18 In the past the main advantages of Angola's petroleum sector were:

(a) the promising geological potential;

(b) the low ratio between investments (for exploration and development) and output;

(c) the low level of operating costs; and, complementarily,

(d) the practical, business-minded attitude of SONANGOL and the Government.

Thanks to these advantages, Angola succeeded in attracting foreign companies and resources necessary to maintain continuous growth of petroleum production in the face of falling world oil prices. For instance, while operating costs in Angola varied between US$1.5/bbl and US$4.9/bbl in 1985, and averaged US$1.73/bbl, operating costs in the Congo varied from US$4/bbl to US$10/bbl. Moreover, in Angola, investment per unit of output was only one-third of that of the Congo. These figures illustrate the fact that Angola's oil reserves are economically attractive (measured in terms of the net-back value of the extracted oil) and, therefore, have encouraged foreign investors even though the contractual terms are among the toughest in the world, the minimum exploration requirements are high, SONANGOL's power to intervene (e.g., through the Operating Committees) is unusually broad, and the Angolan take in any commercial production is very high.

Oil Taxation

2.19 Annex 6 provides a detailed description of the tax and tax-like systems which are applied to foreign companies and SONANGOL. Their main features can be summarized as follows:

(a) under joint venture arrangements (Cabinda) the Government's share in oil revenues is captured in the form of a royalty (which is essentially a sales tax), a tax on "excess profits" (= the income in excess of operating costs and some allowances for investment expenditures), and a tax on net income (= value of output less operating cost less royalty and taxes on "excess profits");

(b) in the case of PSAs, the value of total output is divided between "Cost Oil" and "Profit Oil" whereby "Cost Oil" which covers normal operating costs as well as past expenditures for exploration and development may not exceed a certain percentage of total production (50%) for a predetermined number of years. The "Profit Oil" is split between SONANGOL and the foreign company in accordance with a progressive sliding scale scheme (in favor of SONANGOL) related to the cumulative output of the field. While the "Profit Oil" is subject to income taxation, a price-cap provision (which is essentially a 100% tax on excess profits) would apply if oil prices were to exceed the US$20/bbl level;

(c) the lion's share of Angola's revenues from oil (more than 80%) has been and is still being provided by joint ventures, due to the low output attributable to PSAs (although this is beginning to change with the explosive growth of output in Block E PSA).

(d) the specific tax-contract schemes which apply to joint-ventures and PSAs provide a progressive system of revenue-sharing and are designed to capture windfall profits. While in joint-ventures (from which most of Angola's take is collected in the form of taxes) the effect of volume-induced changes on taxes is less pronounced than that of price changes, the share of "Profit Oil" (which accrues to Angola from PSAs) is dependent on: (i) the speed with which the capital expenditures of foreign companies are recovered; and (ii) cumulative output. Both mechanisms protect the interests of foreign oil companies, particularly under unfavorable market conditions, and provide Angola with returns which adjust to the relative market-dependent profitability of its oil resources; and

(e) PSAs are designed to give SONANGOL a significant part of Angola's take. In joint ventures, the lion's share of Angola's take accrues directly to the Government. This accounting difference and the fact that the time profile of the net revenues from PSAs is not in line with the current financial needs of the Government, have become a minor source of discord between the Treasury and SONANGOL. Furthermore, the taxation of foreign oil companies operating under PSAs has turned into an issue that affects the distribution of Angola's take between the Treasury and SONANGOL.

2.20 As international oil prices weakened after 1981-82, the tax regime for joint-ventures reduced Angola's petroleum revenues. The same mechanism which captures windfall profits for the Government also reduces the take when oil prices fall and output remains constant. Angola's response to the decline in international oil prices was to raise its output significantly. However, in periods of falling oil prices, output must grow at a rate exceeding the rate of price erosion in order to recoup lost income. This explains why Angola's oil revenues, particularly those from joint-ventures, have fallen off sharply even though it has succeeded in boosting its output, above all in 1985 and 1986. Some illustrative figures are given in Table 2.2.

Table 2.2: ANGOLA: CHANGES IN OIL TAX REVENUES AND OIL OUTPUT 1985-86 (Percentage)

	1985	1986
Crude Oil Production	+13.7	+21.0
Price of Crude Oil	-5.5	-51.6
Tax Revenues from Oil	-1.4	-49.3

Source: The MEP.

2.21 The workings of the fiscal regime (taxes, royalties, price cap, other levies) transfer to Angola a large share of windfall oil revenues and prevent "excess profits" from accruing to the oil companies. They also protect the oil companies against a profit squeeze in periods of declining prices by shifting some of the burden of adjustment on to Government revenues. To the extent that the tax system for joint-ventures transforms a decrease in prices into a reduction of Angola's share in oil revenues (since tax income rises faster than the company's profit), it does not erode the incentives for foreign oil companies to continue operating and investing. Thus, the adverse impact of oil price declines on the activities of the oil companies was softened by the tax legislation. This made continued investment and a steady increase in output financially rewarding to the companies, which in turn provided the Government with income partly offsetting the losses caused by the fall in oil prices.

Marginal Oil Fields

2.22 Several suggestions have been made recently to soften the contractual and fiscal terms of production-sharing operations for marginal fields. Many of these suggestions come from Block 1 where more than US$180 million has been invested in exploration since 1982 without finding any commercially attractive deposits. PSAs provide that any find which is not developed within three years of discovery must be handed over to SONANGOL (when no discoveries are made, the company that took the exploration risk must absorb the costs, without any recourse). Usually companies are reluctant to develop marginal fields (i.e., less lucrative than average or even unprofitable, at prevailing prices). However, SONANGOL should be wary of setting a precedent in shading contractual terms. Basically, the tax-contract system of PSAs does not distort the decision of whether or not to develop a marginal field. Oil companies may recover their outlays for exploration and development, and there is no tax on output (which would affect marginal revenues from declining flows or marginal fields). If some fields are not developed (while others are), it is for the reason that they appear less profitable than the average. In principle, unprofitable oil should be left in the ground until it becomes profitable to lift. Funds saved should be invested in the development of more profitable fields, either proven ones or new discoveries (assuming that the probability of new discoveries justifies the delay in investment).

2.23 However, strict economic reasoning may not be appropriate in a second-best world as the Government urgently requires additional oil income. A case could be made for fiscal incentives to encourage the companies to develop less attractive finds: a comparatively lower take from marginal fields may be preferable to no additional revenues at all. And since under prevailing economic constraints any income available today is considerably more valuable than income accruing in the future (i.e., the rate of time-preference is very high), the early exploitation of marginal reserves could be justified. Nonetheless, the Government should be aware of the trade-off between the benefits of short-term revenues and the possibly higher, though uncertain, future revenues forgone by developing these fields now rather than later. Further, the setting of a precedent may undermine future negotiations.

2.24 Also under discussion are: (i) the possibility of extending the period between the commercial discovery and field development; and (ii) the unequal fiscal treatment of joint ventures and PSAs. The latter problem is created because in offshore Cabinda the tax base is calculated by consolidating total revenues and total expenditures for exploration,8/ development, and operation, whereas in PSAs, investments in exploration and development can only be recovered from oil from the same field. As a consequence, under PSAs the pay-back period for development expenditures may prove much longer than for joint ventures. However, in both cases (i.e., the determination of the length of the exploration period and the fiscal treatment of development expenditures) the Government pragmatically intends to adapt contractual terms to field-specific conditions. Thus, the issues in question no longer pose any serious obstacle to future oil development.

Prospects for Oil Field Development

2.25 As can be seen from Table 2.3, the oil activities which the MEP expects to be undertaken between 1987 and 1990 center on the development of proven fields. The average level of planned annual investment is almost twice as much as in the past seven years. Highest priority is given to Cabinda which accounts for about 40% of total planned exploration and development expenditures. More than 70% of the investments projected for Cabinda will be used to develop (i.e., bring into production) new fields. One of the largest projects is the development of the Numbi field in which US$230 million will be invested. The recoverable reserves of Takula, Angola's biggest oil field (about one-third of total current production) were expected to increase to 240 million barrels in 1988 when a US$200 million water injection

8/ This means that exploration expenditures can be used to offset current revenues of other (already developed) fields.

program was to be completed. The second largest investment is in Block 3, where most of the projected expenditures of about US$770 million will be used to accelerate the development of proven reserves. Expenditures for development are also dominant in Block 2. And, in the onshore areas of the Congo and Kwanza basins, the main objective is to maintain the present production of about 33,000 bbl/d. No development expenditures are planned for Blocks 1, 4, 5, 6, and 8.

Table 2.3: PROJECTIONS FOR FUTURE EXPLORATION AND DEVELOPMENT (1987-90)

	Number of Exploration Wells	Number of Development Wells	Total Investments in Exploration & Development US$ million	%
Cabinda	9	134	800	39.0
Cabinda B/C	17	14		
Congo Onshore	3	6	80	3.9
Block 1	1	-	-	-
Block 2	4	24	>180	8.8
Block 3	6	31	770	37.6
Block 4	3	-	-	
Block 5	5	-	135	6.6
Block 6 a/	4	-	35	1.7
Block 8 a/	4	-	35	1.7
Cabinda Onshore a/	5	-	15	0.7
Total	61	209	2,050	100.0
Subtotal b/	48	209	1,965	-

a/ Estimates. Exact figures are conditional on future negotiations.
b/ Not including Cabinda Onshore and Blocks 6 and 8.

Source: The MEP; SONANGOL; and Mission estimates.

2.26 Forty-eight exploratory wells 9/ were firmly scheduled for the period 1987-90, which means 12/y, compared to 15/y in the period 1981-86. Based on previous contractual commitments, the annual number of projected wells will decrease from 20 in 1987 to six in 1990, indicating that new agreements will be required to keep exploration activities at the rhythm of the early 1980s. The majority of the scheduled exploratory wells (26) will be in Cabinda, reversing recent trends. Exploration in Block 1 will stop and the companies concerned will try to obtain better contractual terms to make development of marginal discoveries feasible. Since the prospects for BRASPETRO's Block 4 are not bright, it is likely that exploration there will also stop. On the other hand, a minimum of five exploration wells are scheduled for 1988-89 for Block 5, where

9/ Not including Cabinda Onshore and Blocks 6 and 8.

drilling started in April 1987. Negotiations between SONANGOL and TOTAL/PETROFINA are under way to define an exploration and production program for Block 8 (with TOTAL as the operator), and plans called for the re-opening of Block 6 during 1988. Offers for Block 7 were requested for the second half of 1988, and negotiations are expected to take place in 1989. Further exploration in Cabinda (over what is now planned) may well result now that another international oil company, AGIP, has been admitted to the joint venture. Offers for Cabinda Onshore are still being evaluated. Negotiations may start in 1988, but are expected to be difficult. Thus if Blocks 6 and 8 as well as Cabinda Onshore are included, the total number of exploratory wells drilled in the period 1987-90 may turn out to be 67. On an annual basis, this would equal the 1981-86 average.

2.27 Estimates of future production vary considerably depending on the source of information. The figures published by the MEP (Table 2.4) are based on forecasts prepared by SONANGOL and can be considered a conservative estimate of what is achievable in the light of past and planned development activities. The projections understate the potential for a more rapid exploitation of producing fields, 10/ but also overestimate future success in developing proven fields. On the other hand, average annual investments projected for the period 1987-90 are rather high (relative to the country's finances) and might not be carried out *in toto*. As a result of these countervailing biases, the forecast could end up being rather accurate over a number of years.

2.28 Angola's exploration strategy has been well thought out and successful. However, Angola has usually stuck rather closely to its oil development plans. Now, for the first time, production in Block 3 is exceeding previous, firm plans by a substantive margin with output in late 1987 at 110,000 bbl/d, well above the 70,000 bbl/day that was planned in early 1987. This is leading to a rapid reduction in the reserves-to-production ratio (from about 13 years in 1987, to as little as 8 years by 1990). While there is no magic reserves-to-production ratio, many countries feel that a suitable level is between 10 and 15 years. If output in Block 3 is not expected to return to its earlier time profile, then a reassessment of the planned level of exploration activities may be needed to arrest the decline in the reserves-to-production ratio. Any worsening of exploration performance (i.e., fewer,

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10/ In late 1987, production in Block 3 was raised to 110,000 bbl/d, effectively reducing the reserves-to-production ratio to about seven years. This production is almost double the previous projections (Table 2.4). The reasons for this massive departure from the productive path set forth in early 1987 are not quite obvious. It may be that the Government's short-term revenue needs are in favor of a more rapid exploration, which in the case of Block 3 also "benefits" foreign oil companies since higher production rates shorten the pay-back period of exploration and development costs of PSAs.

or smaller finds) or any slowing down of the pace of exploration could quickly lead to a dangerous situation as the cushion of reserves could become dangerously thin. Also, independently of whether the Angolan authorities consider their level of revenues adequate, international markets might not. This could cause an increase in the cost of raising capital (for any purpose) for Angolan needs.

2.29 As regards the composition of crude oil output, the MEP's scenario predicts that the share of Cabinda crude in total production will decrease from about 70% in the mid-1980s to 55% in 1990, while the share of Block 3 would rise from 18% in 1986 to about 30% in 1990. This shift in output is also reflected in the projected allocation of investment funds, the structure of which will change in favor of Block 3. Thus, the strategy in petroleum is to keep the production level in Cabinda as high as possible (base production) and to spur output growth by expanding activities in Block 3. In other words, Government policy is oriented to the short term objective of maximizing output and revenues, while long term considerations are, at present, given relatively less importance. This is the expected behavior of a country in the political situation of Angola.

Table 2.4: OIL PRODUCTION AND RESERVES, 1986-90
(in '000s bbl/d)

Production by	1986		Projected				1990
Area	Actual	%	1987	1988	1989	1990	in %
Cabinda	190	67.4	220	256	246	246	54.9
Block 3	50	17.7	85	113	128	136	30.4
Block 2	6	2.1	10	29	39	38	8.5
Onshore	36	12.8	36	36	32	28	6.3
Total:	282	100	351	434	445	448	100
Reserves-to-Production Ratio (in years):	13.7			12.6	9.6	8.8	7.8

Source: SONANGOL and the MEP (estimate was done in late 1987).

2.30 According to the MEP, a higher level of investment than in the past will not necessarily prevent output growth from slowing down at the end of the 1990s. Thus any shortfall in planned investments will have a severe impact on future oil output and revenues. Since a considerable share of the investment is to be carried out in Cabinda, a joint venture, the investment program will place a heavy financial burden on SONANGOL. Unlike the "pure" production-sharing operations which, for instance, are carried out in Block 3, the Cabinda joint venture requires a 51% financial participation by SONANGOL. Thus, since most of Angola's oil is produced in Cabinda, increasing output requires the assumption of high up-front costs by SONANGOL, whose financial position is weakening, and could precipitate a serious decline in the country's creditworthiness and credit rating. This also explains why the less costly Block 3 (where no financial commitments by SONANGOL are required) is gaining increasing importance within Angola's crude oil development strategy. But as long as Cabinda remains the country's major source of oil, SONANGOL will have to meet the sizeable financial obligations required (unless it sells part of its shares). As a consequence, SONANGOL's ability to raise the required funds at low cost will be highly sensitive to both its own financial performance and to the country's ability to keep its creditors reasonably content. In such a delicate situation, the Government should not embark on the risky course of offering future oil as a security to creditors (other than SONANGOL's). The Government should also avoid major delays in servicing its external debt since any deterioration in the country's debt discipline will reduce the market value of the loans which have been raised in the past and, therefore, tend to raise the costs of future borrowing.

2.31 SONANGOL has recently expressed interest in gathering practical experience as an operator. So far, SONANGOL's operational responsibilities have been limited to Block 4 where it owns 51% of the mixed-economy company ESPA (the Empresa de Servicios Petrolíferos de Angola). Plans to increase its share to 100% and, thus, to become fully responsible for operations have been dropped because of the disappointing exploration results. Nonetheless, SONANGOL may still intend to expand its upstream activities and is currently exploring the option of assuming FINA's role as the operator in onshore Cabinda. Taking over ongoing operations is a less risky strategy than exploring and developing new fields. However, while additional experience as an operator may help SONANGOL to improve its capacity to supervise foreign oil companies, resource constraints and the scarcity of qualified personnel might complicate SONANGOL's role as controller of oil activities. While this report does not strongly favor either option (operating or not operating), on balance SONANGOL should probably <u>not</u> become more heavily involved in field operations, but direct experience can't hurt, provided its costs are kept low and the operating results are acceptable.

II.B. GAS SUPPLY AND UTILIZATION

Summary and Recommendations

2.32 Significant quantities of associated gas (currently about 50% of total production) are used for gas lift and reinjection schemes. Government policy calls for a rapid increase in the gas utilization rate. New lift and reinjection schemes (where compatible with oil production and reservoir characteristics) and expansion of existing ones (replacement of Livuite gas with associated gas sources) are under way. A target utilization rate of 70% is the goal for late 1990, up from the present 50% or so; this is a reasonable objective. However, pure reinjection of associated gas (to save it for future use) may have costs which exceed the economic value of the gas in the ground.

2.33 No investments in gas field assessment or delineation should be undertaken unless major economic uses have been identified. In particular, only large-scale projects which could steadily consume a considerable amount of gas would justify the delineation and development of known, existing non-associated gas fields. No economic large-scale projects are presently known, and thus prospects for the development of non-associated gas fields are dim.

2.34 The only large-scale project capable of using sizeable quantities of natural gas is the proposed export-oriented ammonia/urea plant which would require about 50.6 MMCFD of gas. However, in view of the depressed international fertilizer market and given that gas supply costs are relatively high, Angola would not have a substantial comparative advantage even in a well-managed plant. Furthermore, there are no other domestic consumers who could absorb natural gas in large quantities or would have an incentive to switch to gas. Thus, the country's non-associated gas should be left in the ground until economic uses for it can be found.

2.35 As crude production in Block 3 rises, the potential for a new large-scale LPG recovery scheme could increase. If world prices for LPG do not deteriorate, such a scheme could expand exports and provide the country with additional foreign exchange.

2.36 SONANGOL's ability to study and supervise even a limited number of gas-related projects sho 'd be strengthened in the small unit responsible for gas matters set up around the few people currently dealing with gas in SONANGOL. This unit should be in a position to monitor ongoing gas-related activities more thoroughly and to coordinate plans for future projects with related activities in other subsectors. It should not become a bureaucratic unit which wastes manpower in the pursuit of elusive gas projects for their own sake.

2.37 Highest priority should be given to two projects presently under consideration by SONANGOL:

(a) the LPG recovery scheme in Cabinda, i.e., on the moored LPG tanker, Berge Sisar, (estimated investment costs: US$2-3 million). This project would increase the domestic supply of LPG by about 60% and replace costly LPG imports of 8,000-10,000 tons/year.

(b) the export-oriented LPG/condensates recovery program in Block 3. This project, if economic, could produce significant foreign exchange revenues.

Other projects which deserve further investigation in the short term are:

(c) the planned LPG bottle rehabilitation plant, with investment costs estimated at US$5 million (essential, if the first project is to go ahead);

(d) the proposed dual-fuel thermal power plant in the Soyo area, and rehabilitation of the gas-fired turbine for Cabinda; and

(e) the onshore plant for recovery of LPG at Malongo costing US$3-4 million (provided that demand will be adequate at the higher LPG prices which this report proposes).

Gas Reserves and Utilization

2.38 Angola's natural gas resources probably exceed 5 TCF. Non-associated gas accounts for about 3 TCF of the probable reserves, and associated gas for about 2.5 TCF, of which 1.8 TCF were proven in early 1987. At present the average associated gas-to-oil ratio is approximately 1.34 MCF/1,000 bbl of oil. Thus, a crude oil output of 282,000 bbl/d in 1986 yielded 379 MMCFD of associated gas (Annex 4, Table 7). By 1990, associated gas production is expected to reach 515-536 MMCFD, although the official forecast is about 488 MMCFD. Non-associated gas reserves are not yet being exploited except for a small offshore field in Cabinda. The main resources are located offshore of Zaire province in Blocks 2 and 3, but because of the limited number of exploratory wells, information about reserves is limited (Annex 4).

2.39 In 1986 about 51% of the associated gas output was actually put to use, primarily in gas lift and reinjection schemes which account for more than 85% of the country's gas utilization (Annex 4, Table 8). Only a minor fraction of the associated gas which is not flared is directly recovered as a fuel, either for use in oil operations or for LPG, and the picture for productive uses (other than uplift and reinjection) is not likely to change in the near future. By 1990 the gas utilization rate is expected to rise to 70%, with most of the gas still being used in lift and reinjection schemes.

2.40 The declared policy of the Government is to increase the utilization of associated gas; hence flaring is prohibited, while recovered gas may be used free of charge. The Government has never conducted a comprehensive assessment of whether reinjection is economically justified. From an economic point of view, reinjection to conserve associated gas for future use makes sense only if the costs per CF saved do not exceed the user costs (i.e., depletion value) of non-associated gas. Although there is a lack of precise data in this area, it is likely that this condition is not met in Angola. While the country's non-associated gas reserves are comparatively small in absolute terms, the ratio of probable reserves to projected production, i.e., the time horizon for resource depletion, is quite high. As a consequence, the user costs of the non-associated gas tend to be negligible (probably in the vicinity of US$0.2/MMBTU), and thus the scope for profitable reinjection is limited.

2.41 A more promising option for associated gas utilization is the production of LPG. At present, the only facility in which associated gas is being recovered for LPG production is located offshore of Cabinda on the tanker, Berge Sisar. The output, consisting of a 66:34 mixture of propane and butane, rose from less than 500,000 bbl in 1983 to about 2 million bbl in 1984 and is now stable. Output is expected to rise to 2.6 million bbl/y over the next few years. In 1986, almost the total output (170,000 t) was sold to Brazil at about US$125/t (FOB Angola) or US$2.89/MMBTU.

2.42 In 1986, sales of LPG in the national market reached 32,000 t. However, the cost of imported LPG (about 12,000 t) is much higher than the FOB value of export LPG. The import parity costs of LPG--(c.i.f. coastal terminals) are US$250/t, while the FOB value of export LPG is US$125/ton. The costs of adjusting the composition of "export LPG" to meet the national specifications and shipping it to coastal terminals are estimated at US$90/t. Thus, the opportunity cost of LPG could be considered either US$250/t, or US$215/t (i.e., US$125/t FOB plus US$90/t fractionation and delivery costs). 11/

2.43 The LPG fractionation project would add about 30,000 t/y (80-85 t/d) to domestic supplies. This would suffice to eliminate high-cost imports (about 10,000 t/y costing about US$2.5 million) and add 20,000 t/y to meet domestic consumption. At present prices, there is

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11/ Gas is both imported and exported. Angola is a net exporter of LPG, but export LPG (66% propane, 34% butane) is not the same as the LPG consumed domstically (produced in the Luanda refinery and imported). Thus if both LPGs can be considered one good, then the opportunity cost is the FOB value of export LPG; while if they are considered to be different goods, the opportunity cost would be the CIF cost of imported LPG, and shipping it to Luanda could be used as a guide to domestic price setting or as the opportunity cost of LPG.

little doubt that this quantity of LPG could be absorbed (provided also that bottles and stoves are available). However, a more reasonable price for LPG (paras. 3.35 and 3.36) in the range of Kz 45-90/kg (with a 12.5-kg bottle costing Kz 563 to Kz 1,125 12/) could well dampen the growth of demand. It might therefore be prudent to increase the supply to the domestic market more gradually than is implicit in the 85 t/d fractionation project. 13/ Similarly, preparation of additional projects to expand the availability of LPG for domestic consumption should best be postponed until the effect of the higher price on demand can be evaluated.

Market Potential of Non-Associated Gas

2.44 As regards the exploitation of the country's non-associated gas reserves, the short- to medium-term outlook is not particularly promising. Unless a large market can be identified, the extraction and gathering of non-associated gas will almost certainly prove to be uneconomic. So far, the only large-scale project which could use a sizeable amount of natural gas as a feedstock is an ammonia/urea plant proposed for the Soyo area. The project has been under study since the early 1980s.

2.45 Indivisibilities and economies of scale require a minimum capacity of 1,000 t/d of ammonia. World-class plants typically have an installed capacity of 1,500 t/d of ammonia and 500 t/d of urea, and cost about US$330 million (at 1987 prices). Capacity utilization in these plants typically hovers in the 80-90% range. The maximum output would therefore be about 164,000 t/y of urea and 396,000 t/y of ammonia. Given the limited domestic demand for nitrogen fertilizers (about 10,000 t/y in 1987), the plant would have to sell most of its output abroad where fierce competition and a general glut of fertilizers are keeping prices low. A sustained market recovery with prices above US$200/t is not likely to occur before the mid-1990s. Moreover, since the plant will require a gas supply of about 51 MMCFD (16.65 BCF/y) which cannot be met from associated gas alone, non-associated gas would have to be developed and used. Therefore, feedstock costs will most likely exceed US$1.5/MMBTU.

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12 Even at the higher price for LPG, the price of one 12.5 kg. bottle could be equal to the parallel market price of only 3-4 kg. of charcoal, i.e., LPG would still be considerably less costly than woodfuels.

13/ In some uses, fractionation may not be needed. The export LPG could simply be mixed with the refinery-produced LPG and used. This is usually acceptable in household use. However, tests should be conducted to see if this is correct for any use being contemplated.

2.46 A detailed appraisal of the economics of the proposed urea/ ammonia plant is given in Annex 7. Table 2.5 summarizes the main findings.

Table 2.5: ECONOMICS OF AMMONIA/UREA PLANT a/

Gas Supply Costs	Rate of Discount (10%)	(12%)	(15%)	Internal Rate of Return
(US$/MMBTU)	--------- NPV ---------			(%)
1.25	+	+	-	12.72
1.50	+	-	-	11.92
1.75	+	-	-	11.10
2.00	+	-	-	10.26
Netback value of gas	2.07	1.48	0.50	

a/ Base case, not considering depletion costs.
- = negative; + = positive.

Source: Annex 7.

Even under the most favorable base case conditions, net returns to the project will be close to zero or negative unless the rate of discount is below 12%. The considerable financial burden of this large-scale investment, the comparatively high costs of gas supply, and the uncertainties of the international fertilizer market make the proposed ammonia/urea project economically unattractive. As better opportunities of using non-associated gas may well be identified in the future, the low-return ammonia/urea project should not be undertaken at this time. Only if a private concern were willing to incur all risks and pay a reasonable price for the gas should Angola consider such a project.

2.47 In industry, the only consumers who could theoretically switch to gas, and absorb enough gas to justify investments in gathering and transport, are the cement factory and the oil refinery. At the current output (720,000 t/y of clinker), the cement plant's consumption of fuel oil is equivalent to 6 MMCFD. A proposed expansion of the factory's capacity to about 1.5 million tons of clinker in 1990 would increase the fuel requirements to 15 MMCFD. However, the cement plant now uses surplus fuel oil costing only about US$1.8/MMBTU (export parity). In addition, the potential gas supply from the nearby Kwanza field (3 MMCFD) would not even be sufficient to meet the plant's current fuel demand so that more remote sources would need to be developed, thereby increasing gas costs to US$1.5-2.0/MMBTU. Gas is therefore not competitive with fuel oil in the medium term. The same argument applies to the Luanda refinery whose fuel oil requirements are equivalent to approximately 4 MMCFD. Other industries which at present account for only 20% of the country's boiler fuel consumption might demand 2-5 MMCFD of gas. Thus, the low potential demand for gas and the availability of cheap alternative fuels make the near-term development of non-associated gas reserves for domestic use uneconomic.

2.48 As for power, most of the electricity is supplied from low-cost hydro plants (with a substantial hydro potential still to be developed). The use of gas would only be needed for peak-load generation in thermal power plants. However, given the alternative of petroleum products and the fact that an optimistic peak-load scenario might require at most an average of 3-4 MMCFD of gas, then power demand cannot justify any investment in gas gathering and transport. Gas for power generation might prove economically viable only in isolated areas with low primary energy requirements and cheap gas available nearby. The most promising options of this type are the 15 MW dual-fuel power plant proposed for Soyo and the rehabilitation of a 10 MW gas turbine in Malongo-Cabinda.

2.49 If the international price of LPG does not fall below the current level, there may also be a significant potential for new export-oriented LPG recovery schemes similar to the one in offshore Cabinda. The most promising area is Block 3 where oil production is expected to increase considerably, in association with large volumes of gas rich in LPG. These schemes will only be justified by exports, but they could also provide a low-cost source for small (gradually increasing) volumes of LPG (adjusted to meet national specifications) used domestically. In this respect, the planned offshore Cabinda production of 85 t/d for the domestic market is a logical step. With estimated investment costs of US$2-3 million, the project will probably replace imported LPG economically. However, small-scale LPG recovery plants will not be economically viable, unless there are isolated markets which can be supplied from nearby gas resources. The onshore Cabinda project, for instance, which is supposed to produce 8 t/d of LPG from gas recovered at the Malongo oil terminal (investment costs: US$3-4 million) is a case in point, and its economics are probably marginal. Other proposals, such as the 3-4 t/d onshore Kwanza LPG recovery plant, will probably not be justified either.

III. CRUDE OIL: REFINING AND PRODUCT SUPPLY

Summary and Conclusions

3.1 Pricing of petroleum products at the refinery gate and to final consumers, and pricing of crude oil for domestic refining, are areas where substantial reforms could be implemented most easily. Yet, specific pricing recommendations are difficult to make in the macroeconomic policy environment of Angola. The normal price recommendation would be to base domestic prices of petroleum products on opportunity costs such as the CIF cost of bringing products to Angola, or the FOB cost for net exports, or full cost recovery for those products produced in Angola (i.e., remove subsidies to crude oil and specific products). However, given the extreme overvaluation of the Kwanza, the standard economic prescription of using opportunity costs as the basis for pricing would only fully make sense after the value of the Kwanza had been adjusted downwards to some sort of equilibrium level (or to a level nearer to equilibrium than is currently the case). But since final petroleum product prices in Angola are below border prices even at the highly overvalued present official exchange rate, and the crude oil for local refining is subsidized, these shortcomings would need to be corrected first. In fact, an overvalued exchange rate doesn't mean that petroleum products should continue to be consumed wastefully by being priced excessively cheap. A series of step adjustments in prices would probably be easiest to apply. The steps could be as follows, using hypothetical exchange rates:

Step One: eliminate all subsidies to crude and products, including LPG, and immediately bring all prices to border levels at the official rate of exchange.

Step Two: adjust all petroleum product prices to an exchange rate of, say, Kz 100/US$.

Step Three: by this time, the SEF should be in progress and a more adequate exchange rate might be available to guide the MEP in the pricing of petroleum products. Should the exchange rate remain fixed in spite of notable domestic price increases, the MEP could use an index of inflation to keep real product prices stable.

Advantage of a Correct Pricing Policy

3.2 Basically, pricing policies should be based on the economic cost of supplying or using a particular energy resource. Adherence to this principle ensures efficiency in resource allocation and provides consumers with correct signals for their economic decisions (i.e., it tells consumers the cost of an additional unit of each resource and thereby enables them to make the best choice). However, given the large distortions and the difficulties of running the economy along optimal lines, second-best policies are more expedient for Angola in the short to medium term. 14/ While these policies would involve a gradual departure from the severe price distortions described below, the medium- to long-term goal should be to adjust prices and tariffs so as to reflect the true economic cost at the margin.

3.3 Currently, the structure of petroleum product prices looks as follows:

(a) the present official refinery gate prices are now, on average, slightly below border prices at the official exchange rate and mid-1987 values. Gasoil and fuel oil are priced considerably below international parity while LPG, gasoline and kerosene/jet fuel are reasonably in line with border price levels;

(b) LPG, kerosene and light fuel oil (LFO) are sold at prices which are less than full cost recovery, while gasoline, jet fuel, gasoil, and heavy fuel oil (HFO) are sold above cost--all in Kz valued at the official exchange rate; and

(c) the FPA refinery pays less than the economic opportunity cost for indigenous crude oil feedstock. The Government provides an effective subsidy to FPA by not collecting royalties on crude for local refining.

Refining

3.4 The refining of indigenous crude in Luanda in a hydroskimmer is an economically viable product-supply strategy for Angola as compared to imports of products. The FPA refinery is a reasonably well run and well maintained facility. Purchasing this refinery (or a controlling interest in it) would seem a wasteful use of limited Angolan financial resources. Furthermore, lack of incentive to reduce costs and possibly high use of expatriate labor are the most apparent contributors to high operating costs. The FPA refinery operates on a "cost-plus" refinery gate pricing arrangement. On the aggregate, all verified operating costs, depreciation and allowable profit are recovered, but there is no particular incentive for cost minimization and optimization of operations. Therefore, efforts should be made to design and implement a pricing scheme which encourages the refinery to operate in a more efficient way. This could be done in the context of an ESMAP activity.

14/ For example, the second-best pricing strategies aiming at the financial strengthening of utilities that the mission proposes for the power sector.

Distribution

3.5 SONANGOL distribution and marketing departments have excessive staff, facilities, and overheads in relation to volume distributed. The operations are based on a "cost-plus" arrangement. All verified costs and a guaranteed profit margin are supposed to be covered either through the final selling price or through a subsidy from either a profitable product or the Government budget. In practice, however, petroleum product distribution is a loss-making business since large consumers (e.g., the army, cement plants) fail to pay their bills.

3.6 In order to improve the situation a study should be undertaken, dealing with revisions in the cost-plus pricing scheme, the enforcement of a higher financial discipline on customers and, most importantly, investigation of the options for a gradual rationalization (privatization) of SONANGOL's distribution and marketing activities.

Procurement

3.7 SONANGOL Limited, London, with its own staff and its joint venture arrangement with the West German trader, STINNES, currently manages Angola's product import and export arrangements. However, SONANGOL itself has the knowledge and capacity to organize tenders or supply contracts either as a buyer or a seller. SONANGOL might consider selling excess fuel oil (as it has done in the past) through an international tender for a one-year contract, or through sales to end-users in the United States via a brokerage firm which could do all the work for about US$0.03/bbl. Jet fuel, kerosene, and gasoil could be procured from a nearby reliable refiner such as CEPSA or CHEVRON, both of whom have processing agreements in Abidjan, Gabon, and Moanda-Zaire (south of Cabinda). In this manner, Angola may be able to lower the cost of its product imports, especially when purchases are made from affiliates of companies already present in Angola.

Production, Supply and Consumption Considerations

3.8 Angola currently consumes some 0.9 million t/y of petroleum products compared with total production of crude and gas liquids in excess of 14 million t/y. In spite of its large oil production and exports, Angola's revenue requirements are so critical that any reduction in domestic consumption of petroleum products would be advantageous. The lack of incentives to cost effectiveness under existing "cost-plus" product pricing regimes for both refining and product distribution appear to be major contributors to inflated product supply costs above "efficient" levels.

Product Trading/Import-Export

3.9 Imports. Although the principal products supply source for inland consumption is the Luanda refinery, shortfalls in certain products are met through direct product imports. Table 3.1 provides a summary of imports for the 1980-86 period. As indicated, jet fuel (A-1) has become the predominant import, mostly because of military use. Table 3.2 illustrates the growth in jet fuel imports versus refinery supply and total supply/requirements over the 1980-86 period. Imported supply in 1986 represented 40% of the total, up from zero in 1980.

3.10 Over the past three years, Angola has also experienced a small shortfall in gasoil supply, which has been met by imports. This was expected to turn into a slight surplus in 1987 as the yield from the expanded refinery at higher throughputs more than matches growth in demand. In addition, there has been a consistent shortfall in high-butane LPG from the refinery, which has been met through imports. On the other hand, since 1983 significant amounts of high propane LPG have been recovered from Cabinda associated gas. This, however, has never been used to supply the domestic market because of the difference in specifications. Since the Cabinda export type of LPG is 70% propane vs. about 30% (maximum) propane for the refinery/imported material, it is not adapted to the storage and end-use equipment in Angola. A project is proposed (para. 2.37) to recover part of the Cabinda LPG for household use and, if required for technical reasons, to fractionate a portion of the Cabinda production on board the floating storage tanker, Berge Sisar, to produce a high butane/low propane LPG for the national market. This would make it possible to eliminate present imports.

Table 3.1: IMPORTS OF PETROLEUM PRODUCTS 1980-86
(Tons)

	1980	1985	1986
LPG	6,942	11,710	10,913
Jet fuel	0	102,633	114,184
Gasoil	0	36,693	16,435
Total products	6,492	151,036	141,532
	Percentage Share of Petroleum Imports		
LPG	100.0%	7.8%	7.7%
Jet fuel	0.0%	68.0%	80.7%
Gasoil	0.0%	24.3%	11.6%
Total products	100.0%	100.0%	100.0%
	Estimated value (US$ million)		
	--	41.85	24.94

LPG: Liquefied Petroleum Gas (LPG).

Source: SONANGOL and MEP.

Table 3.2: JET FUEL SUPPLY 1980-86
IMPORTS VS. LOCAL REFINERY-SOURCED
(Tons)

	1980	1981	1982	1983	1984	1985	1986
Ex-refinery	118,559	126,960	99,493	143,527	161,527	172,809	171,064
Ex-imports	0	7,764	39,796	24,925	62,895	102,633	114,184
Total supply	118,559	134,724	139,289	168,452	224,841	275,442	285,248
				Percentage Share of Total Supply			
Ex-refinery	100.0%	94.2%	71.4%	85.2%	72.0%	62.7%	60.0%
Ex-imports	0.0%	5.8%	28.6%	14.8%	28.0%	37.3%	40.0%
Total supply	100.0%	100.0%	100.05%	100.0%	100.0%	100.0%	100.0%

Source: SONANGOL.

3.11 Since 1986, SONANGOL has procured jet fuel and gasoil imports through its U.K. subsidiary, SONANGOL Limited. This joint venture partnership with the West German trading company, STINNES, has established a steady import pattern of 5,000-ton parcels roughly every month from Tenerife, Canary Islands (Annex 12 gives details).

3.12 The mission believes that Angola can organize its procurement without the help of an intermediary and that there are more logical sources of supply (such as Abidjan, Moanda/Zaire or Gabon) which would cause much lower freight rates (Annex 12 provides some indicative figures). It seems feasible for SONANGOL to procure middle distillates at substantially less than the current cost of Mediterranean plus US$39/t, most probably in the range of Mediterranean plus US$19-22/t. In fact, Angola should consider the option of opening tenders for 10,000-ton parcels CIF Luanda rather than going to the trouble of chartering its own vessel.

3.13 Cargo Exports. The principal export is fuel oil, which is produced in the refinery in excess of requirements. Sporadic naphtha exports also represent a habitual surplus over Angola's requirements. The remaining small, rather sporadic volumes of other clean products are principally exported to favored countries such as Sao Tome and Principe, Guinea-Bissau or Mozambique under special government-to-government arrangements. A summary of cargo exports of finished products is shown in Table 3.3.

Table 3.3: PETROLEUM PRODUCT EXPORTS (CARGO) 1980-86
(Tons)

	1980	1985	1986
LPG at Cabinda	0	173,836	166,782
Ex-refinery:			
Gasoline	2,606	3,192	2,902
Naphtha	0	5,069	8,642
Kerosene	2,375	0	0
Jet fuel	0	2,952	0
Gasoil	23,839	7,322	5,642
Fuel oil	481,613	585,922	528,766
Total ex-refinery	510,433	604,457	545,952
Total all products	510,433	778,293	712,734

Source: SONANGOL.

3.14 Excess fuel oil is sold by the refinery at official refinery gate prices to SONANGOL which then sells it to the SONANGOL-STINNES (U.K.) joint venture. With the U.S. Northeast coast being the major market outlet, SONANGOL currently receives New York harbor cargo prices less US$22/t. It should therefore consider returning to its 1981-82 practice of opening tenders in the international fuel oil market, for which the mission believes SONANGOL has the expertise.

3.15 Refining. Angola's requirements for domestic products are met primarily through refining of domestic crude oil. The principal facility is a simple, 1.7 million ton/y hydroskimmer in Luanda owned and operated by FPA. In addition, there is a small 100,000 t/y topping plant owned and operated by CABGOC at its Cabinda/Malongo base. 15/ The Luanda refinery dates back to 1958 when a 100,000 t/y topping unit was built. At that time, it was fed with crude from the newly discovered onshore Kwanza field.

3.16 The present plant has a nominal capacity of 1.7 million t/y but actual yearly capacity considering planned maintenance shutdowns and unforeseen outages is rated at 1.6 million tons. The plant was recently expanded from 1.5 million t/y nominal capacity through the

15/ This takes a slipstream of crude from the large Cabinda crude production stream, extracts gasoil and jet fuel for local operations, and returns the remainder to the crude stream.

de-bottlenecking of one of the topping plants (Annex 8 gives technical details). Along with minor modification to the tower internals and pumps, the total cost of the expansion was only US$2 million.

3.17 Crude oil feedstock. The present feedstock consists of Kwanza and Soyo crudes, both from FPA-operated fields. Table 3.4 summarizes the estimate of net plant yields from Luanda refinery for the two crudes.

Table 3.4: NET PLANT YIELDS a/
(% By Weight on Crude)

	Kwanza	Soyo
LPG	0.8	1.4
Gasoline/Naphtha	11.8	10.3
Kerosene	8.0	11.0
Gasoil	22.5	24.8
Fuel oil	53.2	48.3
Total	95.8	95.8

a/ After refinery fuel and losses, estimated at about 4.2% by weight of crude throughput.

Source: FPA and SONANGOL.

The Kwanza crude is of slightly lower quality than Soyo, having a higher fuel oil and lower clean products yield. Kwanza is also of slightly higher sulfur content than Soyo, but both crudes would be classified as low sulfur crudes by international standards. 16/ The feedstock mix for 1985-86 shown in Table 3.5.

Table 3.5: CRUDE OIL FEED - LUANDA REFINERY, 1985-86

	------ 1985 ------		------ 1986 ------	
	Tons	%	Tons	%
Kwanza	201,323	13.9	155,363	10.7
Soyo	1,249,993	86.1	1,296,820	89.3
Total	1,451,316	100.0	1,452,183	100.0

Source: FPA and SONANGOL.

16/ The refinery takes the entire production of the declining Kwanza field. The Soyo (Congo basin) crude is also produced from a fairly mature field. At best its production is stable in the face of an increasing refinery throughput.

3.18 Production/Yields. Table 3.6 summarizes the production/yield balance for the refinery from 1980 through 1986. As would be expected with a simple skimming refinery running a fairly steady crude slate over the period, there is not much variation in yield of major product streams. The total kerosene/jet fuel yield has increased as this is the product in greatest demand. There has been a slight reduction in fuel oil yield, probably because of the lightening of the average crude slate as heavier Kwanza decreased as proportion of total feed. There may also have been some improvement in fractionation over the period, since the share of after-refinery fuel and losses has decreased significantly, from an average of about 6% in the 1980-83 period to a reasonably low 4.2% in 1985-86.

Table 3.6: LUANDA REFINERY PRODUCTION/YIELD BALANCE, 1980 AND 1985-86
(Tons)

	1980		1985		1986	
Crude run	(1,237,507)	100%	(1,451,316)	100%	(1,452,183)	100%
Product Yield:						
LPG	11,746	0.9%	18,269	1.3%	18,690	1.3%
Gasoline	89,563	7.2%	103,450	7.1%	104,675	7.2%
Naphtha	0	0.0%	9,914	0.7%	21,471	1.5%
Subtotal	89,563	7.2%	113,364	7.8%	126,146	8.7%
Kerosene	33,007	2.7%	45,598	3.1%	35,637	2.5%
Jet fuel	118,559	9.6%	172,809	11.9%	171,064	11.0%
Sub total	151,556	12.2%	218,407	15.0%	206,701	14.2%
Gasoil	294,728	23.8%	353,699	24.4%	347,288	23.9%
Fuel oil	609,418	49.2%	679,419	46.8%	685,767	47.2%
Asphalt	7,358	0.6%	7,924	0.5%	7,253	0.5%
Subtotal	616,776	49.8%	687,343	47.4%	693,020	47.7%
Total (excl. loss)	1,164,379	94.1%	1,391,082	95.8%	1,391,845	95.8%
Fuel & loss	73,128	5.9%	60,234	4.2%	60,338	4.2%
Total	1,237,507	100.0%	1,451,316	100.0%	1,452,183	100.0%

Source: FPA and SONANGOL.

3.19 Operating Costs/Efficiency. The refinery gives the impression of a well managed, well maintained, neat, and tidy facility. Maintenance, housekeeping, and safety practices have been satisfactory. The fractionation performance and fuel and loss figures look favorable. However, the total operating cost figure of US$2.28/bbl appears high for this type of refinery (Table 3.7). The range of total operating costs for several other hydroskimmers over the past few years (inflated to 1986 levels) is

US$1.20-1.50/bbl, excluding depreciation. This compares with US$1.88/bbl for Luanda, excluding depreciation. The main discrepancy appears to be in labor costs. The figure of almost US$1.00/bbl compares with US$0.40-0.60/bbl in other similar operations. Luanda's high cost reflects both the high level of staffing, 450 in all, and the excessive complement of expatriates. Given the rather low salaries for nationals, the excessive dependence on expatriates is probably the main reason for the higher than normal payroll.

Table 3.7: LUANDA REFINERY OPERATING COSTS AND TOTAL GROSS MARGIN - 1986

	US$/bbl	US$/million
Salaries, wages, benefits	0.98	10.4
Materials, chemicals	0.72	7.7
Depreciation	0.40	4.2
Financial charges	0.11	1.2
Training	0.07	0.7
Total operating cost	2.28	24.2
Allowable profit	0.33	3.5
Gross Refinery Margin	2.61	27.7

Source: FPA.

The expatriates alone probably account for US$4-5 million of the total US$10.4 million/y labor cost. A significant reduction in the number of expatriates would bring the total operating costs for the Luanda refinery more in line with other similar refineries. Given appropriate human resource training and development planning there is no reason why this refinery could not be run with half of its present expatriate force. The biggest problem in encouraging such cost saving may be the lack of appropriate incentives under the existing "cost-plus" refinery gate pricing arrangements.

3.20 Distribution and Marketing. SONANGOL, which has a monopoly on the distribution and marketing of petroleum products in Angola, can rely on an extensive network of storage terminals, most of which were inherited from the former private distributors. The largest concentration of storage is in Luanda, followed by other large coastal installations in Namibe, Lobito, and Porto Amboim (Annex 8, Table 3). The large Luanda, Namibe, and Lobito terminals are tied in to the three major railway lines so as to serve the smaller depots up-country, all of which are on these rail lines. Due to deterioration of the rail systems, the inland terminals are largely dry. Most products that reach the interior come by road tanker direct to customer tanks or to the rare service stations. SONANGOL operates its own fleet of some 300 road tankers with an average capacity of 18,700 liters each.

3.21 Under current conditions, the coastal region is well served, with little evidence of suppressed demand. In the interior, the normal manifestations of shortages such as service station queues and elevated black-market prices are rare for products such as gasoline and gasoil since there is very little transport or commercial activity going on. On products like kerosene for lighting, however, there is suppressed demand and high prices but this also is the case in the outskirts of Luanda. Table 3.8 summarizes total inland sales for 1980, 1985 and 1986.

Table 3.8: INLAND PETROLEUM PRODUCT CONSUMPTION (SALES) 1980-86
(Tons)

	1980	1985	1986 a/	1980-86
				(%) per annum
LPG (Butane)	18,688	28,695	30,200	8.3
Gasoline - Motor	79,567	95,004	103,680	4.5
- Aviation	1,391	987	430	-17.8
Total gasoline	80,958	95,991	104,110	4.3
Kerosene	29,835	43,908	46,310	7.6
Jet fuel	114,350	235,567	260,550	14.7
Total kerosene/jet fuel	144,185	279,475	306,860	13.4
Gasoil	268,806	376,865	344,770	4.2
Fuel oil	121,268	104,622	119,200	-0.3
Asphalt	3,171	5,593	4,200	4.8
Total all products	637,096	891,241	909,340	6.1

a/ 1986 estimate based on 9-month actuals.

Source: SONANGOL.

International Comparisons

3.22 A comparison of Angola's petroleum consumption per capita in 1984 with that for seven "lower middle-income" countries shows Angolan consumption is low compared with the range of values and the average for the group. The stagnation in the economy is probably offset by military consumption but the overwhelming use of hydrogeneration for power would keep Angola's consumption of petroleum products lower than other similar countries, *ceteris paribus*.

Table 3.9: PER CAPITA PETROLEUM CONSUMPTION INTERNATIONAL COMPARISON, 1984

Lower/Middle-Income	GNP	Population	Consumption
	US$/Cap	(millions)	-- Kg/Cap --
Mauritania	450	1.7	100
Zambia	470	6.4	110
Bolivia	540	6.2	195
Côte d'Ivoire	610	9.9	95
Zimbabwe	760	8.1	90
Peru	1,000	18.2	370
Costa Rica	1,190	2.5	380
Total average 7 countries	764	7.6	216
Angola	485	8.9	79

Source: World Bank and Angolan authorities.

Projected Petroleum Product Consumption

3.23 SONANGOL's sales department has developed a forecast of product consumption for Angola to 1992. This projection is summarized for each product in Table 3.10. No details on the rationale for the assumed growth rates for each category were available to the mission. It appears that the growth in consumption of products such as gasoline, kerosene, and gasoil has moderated slightly from the actual 1980-86 rate. The most striking reduction has been for jet fuel for which per annum growth is shown as falling from 14.7% in 1980-86 to an assumed 2.2% per annum growth in 1986-92. This low growth is based on a 24% reduction in jet fuel use assumed for the military in 1987, followed by a 3% per annum growth thereafter, such that 1992 military consumption is still some 12% lower than 1986 levels. Non-military jet fuel use is assumed to grow at a fast 5.6% per annum over the period.

3.24 The basic assumption underlying the SONANGOL forecast, namely that the growth of aggregate petroleum product consumption will slow down until the early 1990s, seems to be reasonable. The mission estimates that during the remaining years of the 1980s, the rate of increase will fall below 3%, but rise above 3% in the 1990s in the event of a return to peace.

Table 3.10: PROJECTED PETROLEUM PRODUCT CONSUMPTION
(Tons)

	Actual a/ 1986	Actual per annum 1980-86	Forecast 1992	Assumed per annum 1986-92
LPG (Butane)	30,200	8.3%	39,213	4.0%
Gasoline (99.5% motor)	104,110	4.3%	131,618	4.0%
Kerosene	46,310	7.6%	65,692	6.0%
Jet fuel	260,550	14.7%	297,051	2.2%
Total Kerosene/jet fuel	306,860	13.4%	362,743	2.8%
Gasoil	344,770	4.2%	431,346	3.8%
Fuel oil	119,200	-0.3%	143,912	3.2%
Asphalt	4,200	4.8%	4,730	2.0%
Total all products	909,340	6.1%	1,112,562	3.4%

a/ Estimated from 9-month actuals.

Source: SONANGOL sales department.

Pricing of Petroleum Products

3.25 The final price of petroleum products to consumers in Angola is affected by price controls at three different downstream levels:

(a) crude oil into the FPA refinery;

(b) products ex-refinery (refinery gate); and

(c) products for final sale by the distributor, SONANGOL.

At present, all of the crude oil feed for the FPA refinery comes from the FPA-operated joint-venture areas. The refinery pays the joint venture crude owners a price that yields to the crude owners an equivalent revenue from a refinery sale as from an export. Since the royalty paid on crude sold to the refinery is deducted from the income tax on production, the crude owners can accept a lower crude price for refining than for export. It also means that the refinery is paying less than the economic (opportunity) value for the crude.

3.26 An illustration of how the system works is provided in Annex 9. In the case considered, the refinery crude prices work out at US$15.25 for Soyo and US$14.40 for Kwanza based on a starting reference marker price of US$20 for "Bonny Light". The forgone Government tax revenues amount to US$2.75 in the case of Soyo and US$2.58 for Kwanza. This loss of Government revenue (US$25-30 million) is a subsidy to domestic consumption of oil.

Refinery-Gate (RG) Pricing of Products

3.27 The refinery-gate prices of finished products for sale from FPA to SONANGOL are fixed in the official price structure established January 1985 (see Table 3.11). They are based on complete refinery cost recovery including a return on net investment. The relative prices of products were set in approximate accord to international/import parity relationships. At the time this official structure was established, crude prices were much higher than at present and the relative volume assumptions and refinery operating costs have changed from the original basis. Rather than have a continuous, regular refinery gate price adjustment based on changes in crude costs and other factors, the Ministry of Finance's General Budget (OGE, Orçamento Geral do Estado) acts as a balancing fund while official prices remain stable for long periods of time.

3.28 A preliminary balance on the refinery cost recovery is performed quarterly and any over-recovery (the case at present) is returned to the OGE. Under-recovery based on the official structure would be received as a subsidy from the OGE. About two months into the new year a final balance is made based on verified operating costs for the previous year and any outstanding imbalance is settled. The pricing system is, therefore, a completely "cost-plus" arrangement. There is no particular incentive on the part of FPA to save operating costs as the saving would simply revert to the OGE.

3.29 At recent lower crude prices and higher production/sales volume there has been considerable over-recovery. During 1986, some Kz 2 billion were returned to the OGE out of total refinery gross sales of Kz 7.5 billion for the year.

3.30 A comparison of present official refinery-gate prices with international prices is provided in Table 3.11. The current structure for all major products is compared with a hypothetical freight and related charges figure of US$20/t added to FOB Mediterranean spot as a basis for border prices for the liquid products. For LPG, a hypothetical freight charge of US$80/t was used, although current LPG imports cost more than this estimated figure. In 1985, the official refinery gate price for all products was below average border prices. Following the decline in crude and product prices in 1986 the official structure moved, on average, above border prices on all products except gasoil. But recent crude and product price increases have undoubtedly pushed international prices to a point where, on an average, the Angola structure is below border prices.

Table 3.11: OFFICIAL REFINERY GATE PRICES VS. INTERNATIONAL PRICES
(Exchange Rate of Kz 29.62 = US$1)

	-- Official Structure --		FOB Mediterranean plus US$20/t a/ 1985	1986	1st Half 1987
		US$/t	US$	US$	US$
LPG	7.8950 Kz/kg	266.54	304.58	204.75	223.57
Gasoline	4.9989 Kz/liter	228.06	275.50	161.25	186.50
Kerosene/Jet fuel	5.0240 Kz/liter	209.40	281.75	172.58	179.33
Gasoil	3.5488 Kz/liter	140.95	255.00	151.92	171.50
Fuel oil (Heavy)	2.6600 Kz/kg	89.80	167.25	87.42	121.00
			Official price as % International		
LPG			88%	130%	119%
Gasoline			83%	141%	122%
Kerosene/Jet fuel			74%	121%	117%
Gasoil			55%	93%	82%
Fuel oil (Heavy)			54%	103%	74%

a/ Except LPG for which US$80/t added to FOB Mediterranean.

Source: SONANGOL and World Bank.

Pricing of Products to Final Consumers

3.31 There is a fixed structure of final prices at which SONANGOL sells the products. This structure was established in 1985 and is still in effect except for a few relatively minor adjustments. The revised pricing scheme as per original documents received from SONANGOL is shown in Annex 9. Allowable SONANGOL profit is 10% of the refinery gate price plus SONANGOL costs and import differential. The latter element is intended to account for the differential between the landed cost of the imported product and the refinery gate cost for domestic-sourced material. The reseller margins have all been increased slightly. The difference between all these allowable costs and the final selling price is made up by a payment to, or subsidy from, the OGE. If these payments/subsidies for each product are multiplied by the 1987 budget-projected volumes of sales for each product, the total gross payment owing to the General Budget for 1987 would appear to be Kz 877 million. SONANGOL is also permitted to deduct its costs of transporting Soyo crude to the refinery. These transport costs were budgeted for 1987 at Kz 111 million. The estimated total net flow to the OGE on this payment/subsidy differential for 1987 would therefore have been Kz 766 million. If we add total budget-projected revenue from product taxes at Kz 1,735 million we arrive at a total Government revenue of Kz 2,501 million on SONANGOL product sales estimated for 1987.

3.32 Looking at the cost recovery on individual products, based on official RG prices and the current SONANGOL cost/profit structure, kerosene, LPG, and LFO (light fuel oil) are the only products which receive a net subsidy from the General Budget. The kerosene net subsidy at Kz 1.2034/liter and LFO at Kz 1.2568/liter are fairly minor, but LPG at Kz 7.1843/kg below cost is a significant distortion.

3.33 Apart from official prices and markets, there is also a parallel market in petroleum products, mainly kerosene and LPG. Even on the outskirts of Luanda, where supplies should be relatively plentiful, kerosene trades at high prices in small quantities. In the interior of Angola, where supplies are extremely short, the parallel market price can reach several hundred Kz/liter for kerosene and similar levels for LPG. There does not seem to be a significant parallel market for products such as gasoline and gasoil, which are normally traded in bulk or through retail service station outlets.

3.34 The fiscal treatment of products is highly discriminatory to the effect that tax considerations rather than relative prices or scarcities determine the allocation of petroleum products. To remedy this problem, products should be taxed roughly equally, at the same rate as gasoline (i.e., 133% of the refinery gate price, adjusted to the level of import/export parity). Arbitrary budget contributions (surtax) could be added to round out the retail price. Also, automotive fuels could be assessed an additional fee to cover road maintenance.

3.35 In order to illustrate the impact of adjustments towards a more reasonable valuation of the Kz, the following pricing analysis will be conducted using an illustrative exchange rate of Kz 104 per US$1 rather than the official rate of 29.62 Kz/US$. The refinery gate price based on world market prices will be recalculated and it is assumed that SONANGOL costs, margins, etc., will rise by about one-third. Since the average level of refinery gate prices was close to world prices in mid-1987, and the structure of refinery-gate prices was closer to economic costs than retail prices were, the refinery-gate prices will be used as the starting point of the exercise, except for the prices of HFO (heavy fuel oil) and gasoil, which were significantly lower than world prices.

3.36 The adoption of a price structure similar to the above would be a useful step towards a more rational price policy. Such a structure of relative product prices approximates economic costs, thus giving consumers appropriate signals as to the relative scarcity or opportunity cost of products. In addition, if these prices were in effect, the Government would have received approximately Kz 15 billion of the Kz 2.5 billion estimated for that year. A more appropriate price level would have to be set in relation to the purchasing power of the Kwanza. To illustrate this, a price build-up at the hypothetical exchange rate of Kz 104/US$1 is shown in Table 3.12. At these prices, Government revenues for 1987 would have exceeded Kz 50 billion (20-25 times the actual estimated level of Kz 2.5 billion). To the extent that this increase in revenues would have helped to reduce the relative magnitude of the budget deficit, it would also have exerted deflationary pressure on the overall price level even though absolute petroleum product prices would have risen only three to four times in the same period.

Table 3.12: ILLUSTRATIVE PETROLEUM PRODUCT PRICING-- 1987
(Kz/liter or kg; Kz 104/US$ Hypothetical Exchange Rate)

	Gasoline	Kerosene	Jet A	Gasoil	LPG	HFO
	(Kz/liter)				(Kz/kg)	
Refinery gate	17.56	17.61	17.61	14.92	27.68	11.68
Tax	23.36	23.42	23.42	19.84	36.82	15.54
SONANGOL cost	4.22	2.67	1.62	2.58	16.72	0.23
SONANGOL profit	1.09	1.01	0.89	0.79	2.88	0.42
Reseller margin	0.51	1.04	-	0.24	1.62	-
Subtotal	46.74	45.75	43.54	38.37	85.72	27.88
Surtax (budget contribution)	3.26	0.25	6.46	7.63	4.28	2.12
Hypothetical selling prices	50.00	46.00	50.00	46.00	90.00	30.00
Government revenue	26.62	23.67	29.88	27.47	41.10	17.66

Source: Mission calculations.

Economics of Refining vs. Direct Product Supply

3.37 Fundamental Economics of Refining at Luanda. Based on Angola's location in relation to major crude markets and major export refining/product supply sources, and on the marketability of its crude compared to standard world "marker" grades, there are certain fundamental advantages/disadvantages to refining Angolan crude in the country in order to supply local markets. These advantages/disadvantages are based on the following factors:

(a) the opportunity cost to a crude-producing nation of using its own crude as feedstock to an indigenous refinery, which is the revenue it will lose by not exporting the crude;

(b) the export opportunity value of crude, which is based on its value in major crude markets in relation to major world "marker" grades; and

(c) the refinery-gate opportunity value of domestically refined products, which equals: (i) the cost of landing products from major world export refining sources, or (ii) revenue earned from export of the products, netted back to the refinery gate (as is the case with heavy fuel, which is currently produced in excess of domestic demand).

3.38 Soyo/Kwanza, the major refined grade in Angola, is not a major export grade since almost all of it is used in local refining. Poor marketability for Soyo compared to the better-known Cabinda would make it sell at a lower price than Cabinda in spite of Soyo's slightly better quality. It is estimated that a combined discount on Soyo for freight and marketability, excluding quality, would be about US$0.50/bbl (US$3.65/t).

3.39 The major export refining sources used as basing point standards for pricing the supply of products for the West African coast are the Mediterranean and Northwestern Europe (Rotterdam). If Angola were to import all its product needs, it is reasonable to expect that an "efficient" freight supply mechanism would cost about US$20/t or US$2.67/bbl. In addition, in order to equate this supply cost to the cost of supplying the products at a refinery gate location, the cost of a receiving and storage terminal operation would have to be included in the calculation. The cost of such an operation on a reasonably large scale would be no less than about US$0.50/bbl. In the particular case of the Luanda refinery, Soyo crude must be transported to the refinery from the same terminal from which it would be exported. An estimated "efficient" cost of such a shuttle movement is US$3/t or US$0.4/bbl.

3.40 The fundamental economic advantage of a refinery in Luanda running local crude to supply local product markets versus a European refinery running the same quality of crude to a similar yield pattern also supplying Angola's product markets is as follows:

	Locational Advantage to Luanda Refinery vs. European US$/bbl
Crude feedstock cost (Soyo)	0.50
Product transport	2.67
Product terminalling cost	0.50
Local transport of crude to refinery	(0.40)
Total Advantage to Luanda	3.27

3.41 As indicated above, this only considers the fundamental crude and product freight differentials based on the location of Luanda in relation to crude markets and product supplies, as well as a "marketability" evaluation of the refined crude. Operating cost differentials among refineries, considering "efficient" refiners in both cases, are rarely more than US$1/bbl and would not outweigh the fundamental geographical advantage that the Luanda refinery enjoys. What matters, however, are the relative prices that the different petroleum products and crude oil capture in the world market, the output mix, and the percentage share of fuel oil that has to be exported. Based on typical plant yields and an 80% share of fuel oil exports, the refinery operating profit has been calculated for import/export parity levels that prevailed between 1985 and mid-1987. The results are summarized in Table 3.14. A more detailed analysis is provided in Annex 10. The figures show that on average, the refinery would have enjoyed a comfortable profit margin on its "efficient" operating costs during that period if the calculations had been based on border prices.

Table 3.14: SUMMARY OF LUANDA REFINERY ECONOMICS

	LSFO a/ to export	Soyo crude discount	Operating Profit 1985	Operating Profit 1986	Operating Profit 1st half 1987
	(%)	US$/t			
Base	80	3.65	8.21	9.69	4.41
Sensitivity I	100	3.65	7.10	8.31	2.11
Sensitivity II	80	0	4.56	6.04	0.76

a/ Low sulfur fuel oil.

Source: Annex 3.3.

3.42 Based on these findings, it can be concluded that the simple hydroskimming refinery in Luanda is an economically justifiable means of supplying local product requirements. Operating profits would prove positive even if:

(a) the total LSFO output had to be exported, thus reducing the net-back value of LSFO by the amount of forgone proceeds from domestic sales at higher import border prices (Sensitivity I); or

(b) the Soyo crude discount in comparison with Cabinda crude were zero (Sensitivity II).

IV. ELECTRICITY SUPPLY

Summary and Recommendations

4.1 Angola's power subsector, which still operates reasonably well, has suffered from more than a decade of neglect, caused in part by continued civil war, sabotage, losses of qualified personnel and an extreme scarcity of other resources. By 1987 the firm capacity had deteriorated to 275 MW, which is less than 60% of the total installed capacity. Transmission and distribution lines have hardly received any maintenance since 1975. Though the present state of the utilities' accounts makes it almost impossible to assess their financial performance, there was little doubt that in 1987 the global cash deficit of the sector would approach the level of US$50 million (or about Kz 1.5 billion).

4.2 In order to safeguard a reasonable quality of service and to gradually restore the utilities' financial viability, immediate, strong measures are required. Priority should be given to:

(a) strengthening the utilities' operational and managerial autonomy and capabilities, including accounting, billing, and the revenue collection system;

(b) raising tariffs to generate a cash flow sufficient to cover financial costs;

(c) reorienting the investment program to favor rehabilitation of the existing physical infrastructure; and

(d) decentralizing responsibility for operations and maintenance, as is largely the case at present.

4.3 A significant and sustained improvement in operations, maintenance and management requires an influx of know-how and finance. Operational support for the Central and Southern Systems as well as advisory assistance to a proposed task force (which will be in charge of all rehabilitation works) would require 75 man-years of long-term consultants plus 25 man-years of short-term consultants at a total estimated cost of US$10 million.

4.4 A minimal priority investment program should be carried out over the next four years to repair and maintain the existing facilities and create some reserve margins to cover rising demand. This would cost about US$200 million. Efforts should be undertaken to obtain financial assistance from bilateral or multilateral aid agencies. Such "soft" financing would help reduce the financial burden of the proposed rehabilitation measures.

4.5 The mission strongly recommends that the existing least-cost capacity expansion plan be updated, based on the best available demand projection. This would also require a reassessment of the future point at which the Capanda power project should be reintroduced in the expansion plan.

4.6 The financial losses of the power sector are no longer sustainable. Therefore, cost recovery is a matter of utmost concern. To ensure cost recovery, there should be immediate increases in tariffs up to 400%. The utilities' billing and revenue collection procedures should also be improved. However, no attempts should be made to set the tariffs at uniform levels throughout the country. In the short term, tariffs need to be simplified and restructured to enable the utilities to meet simple financial targets (e.g., covering 20%-30% of investment programs or obtaining a return of 3%-4% on assets in use). The adjustments should be designed so as to bring the level and structure of the tariffs in line with Long Run Marginal Costs in the medium term (up to 1992).

4.7 In the past, ENE (the national power company) was given neither the authority nor the means of assuming its (legal) duties of managing the entire subsector in a reasonably efficient way. Also, important mergers of utilities did not take place. Therefore, all operations and maintenance and part of the proposed rehabilitation activities should be decentralized to the Regional Directions as this is closer to actual practice than the theoretical centralization implicit in the formal structure of ENE. At the central level, a small planning unit should be established to be responsible for strategic matters (demand studies, capacity planning, tariff studies, etc. and such a unit is being established at present.)

Electricity Supply

4.8 Electricity supply in Angola is the responsibility of two companies: ENE and SONEFE (Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos). ENE is a State enterprise, created in 1980 and intended, eventually, to become the sole national power utility in charge of generation, transmission, and medium voltage distribution all over the country. The company is currently operating the "Central" and "Southern" Systems and several isolated systems. SONEFE is in charge of generation and transmission in the "Northern" System, the largest system in the country, and supplies about 300 clients directly at high voltage (60 kV) and medium voltage. Distribution in the area of Luanda is the responsibility of EDEL (Empresa de Electricidade de Luanda). Low voltage distribution in the rest of the country is sometimes the responsibility of ENE but is often handled by local municipal bodies (Comissariados) who may also own small captive diesel sets.

Overall Generating Conditions

4.9 Total installed capacity in ENE and SONEFE plants is approximately 463 MW. Of the total capacity, 287 MW is in hydro units, 102 MW in gas turbines, and 74 MW in diesel sets. In 1987 available capacity reached 275 MW (59% of total) but there were severe constraints on thermal units due to difficulties in fuel supply. The two gas turbines in Luanda (56.8 MW) burn Jet B fuel while the gas turbine in Cabinda (12.3 MW) runs on natural gas. The two remaining gas turbines, in Biopio (22.8 MW) and Huambo (10 MW), run on diesel oil. Annual electricity generation in Angola peaked at 1,029 GWh in 1974, with 858 GWh (83.4%) from hydro origin. After a sharp decline in the years following independence, generation resumed growth but experienced a second decline over the period 1983-85 and is still below the values of 1974. In 1986, total generation was 754 GWh with 691 (91.7%) from hydro plants. (See Annex 13 for additional information on electricity assets.)

4.10 Electricity supply in Angola consists of three separate grids and numerous isolated systems. The three main systems are associated with the basins of three important rivers: the Kwanza for the Northern System; the Catumbela for the Central System; and the Cunene for the Southern System. These systems supply the main load centers in Angola: Luanda (in the Northern System); Benguela, Lobito, and Huambo (in the Central System); and Lubango and Namibe (in the Southern System). The main isolated systems are those of Cabinda, Uige, and Bié. Another important system in the province of Luanda Norte belongs to the mining company ENDIAMA (Empresa Nacional de Diamantes de Angola) and was mainly used for diamond mining activities.

4.11 Hydro has always been the main supply source. Its share has remained within 80-85% of total supply, increasing to 91% in 1986 in spite of the total and partial unavailability of the Lomaum and Biopio plants. No new hydro plant has been built since 1974. From 1980 onwards, SONEFE and ENE tried to overcome the difficulties caused by sabotage and disruption of the hydro supply by installing new gas turbines in Luanda and Huambo and diesel units in Lobito and other major centers. Because of inadequate maintenance, lack of technical assistance and spare parts, and erratic fuel deliveries, the new facilities have not resolved supply problems. Therefore, current available capacity in the Central System is limited to 47 MW out of the 111 MW installed. Table 4.1 summarizes the installed and available capacities in the various systems and compares them with peak demand.

Table 4.1: INSTALLED AVAILABLE GENERATING CAPACITY, 1987
(MW)

System	Hydro Instl.	Hydro Avail.	Thermal Instl.	Thermal Avail.	Total Instl.	Total Avail.	Peak Demand a/
Northern	197.6	135.0	56.8	56.8	254.6	191.8	90-100
Central	49.4	7.2	61.8	39.5	111.2	46.7	30
Southern	27.2	13.6	25.3	15.1	52.5	28.7	9-10
Isolated	12.9	2.4	31.7	5.0	44.6	7.4	n.a.

a/ Estimated at generation; reflects varying amounts of suppressed demand. Suppressed demand in Luanda (Northern System) is estimated at about 15% of current consumption.
Source: SONEFE and ENE, Annex 13.

Northern System

4.12 The Northern System is operated by SONEFE using the hydro potential of the rivers Kwanza and Donde and two gas turbines in Luanda. The system generated 606 GWh in 1986, or 80% of all the electricity produced in Angola. Peak load at generation oscillates between 90 and 100 MW. The main plant is Cambambe with an installed capacity of 180 MW (four units of 45 MW), the largest in Angola. The plant is run-of-river with daily regulating capabilities, a minimum flow around 130 m^3/s (in October), giving a firm power in the critical day of 90 MW. It was generally assumed that the next demand increase in the Northern System would be met by raising the height of the dam at Cambambe by 20 meters, which would increase total installed power to 260 MW. The site was also meant to receive a second power plant, with four units of 110 MW each. 17/ All the units in Cambambe (four units installed in 1963 and two in 1973) require urgent inspection and overhaul (Unit No.1 received a general overhaul and was recommissioned in mid-1986 but work on unit No. 2 is delayed due to shortages of foreign exchange). The situation calls for urgent attention from SONEFE and the MEP as the supply of the current peak (around 100 MW) requires three units in Cambambe or the starting of one gas turbine with high operating costs. The other hydro plant in the system is Mabubas, 54 km northeast of Luanda, built in 1953 with an installed capacity of 17.8 MW. The plant was derated to half its capacity in 1974 and completely shut down in 1986 for a rehabilitation costing about US$7 million. Due to delays in transportation and payments, it will not resume operation before late 1988.

Central System

4.13 Two companies operated the Central System before independence: the Hydro Electric Company of the Upper Catumbela (HEAC, Hidro Eléctrica do Alto Catumbela), in charge of generation and transmission, and the Electric Company of Lobito and Benguela (CELB, Companhia Electrica do Lobito e Benguela), in charge of distribution in the province of Benguela. In 1982 HEAC was incorporated into ENE as its Central Direction. However, although the merging of CELB was firmly planned, the company is still a separate entity in both the MEP's Plan and in its Reports. The system is based on two hydro plants located on the western course of the Catumbela river: Lomaum (35 MW) and Biópio (14.4 MW). A gas turbine of 22.8 MW was installed in Biópio in 1974 and a second gas turbine in Huambo in 1981, both interconnected with the rest of the system. The system supplies energy to the provinces of Benguela

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17/ The decision to initiate Capanda is currently seen as anticipating an investment included for a later stage in SONEFE expansion plans and postponing for many years (or indefinitely) the investments in Cambambe (see para. 4.100).

and Huambo, the two main districts of Angola (after Luanda) in population and industrial development. The transmission system runs more or less parallel to the Benguela railway.

4.14 In 1974, the Central System supplied 171 GWh, or nearly 17% of generation in Angola. Peak demand (at generation) was about 29 MW, with a load factor of 67%. In 1983, the substation at Alto Catumbela and the Lomaum plant were sabotaged, resulting in the flooding of the station and the destruction of the control and protection system. A project has been negotiated for financing part of the rehabilitation of Lomaum and the installation of two additional units of 15 MW each, to increase installed capacity to 65 MW. Excluding the cost of the new sets, the total rehabilitation cost is estimated at US$55 million.

4.15 The gas turbine at Huambo was installed in 1981 and intended for stand-by duty. The turbine has a nameplate rating of 13.0 MW, but derating due to altitude (Huambo is at 1,800 meters) limits available output to 10 MW. The turbine was bought with a minimum of spares and no service contract and was run continuously but with numerous stops and starts due to fuel shortages or disruptions on the line from Biópio to Benguela. Keeping the unit running without the necessary overhaul caused a serious breakdown in 1985. While negotiations for the repair of this unit (and a similar one in Cabinda) go on, Huambo is supplied from Biópio (264 km, 150 kV line), and has 4 x 0.8 MW rehabilitated diesels and 2 x 1 MW new diesels. The situation is serious and frequently requires load shedding at peak time. In spite of this, the situation at Huambo is much better than in Cabinda where the breakdown of the gas turbine has practically stopped public electricity supply. The required backup in Huambo is more easily insured by traditional diesel sets than by the gas turbine (which could be moved to a coastal area such as Cabinda to replace diesel sets or to Soyo, where SONANGOL has a project with 15 MW of gas-fired turbines). ENE and SONANGOL should jointly evaluate the interest and feasibility of this transfer, taking into account that gas turbines are naturally advantageous for Soyo and questionable in Huambo.

Southern System

4.16 The main facility in the Southern System is the hydro plant at Matala, on the Cunene river, with a total capacity of 27.2 MW in two units. A third unit has been stored for several years in Belgium and its installation is now foreseen for the end of 1987. The Gove dam, upstream from Matala, was completed in 1974 for irrigation but mainly to regulate the flow at Matala. Without Gove, the natural low flow at Matala would not permit significant generation during 4-5 months of the year. Firm power in the critical day is now 10.9 MW, but present operating conditions are bad, with Unit No.1 out of order since 1984 and Unit No.2 derated to 60% of its nameplate rating. The plant suffered several fires which damaged the generators, the control room, and the power cables. A complete rehabilitation program has been designed and was supposed to start in late 1987, to replace the control room and power cables. Next is the installation of the third unit and the rehabilitation of Units No. 1 and 2.

4.17 Both the Matala and Gove dams present serious safety problems. The 29 gates of Matala cannot be operated due to fractures in the dam's structure. The same occurs with the 3 gates at Gove due to sabotage of the control equipment in 1986. Furthermore, Gove dam, which is of earth-fill type, is showing considerable percolation. Unless action is taken to open at least one gate, natural (or disaster) flood conditions could occur and endanger not only Gove but the downstream Matala dam and power plant and, thus, supply to the whole Southern System, let alone loss of life and property.18/ Delays in the process are partly due to the fact that Gove belongs to the Ministry of Construction. An urgent intervention by both parties is necessary to prevent a dramatic accident. The mission suggests that Gove be placed under the responsibility and management of ENE since a power plant of 40 MW is foreseen there later.

4.18 Concerning Matala, ENE consulted several organizations which agree that Matala dam presents serious safety problems resulting from structural anomalies, inoperability of its hydraulic security devices, and complete lack of periodic observations for many years. It is, therefore, risky to start extensive rehabilitation of electrical equipment and installation of a third generator without a rigorous identification (and correction) of the causes of the problems of the dam.

4.19 A diesel plant was built in Namibe in 1980, with an installed capacity of 11.5 MW in two units. Some equipment needed to complete the plant (namely one fuel storage tank) is still missing but the plant has already operated for short periods. Coordinated operation of this facility with Matala is a priority because it is the only supply alternative to the Southern System while Matala is unavailable. ENE may need assistance with the parallel operation of Namibe and Matala as the link between them is very long and weak (330 km with half the distance at 60 kV).

Transmission and Distribution

4.20 Transmission and distribution is made at 220, 150, 100, 60, 30, 20, 15, 10, and 6 kV. The proliferation of voltage levels shows that not enough attention was paid to the advantages of standardization. The situation is typical of different companies, each with its own area of influence. The variety of voltage levels increases the difficulties and costs of maintenance and makes it difficult to keep an adequate stock of spares. The number of standard voltage levels 10, 20, and 100 kV should be eliminated from new investments. The need to keep 15 kV (instead of 20 kV) is unfortunate as this type of equipment is becoming uncommon and expensive. However, since the entire Luanda network is at 15 kV, EDEL has no choice. Total length and characteristics of transmission lines, in 1987, are given in Annex 13, Table 6.

18/ Work to repair the dam started shortly after the mission's visit.

4.21 The 220 kV voltage level exists only in the Northern System and is used to carry energy from Cambambe to Luanda (175 km) and to make the injections to Kwanza Norte (73 km) and Kwanza Sul (125 km). The 100 kV voltage level is used only in the Northern System. No further development of 100 kV lines beyond the two existing ones should take place because it is not a standard voltage and because 60 kV and 150 kV are much more extensively used in Angola. Transmission in the Central and Southern Systems is made at 150 kV, with long lines at 60 kV in the Southern System. The lines have had no preventive maintenance since 1975 and are seldom inspected. The cable and most of the towers on the 60 kV Namibe-Tombwa line (95 km long) are very badly corroded due to a mixture of salt air and desert winds. ENE acknowledges the urgent need to replace cable and wires as well as to rehabilitate the towers, but lack of staff, inefficient organization, and scarcity of foreign exchange are delaying any decision.

Electricity Demand

Past Situation

4.22 Until 1974, electricity generation and consumption statistics in Angola were regularly established and published, giving a rather complete and reliable picture of its situation and evolution. Because of deterioration of metering equipment in power plants and substations, frequent outages (by sabotage or poor maintenance) of generating and transmission facilities, poor record-keeping, and lack of communication between regional centers and ENE headquarters in Luanda, the quality and reliability of electricity statistics have declined. Forced to fill out forms in the absence of hard information, the utilities often supply unreliable, inconsistent figures to satisfy reporting requirements.

4.23 Growing difficulties of supply due to outages or sabotage led the Government, through ENE, to install a large number of small and medium-sized captive diesel units (up to 1.5 MW of rated power) at the facilities of local authorities (Comissariados) and major consumers. Little is known about these sets, yet they may represent a non-negligible share of total generation in Angola, not only in isolated centers but also in areas supplied by one of the three main systems. In 1986, about 200 new diesel units were acquired by ENE and installed all over the country with rated power estimated between 30 and 40 MW (total cost of pounds sterling 30 million). Production from these units partially replaced unavailable supply from the grid but is not accounted for in ENE or MEP statistics.

4.24 Gross electricity generation in Angola totaled 754 GWh in 1986. Final consumption must be estimated, as figures for electricity distribution in the MEP's reports are established from utility estimates of emission to distribution grids. Assuming an overall figure of 22% for transmission and distribution losses, total consumption may be estimated at about 590 GWh in 1986. The share of total generation among the different systems in 1986 was as follows: 80.4% in the Northern System, 10.0% in the Central System, 7.5% in the Southern System, and 2.1% in isolated centers. The absolute values and the pattern of generation and consumption in 1986 are not typical of earlier periods, either before or after independence, as they were constrained by temporary irregularities of supply and demand whose duration is not known. The present overall situation and past trends since 1967 are shown in more detail in Annex 13, Table 2.

4.25 Between 1967 and 1973, generation and consumption increased at an average rate of about 16.3%. The bulk of growth was concentrated in the six major load centers: Luanda, in the Northern System; Huambo, Lobito, and Benguela, in the Central System; and Lubango and Namibe in the Southern System. Only one additional load center grew in relative importance during that period--the isolated system of Cabinda. After independence, in 1975, consumption declined sharply to only about half the level of 1974. Starting in 1977, a slow recovery process lasted until 1982. Annual growth rates during that period averaged 6.0% and consumption in 1982 was roughly equal to that of 1971. Between 1983 and 1985 a new period of decline occurred, due to intensification of sabotage activities. A whole plant (Lomaúm, 35 MW) and a substation (Alto Catumbela) were severely damaged and put out of order, constraining the supply in the Central System. In the Northern System, supply to the whole province of Kwanza Sul, estimated at about 20 GWh, was interrupted due to the sabotage of the 20 kV Cambambe-Gabela line. Supply had not yet been restored in May 1987. The overall negative trend of the period 1983-85 was reversed in 1986 mainly because of faster growth in the Luanda area.

4.26 In 1974, over 50% of the load was already concentrated in the provinces of Luanda and Bengo, which encompass the Luanda metropolitan area. The absolute consumption of Luanda is currently slightly higher than in 1974, and its share of the total consumption of Angola has increased to nearly 76%. The most interesting years for comparison are 1974 (the last year before independence), 1982 (the last year before the second declining period), and 1986. In 1974, 83% of total consumption was concentrated in the five provinces with the six main load centers. In 1986 the share of the same provinces had increased to nearly 96%. Between 1974 and 1986 Luanda's share increased while that of the other four main provinces decreased. Decreases in Benguela and Huambo were not only due to a reduction in economic activity but also to supply constraints, as the Central System facilities which serve both provinces have been particularly hard hit by acts of sabotage. Generation and consumption over the last five years are summarized in Annex 13, Tables 3 and 7, showing the contribution of each system to global supply and the share of each province in total consumption.

Luanda

4.27 The consumption of the Northern System is concentrated in Luanda, which represents more than 90% of the total system load. The main part of the Luanda load is EDEL's distribution network in the urban area, the rest being industrial consumers (around 300) directly supplied at 60 kV, 30 kV, and 15 kV by SONEFE, and some local authorities (Comissariados). Consumption has been stagnant over the period 1982-86, at a level between 480 and 500 GWh. Accepting EDEL estimates of 12% technical and 9% non-technical losses in its distribution network, total sales in the Northern System, in 1986, may have reached about 440 GWh for a total generation of 605 GWh (total losses of 27%). Figures should be taken with caution as the large variations between consecutive years may be due to incorrect measurements (different time periods, for instance) or long and frequent interruption of supply (at any voltage level). A long-run average annual growth rate of 5% is plausible (see Annex 13, Table 8 for further details).

Central and Southern Systems

4.28 The disruption of supply in the Central System is the main cause of decline in overall Angolan generation and consumption since 1982. The share of the Central System in total generation which represented 20% in 1982 declined to 10% in 1986, and consumption in 1986 (79 GWh) was roughly equivalent to half the value of 1982 (145 GWh). The Central System has the highest level of suppressed demand, and more than 50% of the present generation is of thermal origin (from the gas turbine in Biópio with a specific consumption of at least 0.360 kg/kWh or 0.425 liter/kWh). Average operating costs, just for fuel, amount to Kz 3.5/kWh. Rehabilitation of the Lomaum hydro plant, foreseen for early 1989, is thus a priority cost-cutting task for ENE.

4.29 The Southern System currently represents 5.5% to 7.5% of overall generation. No significant disruption of supply has occurred and consumption has slowly but regularly increased. Some potential repressed demand is caused by shortage of materials for network extensions and connections. However, the system depends on practically a single source, the Matala hydro plant. This plant currently has safety problems, partly local (in the dam) and partly related to safety problems in the upstream Gove dam. Furthermore, ENE plans to install a third unit at Matala which will require an interruption of supply. Lubango and Namibe may thus experience serious supply problems, and ENE has not yet taken any steps (e.g., completing the Namibe thermal plant) to minimize the interruptions.

4.30 The share of isolated centers, which in 1974 accounted for a total consumption of 115 GWh, (12.5% of the overall consumption of the country) fell noticeably, to 30 GWh (or 2%), after the breakdown of the Cabinda gas turbine. Aging of units, lack of maintenance and spares, difficulties of fuel supply, the complete cessation of mining activities in Luanda province (representing between 50-60 GWh), and a marked decrease in commercial and industrial activities were the main cause of the substantial reduction of that share. However, part of the already existing demand is likely to be supplied by captive diesel sets, not accounted for in global statistics.

Load Curve

4.31 Information on the daily and seasonal pattern of demand is only available for the Luanda area. Present coincident peak demand is about 90 MW, of which 70 MW corresponds to the EDEL network. For the whole Northern System, annual peak demand measured in Cambambe oscillated between 80 and 100 MW over the period 1978-86.

4.32 For the main load center of Luanda, yearly load factors vary in range between 0.63 and 0.70. Working day load factors are about 0.80. The daily load curve normally features two peaks: a morning peak, lasting from 10.00 to 13.00 and a higher evening peak, between 19.00 and 21.00. Night load remains at about 65% of peak load, indicating a fairly high permanent base load. Night load is mainly due to air conditioning and refrigerators together with public lighting. ENE statistics do not state the peak demand associated with the Central or Southern systems. Present peak demand in Huambo is around 9 MW, for a total of 13,000 customers, but load shedding at evening peak may be quite extensive and an unknown portion of this peak may be covered by captive diesel sets. A 9 MW value can be considered conservative, and could increase 20% to 30% in normal supply conditions from the grid. Peak demand in the Southern System is about 9.5 MW, measured at the Matala power plant, with a peak demand of 5 MW in Lubango, the main load center.

Demand Projections

4.33 In the present context there is no firm basis for making demand projections in Angola with any reasonable degree of confidence. The difficult economic and security conditions of the country, even if considered transient, impede any demand forecasts. Application of standard forecasting methodologies (either the use of statistical data to define approximate laws of probable evolution for already electrified regions, or comparison with areas with similar geographical, demographic, and economic conditions for regions to be electrified) is hindered by an exceptionally high degree of uncertainty about future economic activity, which strongly depends on the return of peace to the country. Past records of power system performance are inadequate and unreliable and do not correspond to historical trends in a stable economic framework.

4.34 The utilities have no idea of the potential number of clients and potential consumption. It is thus understandable that ENE and SONEFE have given up making any medium- or long-term forecasts. Figures sent to MEP and included in the Plan Report of the Ministry cover only 1987 and 1988, and are considered perfunctory by the utilities. Forecasts are not based on a breakdown of total consumption by customer class or load center but only by province, and bear a rough relationship to the values of the two previous years.

SONEFE: Northern System

4.35 SONEFE estimates an annual growth rate of 2% for the Northern System 19/ under the joint effect of two opposite trends: an increase in residential consumption, mainly due to the connection of new customers, and a stagnation (or even decline) of industrial consumption. Global projected generation is distributed among the existing power plants, assuming a certain availability of units and pre-established minimum generation from thermal origin. "Distribution" is calculated using generation forecasts, assuming a fixed value of 10.6% for transmission losses and internal consumption (Cambambe village and installations). This percentage is a traditional value which SONEFE has no means to verify or correct. The share among the four provinces supplied by SONEFE is calculated on the basis of recent figures (1985 and 1986), taking into consideration the actual unavailability and expected repair times of major transmission lines. According to SONEFE, the consumption of the greater Luanda area in 1987 and 1988 is supposed to represent 94.1% and 93.2%, respectively, of the total consumption of the Northern System.

ENE: Central and Southern Systems

4.36 Generation and consumption projections in ENE are even more primitive than in SONEFE. The staff assigned to prepare projections is extremely reduced and ill-prepared. It faces two additional difficulties in comparison with SONEFE: the need to deal with several systems of variable extension and characteristics distributed all over the territory and the lack of information, at ENE headquarters in Luanda, on reliable historical consumption figures and realistic constraints on installed capacity. ENE is currently assuming that all the systems are supply-constrained (which is essentially correct) so that primary forecasting concerns generation according to expected available supply facilities. Forecasts for 1987 and 1988 are optimistic concerning the speed of rehabilitation. Projections of "distribution" were established assuming a certain percentage of losses, arbitrarily set at 4% for the Central System and 9% for the Southern System. "Distribution" should be understood as deliveries to the distribution network at the high voltage busbars of HV/MV substations, although 4% of losses is too low for losses in a long transmission system like the Central System. ENE and SONEFE projections are summarized in Table 4.2.

19/ In October 1988, SONEFE surmised that a repressed demand of 15 MW might exist in Luanda, and 10 MW in the rest of the Northern System. It also thought that peak demand could increase by 6% in 1988 and that average annual growth in the period 1988-1998 could be 6%. The mission's estimates for the same period vary between 6.7% (base case) and 9.3% (high case).

Table 4.2: ELECTRICITY GENERATION AND CONSUMPTION PROJECTIONS
(GWh)

System	1986 (Actual)		Projections 1987		Projections 1988	
	Generation	Consumption	Generation	Consumption	Generation	Consumption
Northern	605.9	506.1	615.9	551.0	628.3	561.6
(Luanda Metro share)		(491.9)		(518.4)		(523.3)
Central	75.2	72.6	71.6	68.7	83.8	80.5
Southern	56.3	43.3	57.4	51.7	58.0	52.2
Isolated	16.0	14.2	25.5	24.4	27.0	25.8
Total	753.4	636.2	770.3	695.8	797.1	720.1
SONEFE	605.9	506.1	615.9	551.0	628.3	561.6
ENE	147.5	130.1	154.4	144.8	168.8	158.5
Total	753.4	636.2	770.3	695.8	797.1	720.1

Average Growth Rate, 1986-88 (% p.a.):

System	Generation	Consumption
SONEFE	1.83	5.34
ENE	7.00	10.40
Total	2.86	6.39

Source: ENE, SONEFE, MEP, and mission estimates.

4.37 ENE and SONEFE face a number of serious and difficult planning issues for the development of the three main systems as well as their possible interconnection. Serious thought about expansion plans and investment options requires some knowledge of future (long-term) electricity demand. The only possible approach is to construct some alternative scenarios for the evolution of demand, which cannot be considered forecasts, but could be used to test policies for supplying load centers and to test alternative timings and options for major development of new power plants and transmission facilities and acceptable delays and cost implementations for major investment decisions.

Alternative Demand Projections

4.38 SONEFE and ENE do not prepare medium- or long-term demand projections. They only compile short-term (2 years) perfunctory figures to satisfy MEP reporting requirements. However, over the years many studies have been done about various aspects of Angola's power subsectors. This report will limit itself to a review of the two most recent ones 20/ and will also present its own set of demand projections based on past studies and on specific hypothesis about the pace of economic rehabilitation in Angola. The various projections are summarized in Table 4.3 and compared with present installed and available capacity. The main assumptions are listed after the table while details and specifics are described in Annex 14.

Table 4.3: ENERGY AND DEMAND PROJECTIONS, 1986-2000
Comparison of Generation Requirements
(Base Cases)

	Energy (GWh)			Peak Demand (MW)			Capacity (MW)	
	BEP	THEMAG	Mission	BEP	THEMAG	Mission	Installed	Available
Northern System								
1987	554	693	618	102.3	123.7	112.0	254.6	191.8
1990	732	943	656	141.1	167.6	118.8		
1995	1,278	1,514	859	244.0	274.3	155.7		
2000	1,876	2,225	1,461	355.0	403.0	264.7		
Central System								
1987	217	175	98	43.2	37.1	18.8	111.2	46.7
1990	263	244	115	52.8	52.8	21.8		
1995	528	375	196	103.3	81.3	35.7		
2000	743	551	329	144.0	119.5	60.1		
Southern System								
1987	57	81	55	1.8	17.4	10.8	44.6	28.7
1990	67	102	58	14.0	22.2	11.7		
1995	132	157	85	26.8	34.1	16.9		
2000	193	231	124	38.6	50.1	24.9		

UNDP: The United Nations Development Program.

Source: BEP, THEMAG, mission estimates, and Annex 14.

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20 Belgian Engineering Promotion: "Etude d'un Plan Directeur du Réseau Electrique National d'Angola", Bruxelles (financed by the African Development Bank); and Themag Engenharia: "Interligacâo dos Sistemas Norte/Centro/Sul em Angola, Possibilidades de Interligacâo com a Namibia", Estudo Preliminar, Sâo Paulo, Outubro 1986 (done within the SDACC framework).

4.39 Table 4.3 shows that this report's projections, based on relatively sanguine hypotheses, are much lower than the base cases of other studies, which must be considered excessively optimistic. If IBRD/UNDP projection figures are even only broadly indicative of future needs, present investment plans will overshoot actual demand substantially, especially if a tariff reform were to take place. These projections further show that demand can be met substantially until the end of the 1990s by rehabilitating presently installed capacity, except in the Northern System where some new capacity will be needed after 1995.

Electricity Tariffs and Utility Finances

4.40 Electricity tariffs have not changed since the 1960s except in newly electrified areas where rates have remained constant since service started. As a result, wide variations in tariffs can be observed in areas served by the same interconnected system. Variations of the order of 3 to 1 are not uncommon. However, absolute tariff levels are so low that consumers perceive electricity to be essentially free. Consumption has therefore increased, with limits set only by supply and appliance constraints.

4.41 A complex and widely varying declining block structure prevails for low voltage tariffs (often with a minimum monthly bill), with higher rates for residential consumers and lower rates for industrial consumers. In the EDEL distribution area (i.e., greater Luanda) LV tariffs discriminate among residential, commercial, industrial, and public lighting uses. Residential and commercial tariffs have a very complex declining block structure, with block sizes related to house sizes or floor area and minimum monthly bills related to meter caliber. The LV industrial tariff, covering only 2% of sales, is a three-period time-of-day tariff with energy rates declining with load factor and meter caliber. Public lighting is charged at a flat rate, which is about one-half of the average price of other LV sales.

4.42 HV tariffs usually include block rates whose size is a function of (non-coincident) peak demand, leading to average prices declining with load factor. Large consumers benefit from contracts negotiated long ago, at times of excess supply capacity. High voltage (HV) tariffs take as billing variables non-coincident peak demand and active and reactive energy. Energy rates decline with the load factor, that is, utilization of peak demand. Demand rates increase with the load factor. In Luanda, the marginal price for active energy declines from Kz 1.1/kWh (load factor of 12.5%) to Kz 0.85/kWh (load factor of 25%) and Kz 0.505/kWh (load factor of 100%). Reactive energy is charged through a monthly bill multiplier: it is free up to 60% of active energy (cos ϕ = 0.8) and is charged at a price rising to 63% of the normal rate when it reaches 92% of active energy (cos ϕ = 0.4).

4.43 This tariff structure cannot be adjusted to the pattern of marginal costs in the Northern System. These are determined by the generation and transmission capacity needed to meet peak demand (at present, only 3 to 4 hours in the evening, and, in the future, also a second industrial peak period during the morning) and by local grid capacity requirements determined by maximum demand. Tariff reform would therefore require significant changes.

4.44 In the Luanda area, tariffs were set in 1962. Residential tariffs consist of three declining blocks varying with house size (12 classes) and meter size (9 classes). The rates vary from Kz 2.50/kWh (first block) to Kz 0.70/kWh (for the third block). The average price of electricity sold is about Kz 0.83/kWh. Industrial and HV tariffs are even lower, as low as Kz 0.55/kWh.

4.45 A rough estimate of the cost of producing electricity in Angola shows that energy costs alone in the ENE systems amount to about Kz 5-6/Kz ($US0.17-0.19/kWh). SONEFE's energy costs (almost 100% hydro) are about Kz 1.0/kWh. 21/ This superficial comparison of tariffs with costs points to one cause of the poor financial performance and condition of the power utilities. Other reasons are that costs are not known accurately, that the utilities are overstaffed, and that billing and collection are extremely inefficient.

Accounting

4.46 The present state of financial reporting makes it almost impossible to assess the financial condition of the utilities. ENE has never produced statements of accounts since its establishment in 1980. A list of ENE's inherited fixed assets and inventories, financial claims, and liabilities was prepared for the approval of its initial net worth, but so far no accounting records have even been made.

4.47 EDEL's legal status as a public enterprise was unclear at the time of the mission.22/ The utility presented a report dated August 1984 showing a balance sheet as of December 31, 1982 based on asset values submitted for Government approval, and is preparing the statement of accounts for 1983. These documents were never approved by the Government.

4.48 SONEFE has closed accounts for 1981 and 1982. Assets are valued at historical book value. Capital and liabilites do not reflect the *de facto* legal status of the utility, i.e., a State enterprise under

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21/ Distribution costs alone add another Kz 0.5/kWh. This would give total average costs (excluding capacity) of Kz 1.3 to Kz 2.5/kWh in the Luanda System.

22/ EDEL's status has been legalized since.

the guise of a private corporation. Poor enforcement of accounting principles and the mixing of traditional and new accounting practices, partially influenced by new national standards (set in "Plano Nacional de Contas") produce statements of accounts that require extensive revision to come closer to international standards.

4.49 No accounting records for CELB are known. Although the transformation of CELB into ENE's Central Region is firmly planned, CELB is still considered a separate unit in plan execution and forecasting reports.

4.50 In conclusion, those power utilities that have accounts at all have extremely weak accounting procedures. While both the utilities and the Government are aware of this, the remedies being proposed are probably not the most effective. The utilities are planning to prepare accounts for the last several years (ENE since its conception in 1980, EDEL since 1982) and the Government is proposing a new, uniform accounting plan for State enterprises. The relative merits of these proposals are questioned and a more modest suggestion, better matched to the abilities of the utilities, will be made in the following paragraphs.

Financial Situation of the Power Utilities

4.51 The power utilities together incurred a global cash deficit of about Kz 1.4 billion (US$46.7 million) in 1985. Total sales revenue that year was about Kz 650 million (US$21.7 million) or 46.5% of the cash deficit. In 1986, thanks to lower investment expenditures, the total cash deficit fell to Kz 1.1 billion or 176% of consolidated sales revenues. This is a significant share of the overall budget deficit which was estimated at Kz 13 billion in 1986. Given the short-term plans of the utilities, cash deficits are expected to increase in 1987 and 1988 (to about Kz 1.4 billion and Kz 1.5 billion, respectively). These cash shortfalls include about 20% of capital expenditure (however difficult that is to estimate).

4.52 Total fixed assets of the power utilities in (about) 1982 were estimated at about Kz 4.5 billion (US$150 million). A net return of 3% to 4% on these assets would require the utilities to produce a consolidated profit of Kz 150-180 million (in addition to covering costs). This is far from the present situation. However, since the cash deficit figures quoted above included some investment expenditures, covering those cash deficits (as presently estimated) would be a reasonable short-term goal for the power utilities. This would require multiplying the present tariffs by an average of 3 to 4 (excluding any exchange rate consideration--more than 50% of operating expenditures of the utilities are in foreign exchange).

4.53 Table 4.4 summarizes the cash flow situation of the power subsector as a whole. It is interesting to note that although ENE sells only one-third as much energy as EDEL (or one-fourth as much as SONEFE), its total costs, on a cash flow basis, are 250% higher. 23/ This is due mainly to the much larger proportion of thermal generation by ENE (even though diesel oil is sold at the low price of Kz 7/liter).

Table 4.4: ANGOLA: ELECTRIC POWER UTILITIES, SALES AND CASH FLOW, 1986
(Million Kz)

	ENE	CELB	SONEFE	EDEL	TOTAL
SALES (GWh)	123.0	n.a.	506.1	365.9	995.0
(Intrasectoral)			(417.2)		(417.2)
Net Consolidated Sales	123.0		88.9	365.9	577.8
CASH INFLOWS (million Kz)	259.7	118.4	346.2	329.2	1,053.5
(Intrasectoral)	(35.0)	(207.8)		(242.8)	
Net Consolidated Cash Inflows	224.7	118.4	138.4	329.2	810.7
CASH OUTFLOWS (million Kz)	1,022.1	196.7	523.5	449.1	2,191.4
(Intrasectoral)		(35.0)		(207.9)	(242.9)
Net Consolidated Cash Outflows	1,022.1	161.7	523.5	241.2	1,948.5
CASH DEFICIT (million Kz)	762.4	78.3	177.3	119.9	1,137.9
FINANCING OF CASH DEFICIT					
Net Budget Inflows	366.6	43.3	-38.0	123.8	495.7
Other Transfers a/ and Variations in Cash Balances	395.8	35.0	215.3	-3.8	642.2

a/ Including payment arrears.

Source: ENE, EDEL, SONEFE, the MEP, and Mission estimates.

External Debt of the Power Subsector

4.54 In 1987, the electric power subsector, excluding GAMEK, had a debt of about US$101 million, of which about US$60 million was disbursed and outstanding. The average maturity was about 8.5 years including a grace period of 2.5 years, and the average interest rate was about 8.5%. These conditions are typical of export financing schemes in the advanced market economies where most of these loans originate. In 1987, the amount needed to service this debt was about $US17 million. It is expected to rise to about US$20 million in the years 1988 to 1989, then to decline to US$15-20 million in the early 1990s. Annex 13, Table 9 gives a more detailed breakdown of available information. GAMEK's

23/ Correcting for capital expenditures (roughly estimated), ENE's costs would still be nearly twice those of EDEL.

currently disbursed debt was about US$250 million as of mid-1987 out of commitments of about US$600 million from various external creditors. It is expected to increase at about US$200 million/y in the next three years. Debt service is currently US$20-25 million/y, or a little more than the debt service of the rest of the power subsector. However, if the Capanda project were to go ahead, GAMEK's debt service would reach US$150 million by 1990. Some part of this amount may be repaid in petroleum.

Billing and Collection

4.55 Billing and collection difficulties are significant in Luanda. Electricity consumption for the last four years has not been recovered. EDEL considers one of the four years (still unbilled) to be recoverable. Consumption for 1986 was expected to be billed all at once, although six-monthly bills were used in 1985. It is obvious that such lengthy billing periods are only possible when electricity tariffs are negligible. This is the case in Luanda at present. 24/ The problem of billing is about to be resolved through computerization and because EDEL management is giving priority to this problem.

4.56 In Luanda, LV collections are effected door-to-door. EDEL employees report serious difficulties in collecting payments. HV and MV consumers pay their bills through bank account transfers ordered by the utilities. The problems are therefore essentially limited to LV residential customers.

4.57 Outside Luanda, LV customers pay their bills at banks or utility offices and recoveries are a high percentage of billings. Severe penalties and disconnections are actively imposed to enforce punctual payments. HV and MV consumers also pay through bank transfers.

Manpower, Staffing, and Technical Assistance

4.58 In mid-1987 the power utilities (EDEL, ENE, SONEFE, CELB) employed 3,830 persons, of whom 30 were senior-level staff (engineering, managerial, and technical grades), 200 were skilled workers, less than 1,000 were semi-skilled workers, and the remaining 2,600 were unskilled workers. The clerical staff constituted 23% of the total labor force.

4.59 To make up for the shortage of qualified personnel, the utilities recruited 104 expatriates (21 senior-level staff, 30 skilled workers, and 53 semi-skilled). Except for some skilled workers and all the semi-skilled workers (most of whom are Angolan residents even if they are classified as technical assistants), the utilities recruited the

24/ For example, one year's average consumption of electricity in Luanda is equivalent to the parallel market price of two eggs (i.e., about Kz 1,000).

technicians either under bilateral agreements (U.S.S.R., 9; Cuba, 11) or under individual contracts (Portugal, 18). Recently, however, the Government passed a law withdrawing some contractual advantages for expatriates (who are also long-term residents). These expatriates are therefore unlikely to stay on and will probably seek work elsewhere, or in other sectors, where perquisites are better.

Misallocation of Qualified Manpower

4.60 To tackle this difficult situation, the power sector should design a manpower policy targeting the operational manpower requirements. This policy should combine: (i) effective allocation of Angolan skills; (ii) technical assistance; and (iii) training. The present allocation of skilled manpower resources reflects recent hiring (of mainly students) which causes low productivity and the lopsided organization of the power utilities (76% of senior-level staff perform non-operational duties and only 50% of the skilled workers are directly involved in operations). Furthermore, skilled personnel are relatively more scarce in the Central and Southern systems (in comparison with the Northern region), and in all parts of the country, the distribution function is least favored with respect to qualified manpower.

Typical utility staffing profiles would be roughly as shown in Table 4.5, Column B. The actual staffing profiles of the utilities in Angola are shown in column A.

Table 4.5: ANGOLA: ELECTRIC POWER SUBSECTOR
Theoretical and Actual Staff Profiles (1987)
(Percentage)

	A	B
	Actual Staff Distribution	Theoretical Staff Distribution
Generation and Transmission	31	35
Distribution	26	50
Functional Services	43	15
Totals	100	100

Source: Angolan authorities and mission estimates.

In addition to this inappropriate deployment, the utilities are excessively overstaffed with unskilled workers and low-skill clerical workers. Although salaries have been frozen since 1977, the utilities' labor costs contribute to financial losses. Labor costs amount to 35% of billed sales in EDEL, 60% in CELB, 29% in SONEFE, and 118% in ENE. Since revenue collection (except for SONEFE and CELB) is low, labor costs are an even higher proportion of sales revenues and generally require subsidization through the Budget.

Technical Assistance

4.61 At present, the recruitment of expatriates for technical assistance does not follow any consistent policy. State-to-State arrangements (U.S.S.R. and Cuba) or individual contracts are entered into on an *ad hoc* basis. These expatriates generally work in isolation and qualified Angolan counterparts are extremely scarce. Furthermore the poor management of these skills, the lack of a structure into which they could be integrated, and the absence of performance monitoring threaten the cost-effectiveness of this assistance. Considering the level of staff shortages and the weak institutions of the power subsector, technical assistance deserves careful attention. In the Angolan context, individual contracts, particularly those shorter than two years, are seldom effective.

Main Issues and Recommendations

4.62 As is evident in the preceding description, the main issues in the electric power subsector are:

(a) organization;

(b) management;

(c) financial situation, tariffs, billing, and collections;

(d) qualified manpower, training and technical assistance; and

(e) investment planning and priorities.

Organization

4.63 A major issue in the organization of the subsector is the determination of an appropriate role and structure for ENE. Formally established in 1980, ENE has not yet been able to assume the role of national electricity utility it was intended to play. The various utilities that should have been integrated into the ENE structure still retain autonomous management and operating procedures. A strong sense of autonomy is felt at the regional level. The only important link with the center is the dependence of the regional departments on headquarters for purchases of imported materials/supplies. Meanwhile, the current Angolan unrest exacerbates transportation and communication difficulties. Also, the fact that 80% of total generation and consumption are outside ENE complicates the establishment of a national power company. Since SONEFE and EDEL were kept out of ENE, what emerged from its creation was an entity responsible for most of the country but without control over the main generating system and the main load center, and with its headquarters and most of its qualified staff in Luanda, far from any of its operating installations.

4.64 ENE has also been acting as a service company, importing supplies and electric materials and selling electrical appliances. 25/ The fact that ENE often supports local authorities (Commissariados) would suggest that it be in charge of LV distribution in the Central and Southern areas which are supplied by its interconnected systems. The rationale behind such an organization is the vertical integration of functions (generation, transmission, distribution) within each regional interconnected system supported by the physical infrastructure of the network.

4.65 The importance of the tasks to be carried out together with the deeply troubled external environment and the day-to-day pressures on the reduced number of managers and skilled personnel of ENE does not permit headquarters to effectively supervise the Regional Directorates. It would seem more appropriate to decentralize all operations and maintenance as well as most of the rehabilitation activities to the Regional Directorates. At the central level, a small central unit should be created, close to the Director General. The unit would have planning and standardization functions and should give priority to demand studies (which ENE lacks), expansion alternatives, and tariff studies. The unit would also be responsible for standardizing accounting and budgeting procedures, standardizing technical characteristics of equipment and maintenance and safety procedures, auditing, evaluating consultants' reports or project proposals, negotiating external credits, and setting guidelines for system expansion.

4.66 In fact, given ENE's lack of success, the question arises whether the initial idea of centralizing everything is appropriate. After thorough review, it would seem that, under present conditions, centralization is not the preferred option. ENE has become a rather top-heavy organization with almost all qualified staff assigned at headquarters while most of the activities (generation, distribution) are in the Central and Southern Directions. Furthermore, communications between the "frontlines", as it were, and headquarters are deficient, so that headquarters can contribute but little to solving problems at the operations level. For all these reasons, of which the Angolan authorities are well aware, the optimal amount of centralization in the electric power subsector is less, probably much less, than was initially attempted by the creation of ENE. While not wanting to go into unnecessary detail, this Report suggests much greater decentralization, with most functions centered on the physical systems themselves.

25/ The importing and selling of materials and electrical appliances could be better handled by a separate company. It is recommended that the Government of Angola set up such a company, thereby freeing ENE from activities marginal to its main role.

4.67 Whether the Southern and Central systems should be separate companies or very autonomous divisions of a reorganized ENE should be decided by the Government after careful analysis. Some centralized functions would need to be carried out for the whole power system, whether in a modified ENE or an "Electricity Commission" (CNE) between the operating utilities and the MEP. The main tasks in question are:

(a) system planning and the standardization of equipment, safety procedures, procurement, and auditing;
(b) evaluation of consultant studies;

(c) coordination/execution/evaluation of demand studies;

(d) setting up accounting and budgeting procedures for all utilities; and

(e) preparation/updating of a least-cost system expansion program for the grids.

4.68 Part of the staff needed for these functions could come from ENE's present nucleus of staff, and part could come from the MEP's Technical Department. Other qualified staff should be assigned in priority to the operating utilities or divisions.

4.69 As for the Northern System, the merger of SONEFE and ENE should be postponed at least until: (a) final decisions have been taken on the organization of the subsector; (b) accounting and budgeting procedures have been defined and put into practice; and (c) the assets and liabilities of both companies have been ascertained and evaluated properly. SONEFE would either become a very autonomous division of a reorganized ENE or a separate entity, but subject to the centralized functions enumerated earlier.

4.70 This report suggests that distribution in the Central and Southern systems be integrated with the generation and transmission activities of the new utilities or autonomous divisions of ENE. In the Northern System, the size of the distribution task would argue in favor of retaining EDEL as a separate entity.

4.71 In management terms, the subsector would thus be made up of the following managerial units:

(a) a central ENE or national electricity commission (CNE, Comissâo Nacional de Electricidade) in charge of tasks that can or must effectively be carried out in a centralized fashion);

(b) a Northern Division or Utility, i.e., SONEFE, in charge of generation in the northern grid;

(c) a Northern Distribution Division or Company, i.e., EDEL;

(d) a Central Division or Utility in charge of generation, transmission, and distribution in the central grid;

(e) a Southern Division or Utility, in charge of generation, transmission, and distribution in the southern grid; and

(f) a number of isolated systems which could either be directly managed by ENE (e.g., the Cabinda or Soyo groups) or by one of the regional utilities, whichever option is the most convenient.

Management

4.72 The utilities provide the MEP with plans and annual reports that could be valuable tools for the coordination of sector/subsector policy and investment. However, these plans and reports have major weaknesses which seriously hamper their usefulness both to utility management and to MEP coordination. The main managerial problems concern the MEP, the utilities, and the relations of both with the rest of the economy. They are briefly described in the following paragraphs. (Further information on institutional arrangements and problems is given in Annex 2):

(a) inadequate accounting, budgeting, and financing systems in the utilities, which give a poor, incorrect, and frequently distorted picture of their situation and performance. Within the utilities, the departments which prepare the Plan (Budget) sometimes do not fully comprehend the official forms. Their contributions are not consistent with each other. No department seems able to consolidate the information received from the various sources.

(b) poor intersectoral coordination. Coordination should take place at the Ministry level and be communicated to the utilities. There is no reliable information on new industrial loads. Major investments may be decided and carried out without regard to energy availability. On the other hand, utilities may be building network extensions for projects that have no priority within their own ministries. Coordination is poor between the utilities and the Ministry, and between the utilities and other Government agencies (such as the National Bank, whose control--or lack of control--over the foreign exchange budget exerts a major influence over the performance of the utilities);

(c) lack of a decision-making process based on or supported by sound technical, economic, and financial appraisal of the projects. Investment plans are shopping lists of works shifted around from year to year as foreign exchange becomes scarcer;

(d) lack of planning capabilities to prioritize investments within budget constraints and allocate resources according to preestablished criteria. Neither the utilities nor the Ministry are able to judge the relative merits of different investments either in terms of their economic return or their impact on preventing future disruptions or meeting demand requirements. Investments are often decided not on economic grounds but based on offers of credit or political pressures;

(e) total lack of information on major ongoing investments in the power subsector. This ignorance extends even to entities responsible for preparing expansion plans or formulating energy policies and strategy, including the Planning Office of the Ministry. For example, without reliable economic and financial data available on the Capanda project, it is impossible for ENE, SONEFE, or the Ministry (assuming they had the necessary manpower resources and technical skills) to evaluate the financial and economic costs of supply and to design a consistent tariff policy; and

(f) the utilities incur chronic financial losses which are covered by the national budget. These losses are mostly due to poor billing and collection procedures and inadequate tariffs. So far, however, these losses do not seem to have spurred much activity to correct the basic causes of financial losses.

Financial Situation and Tariffs

4.73 The financial situation of the utilities is precarious. As described in paragraphs 4.51 to 4.53, the utilities sustain financial losses which are covered by Budget subsidies or other transfers, or by payment arrears. If the Budget had no pressing revenue needs and if public resources were plentiful, this situation could possibly be sustainable. However, this is not the case. High, persistent budget deficits are causing many problems in the economy. Furthermore, with many more critical expenditures (e.g., health, nutrition) drastically curtailed, a subsidy to electricity consumption (by the better-off sectors of the population, by definition) can hardly be justified in distributional terms.

4.74 This report therefore proposes that the electric power subsector cover its costs (and a part of its investment needs--this could also be seen as a return on public capital invested in electric power) with its own revenues. 26/ Covering the present subsector deficits at present price and exchange rate levels would require a multiplication of

26/ Given the weakness of accounting procedures in the utilities, the figures presented here are only rough orders of magnitude.

tariffs by 3 or 4. At the same time, tariffs should be greatly simplified, and inefficient features, such as the "declining block" structure should be removed. However, this report also suggests a general increase in petroleum product prices. Obviously, such price increases (diesel could be increased to Kz 25 or Kz 40/liter) would have to be taken into account in setting tariffs. 27/ In addition, since almost 50% of the operating costs of the utilities are in foreign exchange, any change in the exchange rate would affect these costs and should also be reflected in a revised tariff.

4.75 Since Luanda is the largest load center, it should be dealt with first. In broad terms, EDEL's proposal for tariff reform should be accepted. It should be modified immediately t· result in an average residential LV tariff of about Kz 3/kWh (up from the present Kz 0.80/kWh). Given the low absolute level of tariffs, this increase can probably be effected in a single step. A roughly similar increase should be enacted in other areas of the Northern System and also for MV and HV consumers.

4.76 In other areas, similar basic policies should be pursued. No attempt, however, should be made to set uniform tariffs in all systems, as this would constrain the design and implementation of a more efficient tariff policy in the future. The following steps are suggested as a sequence to tariff reform:

(a) simplify LV tariffs (eliminating declining blocks) and raising the average price level to cover the utilities' financial deficit;

(b) study and introduce changes to bring the tariff system closer to a second-best efficient system (e.g., avoid discrimination by end-use: choose appropriate billing parameters and variables such as supply voltage, contracted peak demand for HV consumers, energy demand during system peak hours, etc.);

(c) set prices to meet specified financial targets (e.g., setting tariffs to cover all costs of operation plus about 20% of investment spending or, more simply, to attain a modest return of 3% to 4% on subsectoral assets in use); and

(d) adjust the tariff to the level and structure of Long Run Marginal Costs. (This is a medium-term goal towards which tariff reform should aim; it should be possible to reach it by 1992, when the present priority investment rehabilitation program will be completed).

27/ The full cost of generation would be about Kz 7.5/kWh with diesel costing Kz 25/liter, and Kz 12/kWh with diesel costing Kz40/liter.

4.77 Setting tariffs on the basis of the utilities' financial requirements is not as simple as it appears. A comprehensive assessment of the utilities' revenue needs would require considerable efforts and time because of the scarcity of accounting/financial skills and the unsatisfactory present state of accounting, budgeting, billing, and collection procedures. Setting tariffs to cover part of investment spending could require that a realistic investment program be prepared. However, if the goal were to achieve a certain return on assets, a better definition/evaluation of assets and overall balance sheets would be required. The initial step to improve accounting information should be the adoption, for present and future operations, of a much simpler accounting system than the existing National Accounting Plan (Plano Nacional de Contas). Also, the idea of re-creating accounts for past years should be abandoned for the time being.

Billing and Revenue Collection

4.78 The main problems in billing and collection are in Luanda. In other systems and load centers, billing and collection are generally satisfactory. For one thing, outside Luanda the problem is on a much smaller scale. Local managers have usually succeeded in resolving the major difficulties. 28/ Although billing and collection are generally adequate, tariffs are extremely low. Some regional managers have decided to extend the higher-priced blocks in an effort to increase the average price per kWh.

4.79 Billing and collection difficulties in Luanda are due to several factors such as the lack of effective penalties for non-payment of bills (EDEL staff are apparently unable to disconnect delinquent customers), the large number of illegal connections (possibly 10,000-15,000 in addition to about 75,000 legal connections), and the lack of a system for the easy payment of electricity bills. In addition to these reasons, EDEL has been unable to bill its customers expeditiously for a variety of reasons (lack of staff, lack of computers, breakdowns). Delays in billing have not helped customers maintain their payment discipline.

4.80 Broad recommendations to EDEL to improve billing and collection should be:

(a) correct the internal (computer) problems which prevent timely issuance of bills. Given the low tariffs, annual or semi-annual bills may be adequate. However, tariffs will eventually rise and then gradually more frequent billing will probably be needed. The MEP should immediately grant any assistance

28/ In Huambo after independence, power company workers resumed service and worked several months without salary. Salary payment was resumed only once successful billing and collection permitted it.

required by EDEL to recreate a credible billing/collection system;

(b) obtain permission from Government authorities to disconnect delinquent customers as a routine measure in order to enforce payment of electricity bills; and

(c) improve the ability to satisfy consumer requests for service promptly (after the increase in tariffs and improvements in billing and collection). A campaign to legalize or rectify illegal connections should then be conducted. Heavy sanctions should thereafter be imposed on illegal connections or re-connections.

4.81 Naturally, efforts to improve billing and collection would be more rewarding if tariffs were more appropriate. Therefore, the efforts mentioned in the preceding paragraphs should proceed simultaneously with an increase in tariffs and reform of the tariff structure. Tariff reform and tariff increases, and improved billing and collection are essential ingredients in a strategy of improving the financial condition and prospects of the electric power subsector. Once these changes have been made, the utilities will be better able to supply power efficiently and reliably.

Qualified Manpower

4.82 In Angola, qualified manpower is extremely scarce. A large number of qualified people left Angola at independence or during the troubled times that followed. Since then, high defense needs for qualified manpower have reduced the supply to all civilian users, whether public or private. The power subsector has suffered from the shortage. Within the subsector, distribution companies have been relatively worse off. Technical, financial/economic, and managerial skills are all extremely scarce. This situation may well explain many of the difficulties the power utilities currently face.

4.83 The organization of the power subsector (i.e., the attempt to create a national power company) and the rather ineffective deployment of what little qualified manpower there is (too many of the few qualified persons available are assigned to Luanda headquarters) compound the utilities' difficulties. Until recently, a problem of lack of incentives (inability to get access to official shops for their qualified people) prevented ENE and EDEL from recruiting qualified people. This obstacle has since been partially overcome but the problem of motivating higher level staff is a persistent one.

Training

4.84 Training programs are costly and time-consuming but necessary. Therefore the most urgent training needs should be identified and acted upon. Most probably, the priority is for on-the-job or "near-the-job" training in operation and maintenance of power plants and distribution lines. Administrative and accounting skills are probably almost as important. Global needs should be arrived at by asking the Regional Directions to estimate their minimum requirements (and, possibly, choose the candidates for training). In this way, training will be concentrated on the highest priorities, and the new electricity training school will be able to make an immediate useful contribution, which would be complemented by training-oriented technical assistance. In addition, the cost effectiveness of training programs/institutions needs to be examined critically as there are currently several cases of extremely high costs per trainee.

Technical Assistance

4.85 The primary objective of technical assistance should be the institutional strengthening of the utilities, especially in operations and maintenance. Because of the length and complexity of this task, an integrated and lasting assistance will be needed. This can probably best be supplied by other utilities. In all likelihood, the best vehicle for assistance would be a contract with another utility to provide management and supervision of expatriates, especially for the Central and Southern systems. Even this approach will only work if Angolan qualified manpower is deployed so that the expatriates have trainable counterparts working with them. Operational support to the Central and Southern systems would require approximately 20 persons for a period of three years.

4.86 Technical assistance will also be necessary to execute the investment program of the electric power subsector. In order to focus on technical assistance and ensure that it is used effectively, a task force in charge of all rehabilitation should be formed with staff contributed by SONEFE, ENE, and MEP. If the Capanda dam were delayed or postponed, some of the staff of GAMEK could also be added to this task force. This task force would be supported by a substantial infusion of external technical assistance: five persons (2 power engineers, 2 power economists, and 1 financial analyst) would be required over a period of three years. At least an equal number of qualified Angolans should work with them. This strengthened task force would prepare and supervise the execution of the various priority rehabilitation tasks. This task force would also help coordinate capital assistance to the projects under its responsibility. The technical assistance considered in the two previous paragraphs would consist of about 75 man-years of long-term consultants and about 25 man-years of short-term consultants and studies. Approximate costs would be US$10 million for the three-year period.

Investment and Expansion Planning

4.87 At the time of the mission's visit, no systematic expansion planning was taking place in Angola. An approximate least-cost expansion plan for the Northern System was prepared before independence and still survives within SONEFE, but it has not been recently updated. This may be due to lack of resources and personnel at a time when the utilities are hard-pressed to cover routine operations which are complicated by the war situation. Investment programming has also suffered, with investments generally conditioned by the availability of finance. Sometimes, when financing is available, it is limited to the foreign exchange share, with no provision for installation or civil engineering.

4.88 The main issues for the electric power subsector can be listed as follows:

(a) There is an absence of a coordinated policy and systematic decision-making process for investments, and this is exacerbated by the war situation. Investment decisions are taken on a short-term basis without the help of economic or financial scrutiny and under pressures of all sorts (political, from supplier countries, etc.).

(b) Financing considerations generally prevail over any integrated approach or strategy. Consistent sequences of activities, when they are identified, are almost always ignored as financing is negotiated on a case-by-case basis. If a package of equipment and civil works is financed (often with pressure-selling on the part of the suppliers), it is then called a "project" even if the financial provision for it does not extend to completion and commissioning.

(c) Contracts are awarded haphazardly, without making sure that the previous and subsequent stages of work have been identified, planned, and financed. As a result of this, millions of dollars of equipment has been purchased but cannot be installed, and is deteriorating. While these assets are not contributing anything, the debt, often incurred on commercial terms, is being serviced.

(d) The utilities have no control over commitments and drawing of foreign exchange. The BNA has this responsibility, and coordination between the BNA and the utilities has proven to be difficult.

(e) The utilities have a tendency to add new capacity rather than relying on preventive and corrective maintenance in order to keep capacity available and operational. This is partly the result of the foreign exchange shortage, which prevents the timely purchase of spare parts and materials while external suppliers and credits are often more easily available for purchase of large quantitites of new equipment.

(f) As a result of lower levels and reliability of service, high numbers of small diesel sets and gas turbines have been purchased and are spread all over the country. They represent a large foreign exchange debt and occupy an inordinate share of the utilities' qualified manpower, which should be concentrated on the main installations. Servicing these scattered, small systems also requires a costly logistical system (fuel, transportation, storage), and places a heavy burden on the limited resources of the utilities.

4.89 In light of these difficulties, the next few paragraphs will suggest some priorities for investment and expansion planning. Better, more effective planning and investment decisions have as goals the satisfaction of Angola's projected electric power needs at lowest cost and the strengthening of the utilities to make them better able to meet these future needs. Minimizing investment expenditures will often be required as a means to reduce costs, and higher tariffs will be needed to provide a safe financial basis for the strengthening of the utilities.

Investment Priorities

4.90 In the short term, investment priorities must, of necessity, center on repair, rehabilitation, and resumed maintenance of existing facilities. Rehabilitation should proceed simultaneously on all three systems as both security and economics relegate an interconnection to a fairly distant future. The medium-term goal should be to fully restore supply capabilities in line with installed capacities, and to create adequate reserve margins for potential demand growth. Uncertainty in the evolution of demand and the high cost of supply options coupled with resource constraints (finance and qualified staff) militate in favor of an investment program that addresses the most pressing needs while meeting the most stringent economic criteria.

4.91 Existing investment programs for the electric power subsector as a whole, excluding Capanda, total about US$100 million for 1987 and 1988, 75% of it in foreign exchange. A program of this size is probably beyond the financial and technical capabilities of the utilities. A scaling down of investments is thus inevitable; this must be done, keeping in mind the key priorities. The utilities' detailed investment programs are reviewed and evaluated in Annex 16.

4.92 A tentative priority investment program is described in Table 4.6 below, based on the following considerations:

(a) assign highest priority to rehabilitation of existing facilities;

(b) strive for improved reliability of supply to main cities which are also the main industrial areas;

(c) improve supply to Luanda by addressing the main problems in generation, transmission, transformation, and distribution;

(d) postpone most small projects in isolated systems, mainly for 'ack of managerial/technical staff, even if equipment has been purchased (only those that can actually be built should be considered);

(e) postpone new rural/village electrification until hydro supply conditions have been improved and tariffs readjusted;

(f) limit new connections in cities until tariffs are adjusted and (especially in Luanda) until billing and collection procedures are substantially improved; and

(g) plan a substantial amount of technical assistance to support ENE task forces in big rehabilitation projects such as Lomaum, the Southern System, and the Luanda distribution grid.

4.93 A general recommendation, in addition to the above considerations, is to subject every substantial project (say, exceeding Kz 50 million) to economic and financial feasibility analysis.29/ This would alert the utilities' management to the need to redesign, scale down or reschedule the project. Accurate cost data would also facilitate the search for financing for the complete projects, rather than having many projects only partly financed as at present. A project evaluation unit should be set up in the central staff of ENE (or CNE) for this purpose. This unit should also advise the Government on the cost of "political priorities" so that the quality of "political" projects could be improved. Finally, the unit would make sure that its programs for the power subsector are consistent with programs in other sectors (industry, mining, agriculture, etc.).

4.94 A minimal priority investment program in line with the above priorities and considerations was prepared by the m'ssion. Given the above priorities and constraints, the mission sees no useful role for additions to capacity of the scale being considered at Capanda. The priority investment program should be carried out over the next five years and would cost about US$200 million (Kz 6 billion). This seems to accord better with the financial and managerial/technical possibilities of the subsector. However, it would still be a heavy financial and management burden on the utilities. The financial burden could be reduced somewhat if efforts were made to obtain financial assistance from the numerous bilateral or multilateral aid agencies. All these agencies require economic and financial analyses (and are willing to fund them) but lend at considerably softer terms than export financing agencies. The suggested five-year priority investment program is presented in Table 4.6.

29/ This would make the project attractive to concessional donors and result in lower financial costs.

Table 4.6: ELECTRIC POWER SUBSECTOR INDICATIVE
SUGGESTED PRIORITY INVESTMENT PROGRAM 1987/88-1992

Project		--- Million ---		Timing
		US$	Kz	
Generation				
Cambambe	- Repair units 2, 3, 4	5	150	ongoing
Mabubas	- Rehabilitation	7	210	1989-ongoing
Lomaúm	- General rehabilitation	60	1,800	1989-92-ongoing
Biópio	- Rehabilitation of 2 units & dam	15	450	1989-91
Southern System:				
Matala	- Repair dams & generators	25	750	1988(89)-92
Gove	- Repair dam	5	150	1989-92
Namibe	- Complete thermal plant	1	30	1989
Huambo	- Repair/replace gas turbine	2	60	1989-ongoing
Cabinda	- Repair gas turbine	1	30	1989-ongoing
Uige	- Erect diesel unit	1	30	1989
Transmission				
Biópio Substation	- Rehabilitation	2	60	1989-90
Viana Substation	- Expand/complete	4	120	1987-89
Quinfangondo	- Complete substation	3	90	
Luanda Substation	- Replace transformers	2	60	1988-90
Renovation of various lines		10	300	1989-94
Distribution				
Luanda	- General rehabilitation	30	900	1989-94
Small urban networks		5	150	1988-92
Renovation of other systems (Lobito, Benguelu, etc.)		15	450	1989-94
Other		22	660	1989-94
TOTALS		215	6,450	1989-94
Average per year		43	1,290	

Source: ENE, EDEL, SONEFE, and Mission estimates.

4.95 The investment program outlined in Table 4.6 may seem modest. This is inevitably so when compared to the huge expenditures programmed for Capanda, where annual investments are expected to exceed the five-year total for all utilities. However, this priority investment program is by no means small: it provides for the rehabilitation of all installed capacity and some additions, notably at Lomaum and Matala. It would be sufficient to meet demand reliably until the mid- to late-1990s. The investment program is by no means easy to carry out. The mission estimates that as much as US$10 million in external technical assistance may be needed to carry it out. But this is a small amount compared to the about US$50 million of technical assistance expected to be provided to the Capanda project by FURNAS alone). This small, priority investment program will certainly do more to improve service and reliability and create a useful reserve margin in all systems than the massive investment at Capanda, which is described in the next section. The smaller program is a better risk-averse response to uncertainty than a big investment in generation in one part of the country because it will equip the utilities to be able to provide power anywhere it may be needed. In any case, before Capanda can help improving supplies to any grid, substantial additional investments will be needed in lines, substations, transformers, distribution grids, user installations, etc. Since the Capanda project can be seen as an issue in investment and system planning, it is discussed more at length in the next section, and in detail in Annex 16.

The Capanda Hydroelectric Project

Summary and Recommendations

4.96 The Government's apparent decision (which can still be reversed) to advance the construction of a dam and power plant at Capanda presents several major issues. Although the analysis done is extremely rough and conclusions should be taken as tentative, several robust conclusions emerge and are stated as follows:

(a) Capanda represents a significant departure from the lowest cost expansion path, even if it is not well-known and has not been updated recently;

(b) the huge capacity (4 x 130 MW) planned for Capanda will probably not be needed until well into the next century. Until the year 2000, maximum requirements to fully meet the projected energy and capacity needs of the Northern System, in the worst case ("High" scenario), with hydrogeneration alone, would only be 170 MW of additional capacity and 520 GWh of additional energy. A "High" dam in Cambambe in the early 1990s, 2 x 100 MW in the second Cambambe power plant in the mid-1990s, and a "Low" dam in Capanda in the year 2000 would be enough to meet those requirements with a high reserve margin at the time of system peak and no need for thermal support. The required investments would be significantly lower and much farther into the future than the Capanda option now being considered;

(c) it is a project which, by itself, will not improve substantially the reliability of service in the Northern System and will not mitigate the problems of the other two systems at all;

(d) actual and expected low demand growth rates and the availability of substantial thermal reserve (capacity and energy) would allow the postponement of this irreversible major investment decision during this period of uncertainty and stringent financial conditions, at a very low risk, until the economic environment becomes more stable and a better perception of the potential medium- and long-term demand market is possible;30/

(e) alternative expansion sequences in the Northern System, with different timings of Capanda and complementary works in Cambambe, should be evaluated in full detail and in the context of the entire power subsector, with all economic and financial implications reassessed in a realistic framework of demand projections and updated costs. Such studies, if immediately initiated, could be carried out within five to six months. The delay would not create any additional risk of energy shortages in the early 1990s and could bring the benefit of redirecting more efficiently the large investments already made in support infrastructures; and

(f) making the investment in Capanda will add substantially to the public external debt burden (commercial financing). It may also undermine Angola's ability to finance the vital petroleum development program on which its future export earnings depend, because part of Angola's future petroleum output has been earmarked as a repayment guarantee on some of the Brazilian financing for Capanda.

While, at times, a state may need to take all manner of risks to finance a vital investment, the case of Capanda definitively does not fall in this category. On the contrary, going ahead with Capanda will prevent Angola from undertaking activities which are truly of vital importance. In the final analysis, therefore, this Report recommends that the existing least cost expansion plan be updated, based on the best available demand projection, so as to confirm the stage and the speed at which Capanda power should be developed.

Background to the Capanda Project

4.97 In 1982, Angola and the U.S.S.R. signed an agreement to develop a major hydroelectric dam and plant at Capanda on the middle course of the Kwanza River. A new organization, GAMEK, attached directly to the

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30/ Satisfying repressed demand in Luanda would require expensive, large, and time-consuming investments in the medium and low tension grids.

MEP, was created to execute this task. Soon thereafter, a "master contract" was signed between the MEP and a Soviet/Brazilian engineering firm, N. ODEBRECHT. By these decisions, the hydro plant at Capanda (4 x 130 MW) was given priority over the further development of Cambambe which was then part of SONEFE's expansion plan.

4.98 TECHNOPROMEXPORT (TPE) is the team leader for the project and supervisor for the construction. Other Soviet firms or institutes are responsible for geological prospecting, dam design, and equipment supply. The Brazilian engineering/construction firm, N. ODEBRECHT, or its subcontractors, are in charge of the civil works. Available information on contractual details is scarce, and seem far from comprehensive. A mechanism has been created to regulate subsequent activities by requiring additional contracts each time an important activity or set of activities is identified and programmed. So far ten "Partial Supplements" have been signed since 1985 (one with the Soviet party for geological prospecting and dam design; nine with the Brazilian party).

4.99 GAMEK's staff is made up of senior people seconded (often part-time) from other enterprises (such as SONEFE and SONANGOL) as well as 55 middle and higher level staff seconded by contract from the Brazilian utility, FURNAS CENTRAIS ELECTRICAS. GAMEK'S complete staff currently totals about 165 persons (55 Brazilians and 110 Angolans). Salaries are similar to those of other utilities in Angola, but fringe benefits (such as access to official stores) are much better. GAMEK is thus successfully competing with other utilities for scarce qualified manpower.

Capanda and the Least Cost Expansion Plan

4.100 Developing the plant at Capanda represents a serious departure from a least-cost expansion plan. The steps in this plan were as follows:

(a) increase the height of the Cambambe dam, thus increasing capacity from 180 MW to 260 MW (which might be needed in the mid- to late-1990s);

(b) build a low retention dam at Capanda giving Cambambe monthly regulating capability, and build a second power plant at Cambambe (2 x 110 MW), pushing total capacity at Cambambe to 400 MW (which would only be needed around the year 2000);

(c) increase the dam height at Capanda and build a second stage of the second power plant at Cambambe (2 x 100 MW) (would be needed beyond reasonable present planning horizon); and

(d) build a power plant at Capanda (4 x 110 MW assumed in old studies, 4 x 130 MW in more recent ones; only required beyond the present planning horizon).

4.101 The investment costs of the above sequence were compared with those for advancing Capanda (as estimated by BEP) and gave the following results: Cambambe, US$1,030/kW; Capanda, US$1,800/kW. The comparison, however, should not be pushed too far as firm capacities are not accounted for and Capanda would look even less economic if the two dams were really considered alternatives rather than complements. Contrarily, however, these figures embody costs of turbine plus generators estimated by BEP at US$500/kW for Cambambe and only US$345/kW for Capanda, without any plausible explanation of the difference.

Long Run Marginal Costs

4.102 The Long Run Marginal Costs (LRMC) of producing electricity from Capanda are a multiple (8 or 10 times) of present average energy costs in the Northern System served by Cambambe. Rough estimates of the investment and operating costs of Capanda and a set of assumptions on the share of demand (as estimated by the UNDP/IBRD mission) supplied by Capanda provide a rough indication of the LRMC of electricity from Capanda.31/ A fair estimate of LRMC is roughly US$0.334/kWh (or Kz 10.03/kWh) with the base UNDP/IBRD scenario of demand, assuming that generation at Cambambe is limited at 780 GWh/y (which is about its firm generation capacity) 32/, and a discount rate of 12%. A sensitivity analysis (three demand scenarios, three discount rates--10%, 12%, and 15%--and three levels of generation by Cambambe) was performed. This analysis shows that LRMC could go from a minimum of US$0.127/kWh (Kz 3.80/kWh) (Cambambe generates only 200 GWh, 10% discount rate, high demand scenario) to a maximum of US$0.547/kWh (Kz 16.41/kWh) or even a bit more if Cambambe generated 1,000 GWh (which it can generate in an average year) rather than its firm energy of 780 GWh. See Annex 16, paras. 15-16 for a detailed comparison/discription of these various cases. It is clear that even under favorable assumptions, covering the costs of Capanda would require a large increase in tariffs (excluding any exchange rate shadow pricing). If demand were to grow more slowly than projected, Capanda power could not be sold and costs could rise enormously. At best, Capanda will be a project of marginal economic interest. At worst, it will be a heavy financial burden making no contribution in the medium term to the development of Angola.

31/ Based on updated information supplied by GAMEK/MEP during the October 1988 mission.

32/ 786 GWh is actually the joint firm generation of Cambambe and Mabutas, assuming 700 GWh for Cambambe and 80 GWh for Mabutas.

Technical and Financial Information

4.103 No preinvestment studies, either technical or economic, were done to aid in the decision to develop Capanda. Some old studies existed but it was decided to proceed with construction *pari passu* with the needed technical studies. No economic or financial studies or demand projections were made specifically for the justification of the Capanda dam. 33/ Given this fact, all statistics connected with Capanda must be considered as rough approximations. Total investment cost was not precisely known but was stated to be about US$1 billion in 1986 prices. This was revised upwards in 1987 (in 1987 prices). Total cost was then estimated at $1250 million for direct costs, that is, about $1600 million including financial costs (and interest during construction). In fact, only in 1987 were technical studies advanced enough to allow the estimation of a cost (the 1985 figures were later described as "guesses"). However, even the 1987 figures probably understate costs as they do not allow for any contingencies. A rough description of costs is shown in Table 4.7.

4.104 The financing package described in Table 4.8 is close to commercial terms (interest at 7%-8%, 2 years' grace, 7-8 year repayment period).

33/ The BEP and THEMAG studies had other specific goals, i.e., expansion plan and interconnection grids.

Table 4.7: CAPANDA HYDRO PROJECT - GAMEK INVESTMENT PROGRAM
(in US$ million)

Firm/Component	Actual 1985-87	1988 Est. Act.	1989	1990	1991	1992-4	TOTAL
N. ODEBRECHT							
TOTAL	327.9	109.1	117.1	119.6	120.3	77.2	871.3
of which: Labor	73.7	40.1	48.0	58.0	59.6	37.3	317.4
Materials	89.1	20.5	23.9	26.8	26.8	14.1	201.2
Food	12.8	8.2	11.4	11.5	10.7	9.2	63.8
TPE							
TOTAL	4.2	8.4	14.3	23.1	79.8	145.4	275.0
of which: Equipment	0	0	0.2	4.8	65.6	99.2	169.8
FURNAS							
TOTAL (Tech. Assistance)	23.4	10.2	7.0	7.0	6.5	11.0	65.0
GAMEK	9.5	4.0	4.0	3.5	3.5	10.1	34.5
TOTAL DIRECT COSTS	365.0	131.6	142.4	153.1	210.1	243.6	1,245.8
Interest + Commission + Exchange Losses	17.1	56.1	34.4	42.9	41.7	164.5 1/	357.1
GRAND TOTAL	382.1	187.7	176.7	196.0	251.7	408.4	1,603.0

1/ Financial charges run up to 2003.

GAMEK: Gabinete de Aproveitamento do Medio Kwanza (Office for the Harnessing of the Middle Kwanza).
Note: Totals may not add up because of rounding.

Source: Angolan authorities and GAMEK.

Table 4.8: CAPANDA: FINANCING PLAN
(In US$ million)

COUNTRY/INSTITUTION	COMMITTED	SOUGHT	TOTAL	TERMS
CACEX/ Banco do Brazil 4/	408	120 2/	528	7%-8% 2 years grace. 7-8 years repayment period.
Cash Payments	—	162	162	
	408	282	690	
U.S.S.R. (for equipment)	275	--	275	3% 10-year life. Includes 3 years grace period.
Other countries 1/ (cash payments until funded)	8	97	105	$8 million for 3 years at commercial rates.
SUBTOTAL	765	475	1,240	
SUBTOTAL (Excl. Cash & Budget) 3/	691	120	811	
TOTAL COST OF PROJECT (Incl. Financial Charges)			1,600	
FINANCING GAP			780	

1/ These amounts are carried as cash payments until such time as they are financed.
2/ This amount was committed by Brazil in 1989.
3/ The Angolan Government (or its Budget) is the financier of last resort, i.e., it would have to make up any shortfall. This shows that the shortfall, which Angola may have to make up, is really $789 million.
4/ The Government of Angola has given a general guarantee in oil to Banco do Brazil for these loans.
5/ This is theoretically in local currency, but local expenditures have an extremely high foreign exchange interest in Angola.

Source: The MEP, GAMEK.

4.105 The total amount being sought, $1240 million, falls short of even direct costs ($1245 million) let alone adding the financial costs. In October 1988, only $691 million was firmly committed (excluding GOA and OGE) which means that there was a financing gap of $909 million (inlcuding financial costs) or $554 million (excluding financial costs). Since then, an additional $120 million has been secured from Banco do Brazil. The financing gaps are therefore US$789 million and US$434 million (respectively including and excluding financial charges). In addition, $17 million of debt service was paid between 1985 and 1987, while in 1988 debt service was expected to reach $56 million. Except for Soviet financing, by October 1988 funds had practically run out. Were it not for an additional $120 million supplied by Brazil, work would have had to stop. All this raises serious questions about the feasibility of building Capanda as planned and reinforces the need to seriously reexamine this investment within the context of an overall system expansion plan, i.e., most probably to abandon the idea of building Capanda in one stage and to weave it into the overall development of generation along the Kwanza River.

Capanda and the Need for Interconnections

4.106 The use of Capanda to supply the three interconnected systems also deserves some comment. Under the present conditions of unrest, the construction of new transmission lines to link the three systems is impossible. The existing Cambambe-Gabela line, the first stage of a future North-Center link, has been out of service since 1984 and security conditions have not allowed a restoration of service, and the Government has therefore installed diesel sets in Porto Amboim. Similarly, Line 1 between Cambambe and Luanda cannot be properly maintained and is in a precarious situation. Major Central and Southern transmission lines cannot receive maintenance for lack of security. In the meantime, regional power supplies will be rehabilitated and expanded to meet potential demand (Lomaum, Biópio, Huambo, Matala, Namibe). The three systems will necessarily remain self-sufficient and will have to provide for their own (separate) reserve margins.

4.107 Prolonged conditions of insecurity will keep demand growth low and will prevent construction of interconnections. Thus a larger market for Capanda power will not be able to develop. A short-term cease-fire followed by a quick economic recovery, approaching the demand growth rates projected by BEP, might allow and possibly call for an interconnection but a least-cost expansion plan would apparently postpone Capanda itself until after the year 2000, giving earlier preference to new supply sources in the Central and Southern Systems.

4.108 In an interconnected environment, Capanda would have difficulty meeting reliability criteria (too much generation in a single pole, hundreds of kilometers away from the main consumption centers), operating problems (the interconnected systems would be of the "weak longitudinal" type which is known to present difficult voltage control and dynamic oscillation problems), requiring the opening of the interconnecting links or putting serious restrictions on power transfers 34/, and on-line dispatching. No experience exists in Angola of real-time dispatching of

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34/ Low load situations require special compensating devices (var static compensators) in different points of the system and may also produce severe cavitation in the turbines of Capanda.

distant interconnected plants; this requires reliable communications and control systems together with highly-trained personnel.

Final Remarks

4.109 Although information is patchy, the decision to advance Capanda rests on highly optimistic expectations regarding economic development and electricity consumption, insufficient appreciation of sound economic considerations, an underestimation of the financial burden, and underestimation of the difficulties of operating and maintaining such a huge installation. The Government's wish to take advantage of its hydro resources is understandable. However, this cannot be done without large investments in transmission and distribution in addition to the generation investments. Two theoretical alternatives might eventually lead to a justification:

(a) attracting foreign investments in power-intensive industries that do not require significant investments in distribution networks; (the negative experience of Zaire with its Inga power plant would be an interesting comparison here); and

(b) providing generalized access to electricity to Luanda's population and providing incentives for industrial rehabilitation.

While the first alternative remains theoretically open but requires a relatively long period of stability before materializing, the second would require enormous investments in distribution networks (from high to low voltage) that the utilities and the Government simply cannot afford. The issue of appropriate tariffs will not even be mentioned here but higher tariffs would have a significant impact on both alternatives.

4.110 The whole issue of Capanda remains basically that a market of a size that could justify the investment does not exist nor can be expected to materialize within a reasonable period. By the end of 1988, almost US$500 million had been spent and heavy infrastructures built in Luanda and on-site. There are large quantities of equipment and the project is at the crucial stage just before the river is to be deviated. On the other hand, financing for the completion of the project is, most likely, unavailable. Finally, there now exists an institution, GAMEK, whose good capabilities should be utilized. For all these reasons, it would seem justified to stop building and carry out a study of the feasibility of stopping the project, of looking for the best alternatives to develop the Northern System and, finally, of the best way of introducing Capanda into this system (when to resume construction, optimizing the power of the units and their coming on-line, etc.) within a global expansion plan which would develop the hydro resources to best advantage. Brief Terms of Reference for such a study (which would also include preparation of a rehabilitation program for the existing power systems) are presented in Annex B.

V. FORESTRY, WOODFUELS AND HOUSEHOLD ENERGY

Summary, Conclusions, and Recommendations

5.1 While available statistics are few and unreliable, two recent studies and mission estimates have produced a picture of the supply and demand for forestry and woodfuels in Angola which can be summarized as follows:

(a) most Angolans use firewood or charcoal for cooking and heating (in the cities, however, a significant minority use LPG);

(b) the aggregate consumption of firewood is in the order of 2.5 million tons/y and of charcoal about 0.5 million t/y, requiring a total removal of 6 million tons or about 10 million m^3 of wood;

(c) Angola possesses some 50 million hectares of dense forests and a further 55 million hectares of woodland and savanna. Together these forests are capable of producing much more wood on a sustained basis than is presently consumed in the country;

(d) out of Angola's nine million inhabitants, almost half live in areas with more or less pronounced fuelwood shortages, either on the dry coast or in inland cities;

(e) in the shortage areas, the periurban population constitutes the group hardest hit. They have limited access to alternative fuels (more easily available in urban centers) and, unlike most rural people, they cannot gather their own fuelwood for free. They are, furthermore, penalized by high market prices for woodfuels: the cost per thousand useful kilocalories is only Kz 10 for LPG but 10 to 20 times as much for firewood and charcoal;

(f) the institutional framework for energy forestry in Angola is weak. Exploitation of fuelwood is regulated by the National Directorate for the Conservation of Nature (DNACO), which issues cutting licenses. The DNACO, however, has no resources to ensure that the actual cutting conforms to the licenses issued; and

(g) the creation of new forests is not the best (cheapest) way to solve the fuelwood problem. This is primarily because the dry coastal strip of Angola, where most of the people experiencing fuelwood shortage live, is poorly suited for tree-growing.

5.2 At present relative prices and depending on the security situation, the priorities for action in forestry/household energy are as shown in Table 5.1.

Table 5.1: WOODFUELS - PRIORITIES FOR ACTION

Area	Action	Fuel Substitution	Increased Efficiency of Stoves	Improved Supply System	Wood Production
Coast	Peace	II	III	I	IV
	No Peace	I	II	III	IV
Inland	Peace	IV	III	II	I
	No Peace	IV	I	II	III

Source: Mission.

5.3 If the reduction in civil strife is accompanied by structural changes in the economy such as a major devaluation carried through to commercial energy prices, then relative prices will probably change drastically. The prices of petroleum products would rise markedly while the reduction of the risk premia and increased competition (because of easier market entry) and lower rents to truck owners and other entrepreneurs would most probably lead to (comparatively) lower prices for traditional fuels. In that case, consumption of LPG might not grow as fast as in the past (although this might not be noticed for some time because of the existence of repressed demand), and traditional fuels might once again become competitive with LPG (or kerosene). Measures to improve the supply of woodfuels to the cities might then become the highest priority, as indicated in Table 5.1.

5.4 This report proposes several sets of priority activities at the regional and national levels. Four are regional in character while two are national. The first regional set of activities covers the provinces of Huila and Namibe, a region where the security situation is fairly good. It includes both city-oriented activities such as the improvement of stoves, and rural-based activities such as improved supply systems for firewood and charcoal. The other three regional sets of activities all cover urban areas: one for Luanda; one for Benguela/Lobito; and one for Huambo township. For Luanda and Benguela/Lobito, it is proposed that emphasis be put on increased use of LPG as a domestic fuel. In Huambo township, improved stoves should be given first priority.

5.5 Two national activities should be carried out in support of the regional ones. One covers the development and introduction of improved stoves and the other concerns initial development work and trials in agroforestry. The activities listed have been grouped into four projects. They are the following:

(a) a pilot project in Huila-Namibe, to integrate the various components of energy forestry, including the development of agroforestry;

(b) improved cooking stoves, mainly for the urban and periurban populations in Luanda, Benguela, Lobito, and Huambo;

(c) an improved supply system for woodfuels, mainly for the cities of Luanda, Benguela, Lobito, and Huambo;

(d) replacement of firewood and charcoal by LPG as a domestic fuel for the urban and periurban population on the coast, at least until more peaceful conditions improve supplies and lower the prices of woodfuels, and until economic adjustment measures increase the prices of petroleum products (LPG, kerosene);

Consumption and Production of Woodfuels

Consumption of Woodfuels

5.6 The consumption of woodfuels in a country is never easy to measure or estimate accurately. It takes place among hundreds of thousands of households, generally in an uncoordinated fashion, largely outside the monetized economy. Until quite recently, knowledge regarding the consumption of woodfuels in Angola was extremely poor. In the absence of any consumption survey, estimates were little more than guesses. Further, available figures on wood removals reflected only officially recorded harvests of wood for fuel, corresponding to a minor share of the total.

5.7 Material presented at the First National Seminar on Woodfuel and Charcoal, held in Luanda, June 8-10, 1987, improved the situation considerably. As a part of the preparation for the seminar, the Department of New and Renewable Sources of Energy (DNRFE) within the Ministry of Energy and Petroleum (the MEP) made a survey of household fuels in seven provinces. The survey covered 4,466 persons, 1,557 of whom resided in urban areas, 2,063 in periurban areas, and 846 in rural areas. In addition, discussions were held with producers and traders of fuelwood and charcoal and traders of LPG and kerosene in the same seven provinces. As one result of the survey, average consumption figures per person and month were obtained for four main fuels (firewood, charcoal, LPG, and kerosene) in each of the three population strata (urban, periurban, and rural). The findings are presented in Table 5.2.

Table 5.2: CONSUMPTION OF HOUSEHOLD FUELS, 1987 a/
(In kg/capita/month)

	Firewood	Charcoal	LPG	Kerosene
Urban	23	10	2.5	1.5
Periurban	30	13	2.2	2.2
Rural	39	13	0	2.0
Average	32	12	2.4	1.9

a/ Figures are based on data from seven provinces.

Source: DNRFE.

5.8 According to this data, the urban population consumes either 23 kg of firewood or 10 kg of charcoal or 2.5 kg of LPG or 1.5 kg of kerosene per person per month. This is probably largely correct for firewood, charcoal, and LPG if the families use either of these three fuels as a source of energy for cooking. However, the figure seems unrealistic for kerosene, which is used mainly for lighting. Moreover, since the data were recorded between late 1986 and early 1987, the energy needs for heating which peak between May and August may not be included. Therefore, average annual household energy consumption is likely to be higher than Table 5.2 suggests.

5.9 In the absence of any population survey since 1970, all figures on the present population of Angola are rough estimates. While they might be fairly correct as regards the national totals, they are probably quite unreliable as to the distribution of the population between different provinces or, indeed, between urban and rural areas. Most recent reports estimate that between one-quarter and one-third of the population lives in urban areas, while observations during the survey pointed to a quite different picture, with half the population living in urban and periurban areas. For the sake of the present report, it is assumed that the population is distributed as follows:

	Absolute (millions)	Share (%)
Urban population:	2.5	28
Periurban population:	1.5	17
Rural population:	5.0	55
Total	9.0	120

5.10 Based on the results of the DNRFE survey, with the specific fuel consumption figures adjusted upwards to acount for heating and taking into consideration the estimated distribution of the overall population, the tentative picture of aggregate fuelwood and charcoal consumption may look as shown in Table 5.3.

Table 5.3: AGGREGATE USE OF FIREWOOD AND CHARCOAL IN 1987

	Amount 1,000 t/y	Wood Needed 1,000 t/yr
Domestic Consumption as Surveyed by DNRFE		
- Firewood	1,920	1,920
- Charcoal	440	3,080
Domestic Heating		
- Firewood	360	360
- Charcoal	84	590
Industry	180	180
Total		6,130

Source: DNRFE.

The figures suggest that aggregate woodfuel consumption amounts to a fuelwood equivalent of ten million solid m^3/y, which corresponds to 670 kg (about 1.1 m^3) of wood per person per year.

5.11 A consistency check makes the above estimate appear reasonable. Based on a set of general assumptions, 35/ the country's overall woodfuel requirements are likely to amount to about 7.5 million tons, as detailed

35/ First, it is assumed that the daily minimum per capita requirements of cooking are equivalent to 160 kcal delivered to the pot. Second, the gross calorifics are assumed to be: 5,000 kcal/kg at 5% mcwb for charcoal, and 3,000 kcal/kg at 25% mcwb for wood. Third, stove efficiencies are 15% for charcoal and 10% for wood stoves. Fourth, it is assumed that 50% more energy is delivered to the pot than strictly necessary (rice boiling rather than simmering, for example). Fifth, an allowance of 50% on top of the total above is made for preparation of beverages and for water heating for other purposes. Sixth, an allowance is made for non-cooking use of firewood, for example as a source of light or as a focal point for social gathering, corresponding to 25% of the energy used for cooking and water heating. Seventh, household use of firewood or charcoal for space heating is assumed. It is assumed that four million persons need such heating for four months per year, three-fourths using firewood and one-fourth using charcoal. Each person is supposed to need 1 kg of wood or 0.7 kg of charcoal per day. Eighth, an allowance is made for non-household uses of firewood in restaurants, small-scale industry, lime factories, schools, hospitals, and so on, amounting to 10% of the energy value of all household use of firewood and charcoal in urban areas and 5% in rural areas.

in Table 5.4. 36/ These figures are roughly in line with findings of the DNRFE survey. While the survey recorded a total annual consumption of 2.46 million tons of firewood plus 0.52 million tons of charcoal (with a roundwood equivalent of 3.64 million tons), Table 5.4 suggests that woodfuel consumption amounts to 2.63 million tons of firewood and 0.69 million tons of charcoal (with a roundwood equivalent of 4.83 million tons).

Table 5.4: HYPOTHETICAL ANNUAL WOOD FUEL DEMAND

	Population (millions)	Fuel Needed (million tons)	Annual Wood Equivalents (million tons)
Cooking			
- Firewood	4.3	1.55	1.55
- Charcoal	3.1	0.61	4.27
Light and Social	7.4 a/	0.54	0.54
Heating			
- Firewood	3.0	0.36	0.36
- Charcoal	1.0	0.084	0.59
Sum for Households	7.4	-	6.38
Industrial Use (Firewood)	-	0.18	0.18
Total	-	-	7.49

a/ Firewood with energy value corresponding to a quarter of the total fuel used for cooking (1 kg of firewood per day by 365 days by 4.3 million persons plus 0.36 kg of charcoal by 365 days by 3.1 million persons).

Source: Mission estimates and calculations.

Wood Production

5.12 No national forest inventory has ever been carried out in Angola. Depending on how the term "forest" is interpreted, the country may possess between 50 and 75 million hectares of forests, or 40% to 60% of its land surface. Recently, however, two new estimates of forest area and wood yields in Angola have been made. One was carried out by the

36/ Not all of this amount is burned in the form of wood. At least some of the agricultural residues, such as corn stalks and cobs, end up in the domestic fire. In overall terms, however, the amount is not likely to be large, as wood and charcoal are uniformly claimed to be the dominant household fuels.

consulting company E.T.C. as part of a survey of fuelwood resources in all Southern African Development Coordination Conference (SADCC) countries, while the other was part of the preparatory work for the First National Seminar on Firewood and Charcoal, held in June 1987 in Luanda.

5.13 Remote Sensing Estimate. The E.T.C. study is based on satellite images of all SADCC countries taken between 1984 and 1986. Ground truthing was undertaken in most of the 26 vegetation classes distinguished. However, none of these checks were made in Angola. The results of the study for Angola are summarized in Table 5.5.

Table 5.5: MAIN FOREST FORMATIONS

Vegetation Class	Area (million hectares)	Standing Woody Biomass per hectare (tons)	Mean Annual Increment (tons per hectare per year)	Total Annual Increment (million tons)
1. Transitional Rain Rorest/ Miombo Woodlands	16.0	200	6	96
2. Dense High and Medium-High Miombo Woodlands	33.2	71	2.2	73
3. Seasonal Miombo Woodlands and Wooded Sav nnas	30.7	20	0.5	15
4. Dry Deciduous Savannas	23.0	17	0.5	12
5. Other Open Forest & Bush Formations	15.8	13	0.4	7.2
TOTAL	118.7	-	-	203
AVERAGE	-	57	1.7	

Source: E.T.C., but standing mass of Vegetation Class 1 has been reduced from 440 m^3/ha to the more plausible 200 m^3/ha by the mission, and M.A.I. reduced from 17 T/Ha to 6 T/Ha (or from 3.8% to 3% of standing mass).

Production Estimate by DNRFE

5.14 During the first half of 1987, DNRFE also made an estimate of production potential for fuelwood throughout the country. DNRFE based its work on an ecological classification scheme elaborated by GRANDVAUX

BARBOSA in 1970, where the natural vegetation of the country is broken down into 32 groups. DNRFE obtained updated figures for 21 vegetation groups relevant for the production of fuelwood in the country. Table 5.6 provides an overview of the main results. 37/

Table 5.6: SELECTED VEGETATION GROUPS AND THEIR FUELWOOD PRODUCTION POTENTIAL

Vegetation Type Number According to Barbosa	Vegetation Group	Area (million hectares)	Natural Fuelwood Production Potential (m^3/ha/year)	"Human Influence Factor"	Total Wood Production Potential (million m^3)	Tons a/
2-4	1. Humid Forests	2.6	2.0	0.58	3.0	1.9
7-10	2. Mixed Moist Forests	13.4	0.46	0.70	4.3	2.8
11-14	3. Mixed Dry Forests	10.1	0.31	0.75	2.3	1.5
16-19	4. Miombo Formations	44.0	0.45	0.70	13.9	9.0
20-22	5. Bushland	10.2	0.19	0.78	1.5	0.9
23-24	6. Wooded Grasslands	14.0	0.20	0.81	2.3	1.5
25-26	7. Mixed Savanna/ Open Grasslands	16.5	0.10	0.86	1.4	0.9
27	8. Steppe	3.5	0.05	0.75	0.1	-
Total		114.3	-	-	28.8	18.4
Average			0.34	0.75		

a/ Conversion factor 0.65.

Source: DNRFE.

37/ DNRFE proceeded as follows: (a) determined the area of each vegetation group in each province; (b) determined the share of each vegetation group in each province where the natural production potential has been destroyed through human influence; and (c) estimated the fuelwood production capacity of the remainder of the various vegetation groups in the various provinces.

Production Versus Consumption

5.15 Both E.T.C. and DNRFE compiled production/consumption balances for woodfuels in Angola. As some of the data--particularly on the production potential of the Angolan forests--are widely diverging, it appears that the conclusions of the two studies are quite different. Table 5.7 compares the different findings by region.

Table 5.7: PROVINCIAL FUELWOOD PRODUCTION POTENTIAL

Province	Estimated 1980 Population ('000s)	Estimated Fuelwood production Potential ('000s tons)		Fuelwood Production per capita/year (tons)	
		ETC	DNRFE	ETC	DNRFE
Luanda & Bengo	1,200	650	380	0.49	0.32
Benguela	590	1,400	450	2.9	0.76
Bié	780	14,600	1,000	19	1.3
Cabinda	100	560	390	6.0	3.9
Cuene	130	8,800	590	68	4.5
Huambo	1,100	5,500	530	5.0	0.48
Huila	740	8,100	1,290	11	1.7
Kuando-Kubango	140	21,000	1,890	150	14
Kwanza Norte	390	1,200	670	3.2	1.7
Kwanza Sul	590	5,300	830	9.2	1.4
Lunda Norte	150	54,700	2,190	364	15
Lunda Sul	220	7,600	1,510	35	6.9
Malanje	690	23,200	1,440	34	2.1
Moxico	230	20,000	2,880	87	12
Namibe	60	1,200	180	21	3.0
Uige	490	27,300	1,680	56	3.4
Zaire	50	1,600	480	32	9.6
Total	7,650	202,700	18,380		
Average				36	2.4

Source: E.T.C., DNRFE, and Mission computations.

5.16 According to DNRFE, three provinces (Luanda/Bengo, Benguela, and Huambo) show production capacities below one ton of fuelwood per capita, while five (Bié, Huila, Kwanza Norte, Kwanza Sul, and Malanje) have potentials between 1 and 3 tons per capita. The first group of provinces, where around 3 million people live, is clearly unable to supply its own population with firewood from within its own borders. The other group of provinces, where a further 3 million people live, are barely able to do so. In fact, the estimated deficit from Luanda/Bengo, amounting to some 200,000 tons, probably further aggravates the situation in nearby areas, particularly in Kwanza Norte. On the other hand, the DNRFE figures suggest that only about one-third of the population of Angola lives in provinces with ample supplies of fuelwood. Those provinces have a combined surplus of production over consumption of some 9 million tons.

5.17 Compared to the DNRFE estimates, the remote sensing data of the E.T.C. study indicate a significantly higher potential for woodfuel production, both at the macro and micro level. On average, the E.T.C. figures exceed the DNRFE estimates by a factor of 10. This may grossly underestimate the scarcity of woodfuels, but it does not contradict the view that the urban concentrations in the coastal area, compared with other regions, are poorly endowed with woodfuel resoures.

5.18 The wide gap between the two estimates may in part be attributable to the fact that they measure different things. The E.T.C. study draws a picture of Angola's overall potential for woodfuel production, regardless of whether the resource base grows close to where people live or whether the wood is obtained in small sizes, useful for rural people with simple tools, or as large tree trunks, practically useless as a raw material for domestic fuel. Thus, while it is probably correct to conclude that the aggregate sustained yield in Angola is in excess of 100 million tons per year, the annual yield accessible to and directly useful to the population of the country is certainly much lower, maybe in the vicinity of 20 million tons or somewhat higher.

5.19 Neither study, however, succeeds in convincingly describing the situation of the people concerned; nor do they provide a statistically accurate overall picture of the country's biomass reserves. What is undisputed is that from a global point of view Angola is not running short of biomass stocks. Both studies also indicate where the problem areas in domestic woodfuel supplies lie. The situation is crucial for two kinds of population concentrations: all urban concentrations on the seaboard, particularly Luanda and Benguela/Lobito, and the major urban concentrations inland, particularly Huambo. It is obvious that any attempt to solve the woodfuel problem in any of these areas will have to involve areas far beyond the urban concentrations, often even reaching beyond the home province.

Institutional Issues: Administration of the Forestry Sector

5.20 The institutions dealing with forestry and woodfuels in Angola are very weak, particularly at the field level. The DNACO (National Directorate for the Conservation of Nature) within the Ministry of Agriculture has only one professional Angolan forester. In addition, there are a number of expatriates, mostly Cubans, working mainly in industrial forest operations in Cabinda. One expatriate forester is, however, working in DNACO. In the provinces where woodfuels are the dominant forest products, DNACO is typically represented by a mid-level forest technician who has received his training, mainly in silviculture, in Cuba. As a direct consequence of its lack of funds, DNACO has very little influence over forest operations in Angola. It issues cutting licenses for both forest industries and charcoal makers but is unable to verify whether actual cutting is carried out according to the licenses. It is, of course, even less able to carry out field operations, such as reforestation.

5.21 The other institution is the DNRFE of the MEP. This Department, created in 1981, has a small but growing staff of qualified people, although none with training in forestry. DNRFE is not represented at the provincial level.

5.22 DNRFE pursues various objectives such as research and transfer of technology in new, renewable, and non-conventional forms of energy. Although it does not have any staff trained in forestry, DNRFE has conducted, so far, the only credible study of the use of woodfuels in households. The reorganization of the MEP calls for the transformation of DNRFE into a separate "institute" whose goals would be principally research and experimentation. The splitting-off of DNRFE from the MEP would leave it without any capability either in research or policy-making in woodfuels/biomass and household energy. It has taken years for DNRFE to put together a nucleus of qualified staff, which is exceedingly scarce in Angola. The MEP must have some capability and, if qualified staff are not readily available, then the removal of DNRFE from the MEP should be delayed until at least some qualified persons can be attached to MEP proper. A unit or division for woodfuels/biomass for household energy should be located within the reorganized Technical Department (Gabinete Tecnico).

Marketing and Pricing

5.23 In Angola, marketing and pricing mechanisms operate in a distorted economic environment. Official rules for production and marketing of firewood and charcoal, which exist mostly on paper, are seldom applied in practice. Prices paid by consumers often exceed the officially set levels by a factor of 10 to 50. 38/ Thus, while official retail prices for firewood and charcoal are Kz 1.2/kg and Kz 7.5/kg, respectively, effective retail prices are between Kz 5/kg and Kz 300/kg for firewood and between Kz 13/kg and Kz 600/kg for charcoal according to the recent survey undertaken by DNRFE (Table 5.8).

38/ No one knows why official prices for woodfuel are set at all. They are not readily available; they are obviously not meant to be enforced; and except in Namibe, which is in a special situation, they are meaningless.

Table 5.8: PRICES PAID FOR FIREWOOD AND CHARCOAL IN SEVEN PROVINCES, 1987
(Kz/kg)

	Firewood			Charcoal		
Province	Urban	Periburban	Rural	Urban	Periburban	Rural
Luanda	-	105	235	265	[illegible]30	280
Bengo	-	60	-	130	85	165
Cabinda	40	40	-	200	320	-
Huambo	40	60	55	65	310	55
Huila	50	15	-	30	75	40
Namibe	20	15	-	35	35	35
Uige	-	80	-	165	160	75
Country	30	40	120	145	220	80
(Official price)	(1.2)	(1.2)	(1.2)	(7.5)	(7.5)	(7.5)

Source: DNRFE.

5.24 The picture on woodfuel prices provided by DNRFE constitutes a vast improvement over the previous state of affairs, when there was virtually no reliable data on prices at the consumer level. The mission has also conducted a small survey of charcoal and firewood prices in each of three markets in or near Luanda. Retail charcoal prices were about Kz 500/kg in all three markets, i.e., somewhat higher than found by DNRFE. Firewood was sold at Kz 150/kg in the market on the outskirts of Luanda and at Kz 50/kg at the village of Cacuaco near Luanda. This result contradicts the findings of the DNRFE study (which may have been in error) where the price of firewood in the rural areas of Luanda province was found to be much higher than in the periurban areas.

5.25 The system suppling charcoal and firewood to Luanda is not well known. In theory, in order to engage in the woodfuel business, persons or organizations have to apply to DNACO for a cutting license. In reality, these licenses often function as a clearance to transport firewood and charcoal through the checkpoints on the outskirts of Luanda and other cities and towns. This is indicated by the fact that the volume of woodfuel cuttings covered by official licenses amounts to no more than 150,000 m^3, while total cuttings are in the general order of 10 million cubic meters.

5.26 Not all the difference between the total cuttings and those licensed are illegal, however, since fuelwood cutting and charcoal production for home consumption are permitted without license. There is evidence that a significant proportion of the charcoal traded in Luanda passes the checkpoints under the guise of "home consumption". Small-scale traders shuttle between central Luanda and Viana (the woodfuels terminal, outside the Luanda checkpoints) bringing only two sacks of charcoal per person per trip. They pass the checkpoints claiming that the charcoal they are carrying is for their own home consumption.

5.27 Based on data gathered by DNFRE, the costs of various fuels as a source of cooking heat can be approximated as shown in Table 5.9.

Table 5.9: COMPARATIVE COOKING COSTS OF FOUR HOUSEHOLD FUELS a/

Fuel	Price Kz/kg	Heat Value kcal/kg	Estimated End-Use Efficiency	Effective Cost of Useful Heat Kz/1000 kcal
Firewood	45	3,500	10%	130
Charcoal	180	5,000	15%	240
LPG	60	11,000	55%	10
Kerosene	135	9,000	40%	38

a/ Fuel prices are calculated as means.

Source: DNRFE and mission calculations.

5.28 On average the price structure of cooking fuels is strongly biased in favour of those households which have access to LPG or kerosene, i.e., mainly relatively well-off families living in urban centers. Thus, policy measures designed to raise the relative price of LPG and kerosene will mainly affect those households which, under the present conditions, are well-off. Charcoal, on the other hand, turns out to be the most expensive urban household fuel. Clearly, the terms of trade between commercial fuels (LPG, kerosene) and woodfuels are hardly in line with their relative scarcities. Rather, they reflect the fact that the fuels are currently supplied to two different markets (official and parallel) where the purchasing power of the Kwanza varies considerably.

Organizations of Woodfuel Suppliers

5.29 In most cases, owners of means of transport occupy a key position as regards exploitation of wood, its conversion to firewood and charcoal, and transportation to urban areas. Truck owners engage laborers for cutting wood and producing charcoal. In certain areas of the country, however, for example in the province of Namibe, local laborers formed cooperatives which apply for cutting licenses, produce firewood and charcoal and transport it to the consumption centers. As the cooperative is formed among local inhabitants licensed to use a specific area, its members are more likely to have an interest in the sustained production of wood. They might, thus, respect certain restrictions such as minimum diameters for cutting, prohibition to cultivate exploited areas, obligations to carry out reforestation, etc. A limited number of cooperatives, each working within a set geographical area, is also fairly easy to supervise. To improve the supply of woodfuels, cooperatives might be an option where security conditions make them feasible and where the problems (as in Namibe) are not excessively serious. Elsewhere, private truck owners using hired labor would have to continue supplying the bulk of woodfuel needs. While it is not possible to do so at present, these private entrepreneurs would eventually have to be supervised more stringently to ensure that minimal rules are followed to permit forest regeneration and, thus, sustained wood production.

Issues and Recommendations

5.30 In comparison with most other countries in Sub-Saharan Africa, the wood resources of Angola are large, particularly in relation to its population. Thus, for a significant percentage of the inhabitants of Angola, there is no serious fuelwood problem. Most of the forests of Angola are exploited for fuelwood far below their rates of growth. However, all urban concentrations on the seaboard and the major inland cities constitute pockets of wood shortage.

5.31 Although reliable statistics are not available, it is estimated that 3 million people live in the comparatively dry coastal areas with scarce supplies of woodfuels. While some scattered fishing and farming communities can obtain the woodfuel they need from the local bushland, most concentrations of people have to obtain woodfuels from considerable distances. Inland, mainly in the township of Huambo and other provincial capitals, about one million persons are experiencing a shortage of fuelwood. Thus, a total of some four million people in Angola, i.e., almost half the population, live in areas with a more or less pronounced shortage of woodfuels. Unless serious action is taken, the problem will probably continue to grow as people migrate toward the coast and toward towns and cities.

5.32 The characteristics of supply and demand for woodfuels are quite different on the seaboard than inland. First, the natural conditions for tree growth are less favorable in the dry coastal areas than in the moister inland areas. This means that there is less wood available per unit area, both at present and as a result of possible reforestation activities. Second, the access to alternative sources of household energy, mainly LPG and kerosene, is much easier on the seaboard than inland.

5.33 In the short run, security problems severely restrict the movement of fuelwood from wood-rich to wood-poor areas of the country. When the security situation improves, the institutional weaknesses of the forestry sector are likely to become the main bottlenecks to rapid improvement. Consequently, the discussion of possible activities aiming at an improvement will have to be made in two parts: actions that can be carried out under the present security situation and those that require marked improvements in the security situation. They are labelled "Peace" and "No Peace". The priorities for action are summarized in Table 5.10.

Table 5.10: PRIORITY LISTING OF ACTIVITIES

		Increased Fuel Substitution	Improved Efficiency of Stoves	Supply System	Wood Production
No Peace	Coast	I	II	III	IV
	Inland	IV	I	II	III
Peace	Coast	II	III	I	IV
	Inland	IV	III	II	I

Note: Although not shown as a distinct activity, institutional strengthening and technical assistance would become much more urgent and important with the return of peace.

Actions That Can Be Undertaken Under the Present "No Peace" Situation

5.34 As the problem is different on the coast versus inland, the two areas will be treated separately. Only activities explicitly directed at the problem areas, i.e., the urban concentrations on the coastal strip and the major urban concentrations inland, will be discussed. This does not imply that all is well for the estimated four to five million people living in the countryside but only that major woodfuel problems lie elsewhere. Also, information on the overall rural energy situation is unavailable. A major survey would be needed to obtain such information.

The Coast: "No Peace"

5.35 A number of alternative actions to improve the situation can be envisaged. They would comprise the following:

- Increased use of fuels other than firewood and charcoal (substitution).

- More efficient use of firewood and charcoal.

- Improvements in the present supply system.

- Establishment of forest plantations.

(a) Increased Use of Fuels Other than Firewood and Charcoal. In the coastal cities and towns, the use of LPG as a cooking fuel is already fairly widespread. For the population, this fuel represents a very attractive option. Its average cost, according to DNRFE, is only about Kz 60/kg, (although the official selling price to the public is Kz 15/kg), i.e., much less per useful energy unit than both firewood and charcoal, which sell at average prices of Kz 45/kg and Kz 180/kg respectively. LPG could become an even more important household fuel in the coastal areas, 39/ even if it were to increase considerably in price. The main problems are likely to be supply shortages of gas bottles and stoves, and, possibly, cash-flow difficulties for the initial purchase of bottles among poor families.

The low cost of kerosene parallels that of LPG. It is, however, much less widespread as a cooking fuel and has a less developed distribution network. On the other hand, it poses fewer technical problems in distribution. Perhaps the most important role of kerosene would be as a source of light in rural dwellings. The economics of kerosene versus LPG in urban household energy have not been studied.

(b) More Efficient Use of Firewood and Charcoal. At present, firewood is almost universally burned in three-stone hearths whose thermal efficiency is quite low, probably about 10%. Charcoal is generally burned in simple square metallic stoves with efficiencies around 15%. There is obvious scope for improvements in stove design for both firewood and charcoal. There are also local varieties of improved stoves which could be used as demonstrations or starting points for more efficient designs.

(c) Improvements in the Present Supply System. The present supply system is not well known as it is organized informally, with the owners of means of transport having a key position as holders of cutting licenses. In Namibe, where the security situation is much better than average, the charcoal producers have formed cooperatives which, in turn, have obtained cutting licenses and also organized the transport of the charcoal to the consumption centers. Where possible, woodfuel cooperatives are recommended. A limited number of charcoal cooperatives constitute a more easily managed group than a much larger

39/ About 30,000 tons of LPG are currently being consumed, mostly in Luanda and other coastal cities.

number of truck owners, charcoal producing farmers, and unorganized laborers. The cooperatives could get various kinds of support (tools, etc.) as compensation for the obligation to follow certain conservation rules in their operations. Those rules would primarily consist of forestry and cutting management principles to be followed in forest operations to ensure sustained wood production.

(d) Establishment of Forest Plantations. The establishment of forest plantations is an awkward proposition for the coastal areas of Angola. If they were to be established close to the consumers, in the arid coastal areas, their establishment would be technically difficult and expensive. Further, tree growth would be slow, resulting in long rotations and low yield, again causing higher costs. If the plantations were to be established in the moister inland areas, long transport distances might outweigh the more advantageous growth conditions. Further, the general security situation would make the establishment and management of forest plantations difficult and costly, and the same applies to transport of the output of the plantations. Finally, in those areas where forest plantations could be expected to yield well, there are often natural forests available, which can be exploited. By exploiting the natural forests, the initial investment and the delay of five to ten years before harvesting can be avoided.

Inland Areas: "No Peace"

5.36 Inland, where about one million persons live in wood-short areas, replacing wood and charcoal by other fuels, mainly LPG, is much less attractive. Instead, the following options (in order of priority) would seem more appropriate:

- More efficient use of firewood and charcoal.
- Improvement in the present supply system.
- Improved use of existing forest plantations or establishment of new ones.
- Improved supplies of modern fuels (kerosene, LPG).

(a) More Efficient Use of Firewood and Charcoal. In the inland cities (Huambo and other provincial capitals) three-stone hearths for wood and simple metal stoves for charcoal are in general use. As in the coastal areas, there is scope for improvement.

(b) Improvement in the Present Supply System. The average transport distance for woodfuels from existing forests--natural or planted--to the consumers is much shorter inland than on the coast. Although it seems that the present supply systems function better inland than on the coast, there is scope for improvement, particularly in order to safeguard the long-run productivity of the wood sources. This would require the establishment of rules guiding the exploitation of the forest areas and a system for supervision and control of the licensees.

(c) Improved Management of Existing Forest Plantations or Establishment of New Ones. At present, existing forest plantations, for example in the province of Huambo, are not used in any systematic manner for the supply of woodfuels to urban centers. Furthermore, present practices (cutting, burning of stumps, cultivation of cleared areas) prevent the regeneration of the harvested areas. A program for controlling cutting methods in nearby plantations should be developed. Of lower priority is whether any additional plantations are required. Inland, the growth conditions for forest plantations are generally good. Security and the difficulties of mobilizing sufficient funds for such plantations are likely to be serious problems.

Alternative Priorities in a "Peace" Situation

5.37 In a situation of peace, the order of priority of the various actions would change somewhat, so that field activities, particularly forestry management and plantations, would ascend in priority when the countryside becomes secure. Such increased field activities would, in turn, require a strengthening of the institutions concerned. Institutional strengthening is not the highest priority (although gaps in the institutional structure need to be filled even under the current security situation) but with the return of peace, institutional strengthening would become a high priority.

Proposed Actions

5.38 Various solutions for the problem areas on the coast and around the urban centers inland were discussed in the previous section. In this section, four groups of activities for the major problem areas will be proposed. The first is a pilot project to be executed in Huila-Namibe. The second and third ones are activities for Luanda and Benguela/Lobito, respectively, while the fourth one concerns the township of Huambo. In addition, three national-level activities are proposed to support these four regional projects: improved stoves, agroforestry, and institutional strengthening.

Pilot Project in Huila-Namibe

5.39 In the provinces of Huila and Namibe, the military situation is much better than elsewhere in Angola, with most of the two provinces safe. Also, the economy in these provinces seems to be functioning better than elsewhere. Additionally, the provinces do not have large population concentrations in areas far from the forests. It is true that the coastal towns of Namibe and Tombwa have virtually no wood resources in their neighborhood, but the fact that the towns are fairly small makes the problem more easily managed than in the cases of Luanda and Benguela/Lobito. Taken together, these facts point to the possibility of developing a pilot project in energy forestry in these two provinces.

Coast

(Mainly Namibe Township and its Neighborhood)

- Priority I: Fuel subsitution.
- Priority II: Increased efficiency of stoves.
- Priority III: Improved supply system.

Inland

(Mainly Lubango Town and its Surroundings)

- Priority I: Increased efficiency of stoves.
- Priority II: Improved supply system.
- Priority III: Wood production/forestry management.

5.40 Luanda. The city of Luanda and its surroundings constitute the single largest consumption center for household fuels. The use of LPG, kerosene, and electricity in households is more widespread than elsewhere but woodfuels, mainly charcoal, are still used by almost half the population. Wood and charcoal are bought in the parallel market, at about Kz 140/kg for firewood and Kz 320/kg for charcoal. In comparison, the average price for LPG in Luanda is about Kz 100/kg. In terms of useful heat delivered to the pot, the cost of wood and charcoal is about 15 times higher than LPG (Kz 400, 400, and 27 per 1,000 kcal, respectively). A logical first priority is thus to spread the use of LPG among the urban and periurban population of Luanda. At the same time, however, improved stoves for firewood and charcoal should be made available to the large share of the urban and periurban population that will continue to use wood or charcoal for many years.

5.41 The supply system for woodfuels is not well known, or at least not well documented. Many of the present operations are carried out by individuals operating informally outside the legal framework. Therefore, mapping of the supply system is not likely to be an easy task. Improved knowledge of that system seems, however, to be a necessary condition for any action aimed at its improvement. A survey of the present supply system for firewood and charcoal to Luanda is, thus, the first step in the design of an improved system for supply of firewood and charcoal to Luanda.

5.42 Benguela/Lobito. The coastal cities of Benguela and Lobito, in the province of Benguela, exhibit much of the same characteristics as Luanda. Generally speaking, the solutions in the medium term would also be similar, i.e., a gradual change to LPG for household cooking fuel, improved stoves for fuelwood and charcoal, and preparations for an improved system for the supply of firewood and charcoal to the urban and periurban areas. The geographical/ecological position of Benguela/Lobito is, however, somewhat more favorable than that for Luanda, as areas favorable for tree growth (i.e., the escarpment) are closer to the population centers. Further, there are plantations, mainly of eucalyptus, on the escarpment close to the border with the province of Huambo. Those plantations were established as the raw material source for the Alto Catumbela pulp and paper mill. As the mill has been closed for some time, the forests might be available for an alternative use. The fact that the forests are located fairly close to the railway line between Huambo and Benguela should facilitate their use for energy in Benguela and Lobito.

5.43 Huambo Township. With about half a million inhabitants using firewood and charcoal, Huambo is the largest inland fuelwood shortage area. For that area, the order of priorities is the following:

(a) increased efficiency of stoves;

(b) improved supply system;

(c) wood production (or better forestry/plantation management); and

(d) fuel substitution.

A project for the development and dissemination of improved wood and charcoal stoves for Huambo would have much in common with the corresponding projects in Luanda and Benguela/Lobito. The same is basically true for the improvement of the supply system, even if the natural conditions for tree growth are much more favorable in Huambo. In fact, the province of Huambo already has extensive plantations of eucalyptus, mainly along the Benguela railway line, established to provide firewood to the steam engines. Most of the locomotives now run on diesel oil instead of wood, which means that the forests should be available for other uses. Some of the forests may have been damaged or destroyed due to excessive cutting or clearing for agriculture, but most are likely to have remained productive. In the short term, the lack of security in the forest areas may be the more serious limitation to their increased use as woodfuel sources.

5.44 In seeking to improve the supply of woodfuels for Huambo township, an inventory should be made of the existing raw material sources, whether natural or man-made. Second, a management system should be developed for the forests. Further, it might be advantageous to establish cooperatives among the producers of firewood and charcoal. It is also necessary to consider whether longer-term needs can be met from existing forests or would require additional plantations.

Proposed Supportive Action at the National Level

5.45 There are three activities of value for all the provincial projects which would be carried out most advantageously at the national level or at least with strong support from an institution at the national level. First, improved cooking stoves for firewood and charcoal need to be designed and introduced. Second, suitable forms of tree cultivation in conjunction with agriculture (agroforestry) should be developed. Third, there is a need to strengthen the forestry institutions in Angola to help define and enforce policies, to support the provincial projects, and to prepare for more activities when the security situation improves.

5.46 Improved Cooking Stoves. In its preparations for the Seminar on Firewood and Charcoal in Luanda in June 1987, DNRFE made a survey of biomass cooking stoves in the seven provinces surveyed. This is the appropriate, albeit modest, beginning of a national program for the design, production, and dissemination of improved cooking stoves in Angola--which are a priority in Luanda, Benguela/Lobito and Huambo. It seems practical that much of the development work should be carried out at the national level or at least with strong technical support from that level. It is, further, advantageous that field trials for improved stoves should initially be concentrated in Luanda, where a large number of people use inefficient stoves for woodfuels bought at quite high prices. Benguela/Lobito would get second priority in the program and Huambo, third.

5.47 Agroforestry. Planting of trees which (among other things) yield fuelwood can take various forms. At one end of the spectrum there is the dedicated energy plantation, where densely planted trees form a forest which is managed for the main purpose of producing fuelwood. At the other end of the spectrum, there are trees planted for other purposes, such as to provide shade, shelter against wind, or to produce fruit, fodder or other non-wood products. While international assistance in energy forestry during the 1970s focused on "village woodlots" and other forms of collective creation of fuelwood forests, attention has shifted towards other forms of tree cultivation during the present decade. There are several reasons for this shift. First are the technical and economic problems associated with village woodlot schemes and other forms of collective or centrally organized fuelwood plantations, such as peri-urban plantations. Another is the realization that the planting of trees for the production of fuelwood alone does not rank high in the list of priority for most rural inhabitants.

5.48 In Angola at present, both the village woodlot and the peri-urban fuelwood plantation are concepts likely to face severe implementation problems. They would face the same technical and economic problems encountered elsewhere but with much less favorable technical and economic conditions. Further, the extreme scarcity of trained people for project planning and management, together with the poor security situation, would make fuelwood plantations a risky venture. Instead, the agroforestry approach would stimulate other forms of tree cultivation, where farmers plant trees for a variety of purposes, with fuelwood as a by-product. Such plantations can take the form of windbreaks, a small grove to provide shade or shelter, fruit orchards, single trees in agricultural fields, contour plantations (or soil conservation and erosion control), possibly for fodder, and so on. In many of those cases, the trees supplement rather than compete with agriculture and animal husbandry, thereby eliminating one difficulty and reducing the opportunity cost of land, so that economic criteria are more easily satisfied.

5.49 The forms of tree planting referred to above are often collectively called "agroforestry". Such tree planting, for food, fodder, shelter, etc., would obviously be only a minor source of woodfuel for the major urban areas, but could become an important woodfuel source for rural people. An important advantage of such tree planting in Angola is that it does not need centralized project management but can be integrated into other agricultural activities. Thus, the weakness of the forestry administration in Angola is less of an obstacle for agroforestry than for the traditional forms of forestry.

5.50 In the present security situation in Angola, activities in the field of agroforestry might have to be limited to training combined with field trials. Among the activities proposed above, all but one are urban-oriented. The exception, the pilot project for Huila/Namibe, would thus provide a focal point for agroforestry centered on the agricultural school of Tchivinguiro, 35 km from Lubango.

Strengthening of Institutions

5.51 In Angola, the institutions in the forestry sector, i.e., the DNACO and the DNRFE, are weak. The selection of activities proposed in this chapter has been made against this background. Nevertheless, these activities would be very much easier to carry out if the institutions concerned were strengthened. The minimal needs are for some capability in the MEP (currently provided by DNRFE), a strengthening of DNACO in the provinces where projects are proposed, some technical assistance at the central level for DNACO, and some funds for very limited studies, such as a forest inventory around Huambo, and a study of woodfuels marketing systems in Luanda, Benguela/Lobito and Lubango.

MACROECONOMIC INDICATORS

Table 1: INDICATORS FOR GDP AND GNP

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
GDP at factor cost (In million US$)	n.a	n.a	n.a	n.a	n.a	n.a	3,922	4,307	4,811	4,174
- of which petroleum	n.a	n.a	n.a	n.a	n.a	n.a	1,098	1,383	1,487	1,131
GDP at market prices (In million current US$)	2,445	2,750	3,323	3,617	3,933	3,647	4,212	4,719	4,831	4,409
Deflator (1980=100) a/	78.2	85.2	91.3	100	92.6	84.8	77.8	71.5	65.6	60.3
GDP at 1980 prices a/ (In million US$)	3,127	3,228	3,640	3,617	3,642	3,091	3,278	3,373	3,[illegible]70	2,658
GNP at current prices b/ (In million US$)	n.a	n.a	n.a	n.a	n.a	3,529	3,725	4,153	4,199	3,863
GNP at 1980 prices a/	n.a	n.a	n.a	n.a	n.a	2,991	2,899	2,969	2,755	2,329

Exchange rate: US$1= 30 Kz.

a/ Estimate for 1983-86.
b/ Estimates based on balance of payments statistics.

Source: Ministry of Planning, the National Bank of Angola (BNA), and mission estimates.

Table 2: GOVERNMENT BUDGET
(In million Kz)

	1978	1979	1980	1981	1982	1983	1984	1985	1986
Total revenues	38,866	37,155	60,143	73,708	50,656	55,589	74,556	78,528	71,205
- of which petroleum(%)	n.a.	n.a.	56.4	61.3	41.5	48.0	56.7	53.1	29.7
Tax Revenues	n.a.	n.a.	51,556	63,340	41,573	47,136	62,193	66,646	51,945
- of which petroleum	n.a.	n.a.	33,917	45,185	21,046	26,672	42,267	41,667	21,132
Non-tax revenues	n.a.	n.a.	8,587	10,368	9,083	8,453	11,643	11,882	19,263
Total Expenditures	41,331	57,540	76,920	91,640	72,133	74,427	86,360	97,987	84,207
- of which Defense	10,270	15,100	16,821	18,505	18,257	23,295	31,943	34,306	32,630
Deficit	2,465	20,385	16,777	17,932	21,477	18,838	11,804	19,459	13,002
Other areas	5,253	5,712	13,100	13,100	2,000	2,379	2,857	4,063	4,831
Deficit	2,465	20,385	27,000	17,900	21,500	11,990	7,746	11,960	15,000

Source: Ministry of Finance.

Annex 1
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Table 3: BALANCE OF PAYMENTS
(In million Kz)

	1978	1979	1980	1981	1982	1983	1984	1985	1986
Exports a/	29,940	35,460	48,699	38,126	44,705	47,493	58,800	59,280	38,350
- of which petroleum	16,507	26,745	41,730	40,350 b/	37,029	45,768	52,455	56,868	34,485
Imports	26,640	38,840	44,503	45,417	(33,684)	(29,708)	(37,950)	(41,527)	(31,868)
Balance	3,300	(1,380)	4,196	(7,291)	11,021	17,785	20,8509	17,753	6,482
Invisibles (net)	(3,720)	(4,350)	(5,734)	(12,683)	(19,007)	(19,792)	(23,613)	(26,494)	(22,009)
of which:									
- Factor services (net)	n.a	n.a	n.a	n.a	(13,050)	(14,520)	(16,950)	(18,960)	(16,410)
Unrequted transfers	90	300	508	1,505	794	986	1,047	1,657	2,108
Current account	(330)	(5,430)	(1,030)	(18,469)	(7,192)	(1,021)	(1,716)	(7,084)	(13,419)
Medium- + long-term capital	1,950	1,950	7,016	7,110	3,026	1,628	6,103	5,335	1,567
Basic balance	1,620	(3,480)	5,986	(11,359)	(4,166)	607	4,387	(1,749)	(11,852)
Short-term capital, errors and omissions	1,080	3,930	(8,096)	5,566	3,901	(466)	(2,557)	2,709	11,103
Overall balance	2,700	450	2,110	(5,793)	(265)	141	1,830	960	(749)

a/ Between 1978 and 1981 taxes on oil exports paid by foreign oil companies are included in service income.

b/ Figures were obtained from MEP independent of total export figures (BNA).

Source: National Bank of Angola (BNA).

Table 4: DISBURSED PUBLIC EXTERNAL DEBT
(In million Kz)

	1978	1979	1980	1981	1982	1983	1984	1985	1986
Short-term	n.a	n.a	n.a	n.a	8,138	7,551	4,888	7,525	18,434
Medium- Long-term	11,340	11,430	18,420	59,490	62,259	63,193	68,482	73,482	73,695
TOTAL	n.a	n.a	n.a	n.a	70,397	70,744	73,370	81,007	92,129
Total as % of GNP	n.a	n.a	n.a	n.a	73.1	63.3	58.8	64.3	79.5
Total as % of exports of goods and services	n.a.	n.a	n.a	n.a	144.7	142.1	118.7	128.3	223.9

Source: The National Bank of Angola (BNA) and own calculations.

Table 5: GOVERNMENT PROJECTIONS FOR KEY ECONOMIC FIGURES
(in million US$)

	Actual	------------ Projected	-----------		
	1986	1987	1988	1989	1990
Revenues from oil exports	1,150	1,653	1,841	2,018	2,137
Average price of oil (In US$/bbl)	12	16	16	17	18
Trade balance	216	602	682	756	777
Current account	(448)	(238)	(181)	(142)	(135)
External debt	3,024	3,163	3,289	3,335	3,393
of which:					
- Short-term	568	219	257	309	359
- Long-term	2,456	2,944	3,032	3,046	3,034
Potential for gross domestic investment	1,123	659	1,320	1,562	1,692

Source: The National Bank of Angola (BNA).

Table 6: COMPARATIVE ECONOMIC INDICATORS

Country	GNP per Capita	GDP Growth a/	External Public Debt as % of GNP	Debt Service Ratio	Government Expenditure as % of GNP	Broad Money as % of GDP	Current Account Deficit as % of GDP	Share of Petroleum Sector in GDP	Share of Oil Income in Goverment Revenues
	(1985 US$)	(1980-85)	(1985)	(1985)	(1985)	(1985)	(1985)	(1985)	(1985)
Zambia	390	0.1	150.8	10.2	30.3	33.4	4.2	--	--
Zimbabwe	680	2.5	31.3	32.2	39.1	45.2	2.1	--	--
Tanzania	290	0.8	48.5	16.7	24.7	--	--	--	--
Malawi	160	2.0	75.7	--	29.5	24.3	--	--	--
Lesotho	470	0.5	30.1	6.2	22.7	48.8	3.5	--	--
Botswana	840	12.1	47.3	5.4	48.2	29.5	16.9	--	--
Mozambique	160	-9.6	--	--	--	94.8 b/	--	--	--
Angola	485	-2.3	59.2	22.0	71.8	142.6	4.9	30.0	53.1
Tunisia	1,190	4.1	56.1	24.9	40.4	48.6	7.4	--	--
Congo	1,110	7.8	86.5	19.6	--	16.2	--	40.0	66.6
Gabon	3,350	4.5 a/	n.a.	--	--	--	--	45.0	66.0
Nigeria	800	-3.4	17.8	30.8	--	34.7	1.6	23.0	--

a/ Least square estimates.
b/ 1984 estimate.
c/ 1980-84

Source: World Development Report, 1987 and mission estimates.

INSTITUTIONAL ORGANIZATIONS WITHIN THE ENERGY SECTOR

The Ministry of Energy and Petroleum (MEP) is the principal Government body responsible for the development and implementation of national policy within the energy sector. In practice, it deals with the major aspects of the oil, gas, and electricity power industries.

The main responsibilities of the MEP include:

(a) preparing the National Plan for the energy sector;

(b) supervising SONANGOL and the power utilities;

(c) promoting and coordinating training activities within the sector; and

(d) implementing international technical cooperation.

The present Ministry has its origin in the 1984 merging of the Ministry of Energy and the Ministry of Petroleum--both separate entities created in 1976. In 1987 the MEP was re-organized into four units or Gabinetes with functional responsibilities over the electricity and petroleum subsectors. The four Gabinetes are: Planning, Technology, Legal, and Human Resources.

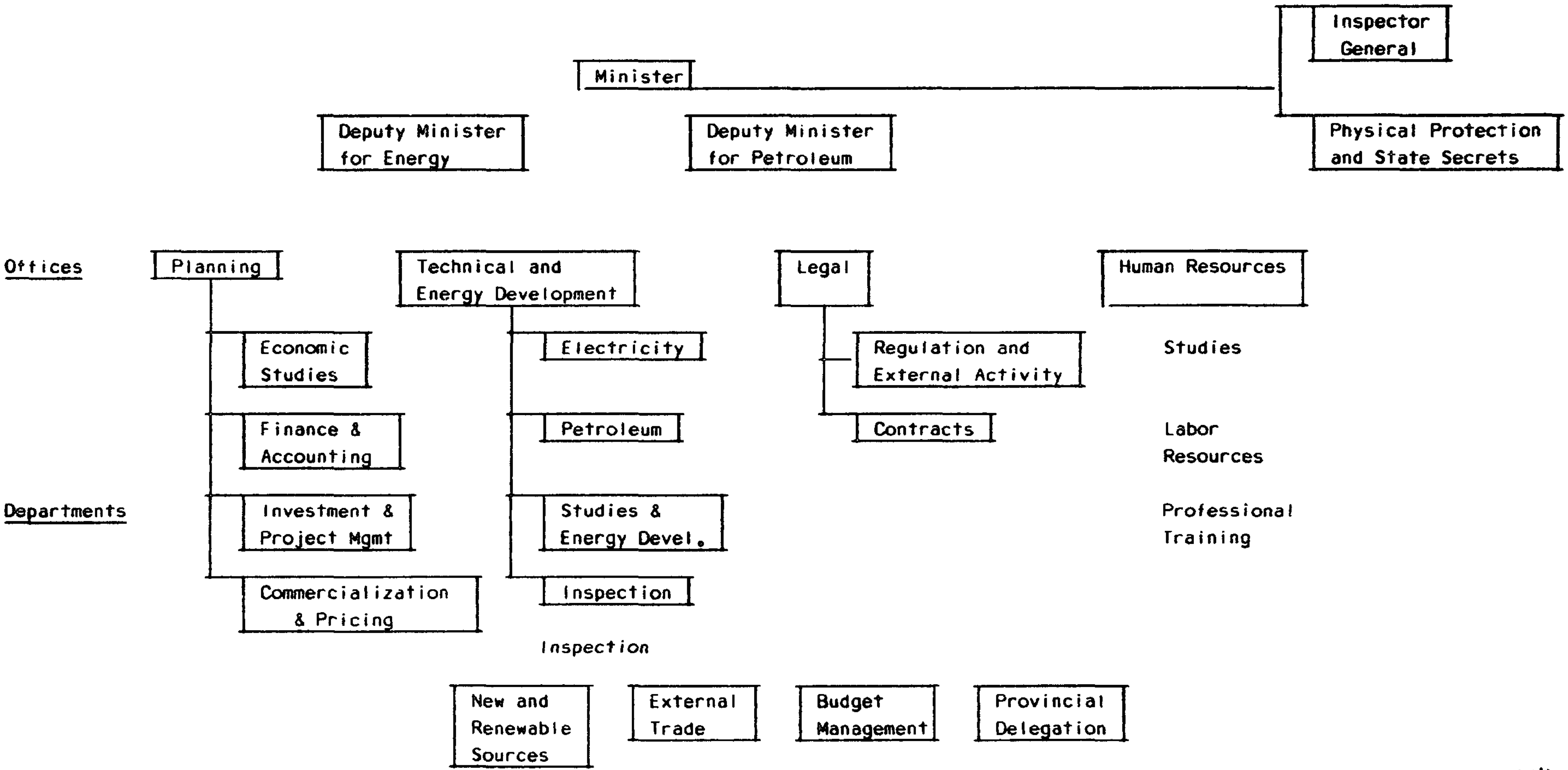
In addition to the Gabinetes, the departments of New and Renewable Energy Sources and of Budget are kept under the MEP's direct supervision, at a lower administrative level.

Within the MEP, the National Department for Transformation is responsible for coordination with and monitoring of the refinery industry, and the Department of External Trade monitors external and internal trade in crude oil and petroleum products. These two departments have continued in existence in spite of the reorganization. Their functions will eventually be redistributed to the Gabinetes.

The MEP itself is not involved in the day-to-day management of the sector but establishes guidelines to be used by executing agencies in the implementation of policies.

An organization chart for the MEP is given on page 2.

MINISTRY OF ENERGY AND PETROLEUM (MEP)



Source: MEP.

PETROLEUM PRODUCTS

The MEP has specific managerial responsibilities within the petroleum subsector:

(a) authorizing the opening of blocks for bids;

(b) approving development programs;

(c) authorizing the commencement of production;

(d) regulating field production levels;

(e) sanctioning the flaring of natural gas in special cases;

(f) setting crude oil prices for tax purposes; and

(g) reviewing SONANGOL's investment programs and foreign companies' accounts.

Sociedade Nacional de Combustiveis de Angola (SONANGOL) is the State-owned company established in 1976 as the business arm of the Government with the main responsibility of implementing policy for the petroleum sector. Its structure is based on that of ANGOL, the only Portuguese company in Angola with interests in petroleum, which was nationalized after independence.

SONANGOL is managed by a Director General who reports to the MEP, and three deputy directors responsible for hydrocarbons, distribution, and administration and finance. The Deputy Director for Hydrocarbons supervises four departments: Exploration, Production and Reserves, Administration and Finance 1/, and a fourth department which handles air transport services for the oil companies.

The Director General directly supervises a unit responsible for negotiations.

The main function of SONANGOL is to oversee the petroleum operations of all foreign companies. It makes recommendations to the Government in respect to areas that should be open for exploration, conducts the bidding process, and handles negotiations. SONANGOL reviews the foreign companies' proposals, and, once operations begin, discusses work programs and budgets and supervises activities.

1/ The Deputy Director for Administration and Finance deals with corporate functions.

In addition to exploration and production activities, SONANGOL is responsible for domestic product distribution and marketing. SONANGOL owns and operates a network of storage installations throughout the country and maintains a small marine tanker fleet and a sizeable fleet of road tankers.

SONANGOL enters into partnerships with qualified foreign companies in order to obtain the requisite financial and technical resources for exploration, development, and production. These partnerships take one of two forms:

(a) Joint Ventures in which both SONANGOL and its partners share in investments and receive petroleum produced according to their percentage interests. Foreign companies pay taxes and royalties on their equity shares of production. SONANGOL pays taxes to the Government and operates under the same foreign exchange regulations that govern oil companies.

(b) Production Sharing Agreements in which the companies serve as contractors to SONANGOL, finance the full cost of investment in both exploration and development, and are compensated with a share of the oil produced. Companies' investments costs are recouped from "cost oil", set at a fixed proportion of production (normally 50%) and are then taxed on their "profit oil".

Hydrocarbon deposits declared non-commercial are the property of the State and revert to SONANGOL.

SONANGOL has a joint venture arrangement with STINNES, a West German oil trading firm, in which all matters pertaining to the export/-sale and import/procurement of petroleum products for Angola are handled.

As a working partner, SONANGOL finances its share of investment programs in both offshore and onshore activities with CHEVRON in Cabinda, FINA in onshore Angola, and TEXACO in Block No.2. It has supervisory rights over these ventures, but limited day-to-day operational capacity.

In one instance SONANGOL indirectly acts as operator. Emprcsa dos Servicios Petroliferos de Angola (ESPA) is a mixed-economy enterprise set up to operate Block No.4. It is owned by: SONANGOL (51%), BRASPETRO (24.5%), and PETROFINA (24.5%). Each company contributes to the management and staffing of the operating company.

Fina Petroleos de Angola (FPA) is primarily a privately-owned company within the petroleum industry. Shares are owned: 55.6% by PETROFINA, 11.1% by the public, and 33.3% by the Government. Government shares are described as "non-participating", and do not entitle it to any share of the profits.

FPA owns interests upstream in two blocks. It acts as operator of the Kwanza and Soyo fields on behalf of its joint venture partners--SONANGOL in Kwanza, SONANGOL and TEXACO in Soyo. FPA owns and operates the refinery in Luanda, the principal product supplier to SONANGOL for the domestic market, and also provides SONANGOL with its export volume.

The refinery is a comparatively high-cost operation by international standards. It operates on a "cost plus" refinery gate pricing arrangement. All verified operating costs, depreciation, and allowable profit are recovered and there is no particular incentive for cost minimization and optimization of operations.

ELECTRIC POWER

MEP is responsible for the main operating organizations in the electric power subsector. These are:

(a) Empresa Nacional de Electricidade (ENE). ENE was created in 1980 with the aim of becoming the sole national power utility in charge of generation, transmission, and medium-voltage distribution across the country. After independence, ENE received the assets of the Junta Provincial de Electrificacao de Angola (JPEA), represented by the Southern System. The main facility in the Southern System is the Matala hydro plant on the Cunene River. The system also includes the upstream Gove dam, and an unfinished diesel plant in Namibe. In addition to several isolated systems, ENE also currently operates the Central System. This system is based on two hydro plants located on the western part of the Catumbela River at Lomaum and Biopio, and two diesel-fired turbines at Biopio and Huambo;

(b) Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos (SONEFE). SONEFE is the utility in charge of generation and transmission in the Northern System, the largest in the country. The system directly supplies about 300 industrial consumers at high and medium voltage and operates using the potential of the Kwanza and Donde Rivers and two Jet B-fueled gas turbines in Luanda. The plant in Mabubas, also part of the system, has been shut down for rehabilitation and will remain shut down until late 1988. SONEFE has no centralized department for operations. It is organized into five departments: Planning and Finance, Studies and Projects, Stocks and Purchases, Human Resources, and Administrative Services;

(c) Empresa de Electricidade de Luanda (EDEL). EDEL is the utility in charge of medium- and low-voltage distribution in the urban area of Luanda. Autonomous since 1980, and with its legal status not fully clarified, it remains separate from ENE due to the significance and volume of its services;

(d) Companhia de Electricidade do Lobito e Benguela (CELB). CELB is the utility in charge of distribution to Lobito and Benguela. Nationalized in 1982, it remains a distinct, separate management unit, as its assets have not yet been integrated into ENE; and

(e) Gabinete de Aproveitamento do Medio Kwanza (GAMEK). GAMEK was created in 1982 with the two immediate goals of coordinating and supervising the work to be done at Capanda and defining a development plan for the Middle Kwanza. Over the long term, GAMEK will be in charge of all works related to the exploitation of the hydro resources of the Middle Kwanza basin and any new major hydrogeneration investments in the Northern System.

NATURAL GAS

A limited task force attached to the Oil Production/Reserves Management in SONANGOL deals specifically with the supply aspects of the gas industry. It monitors appraisal and feasibility studies requested by oil companies operating in Angola or presented by foreign companies and consultants.

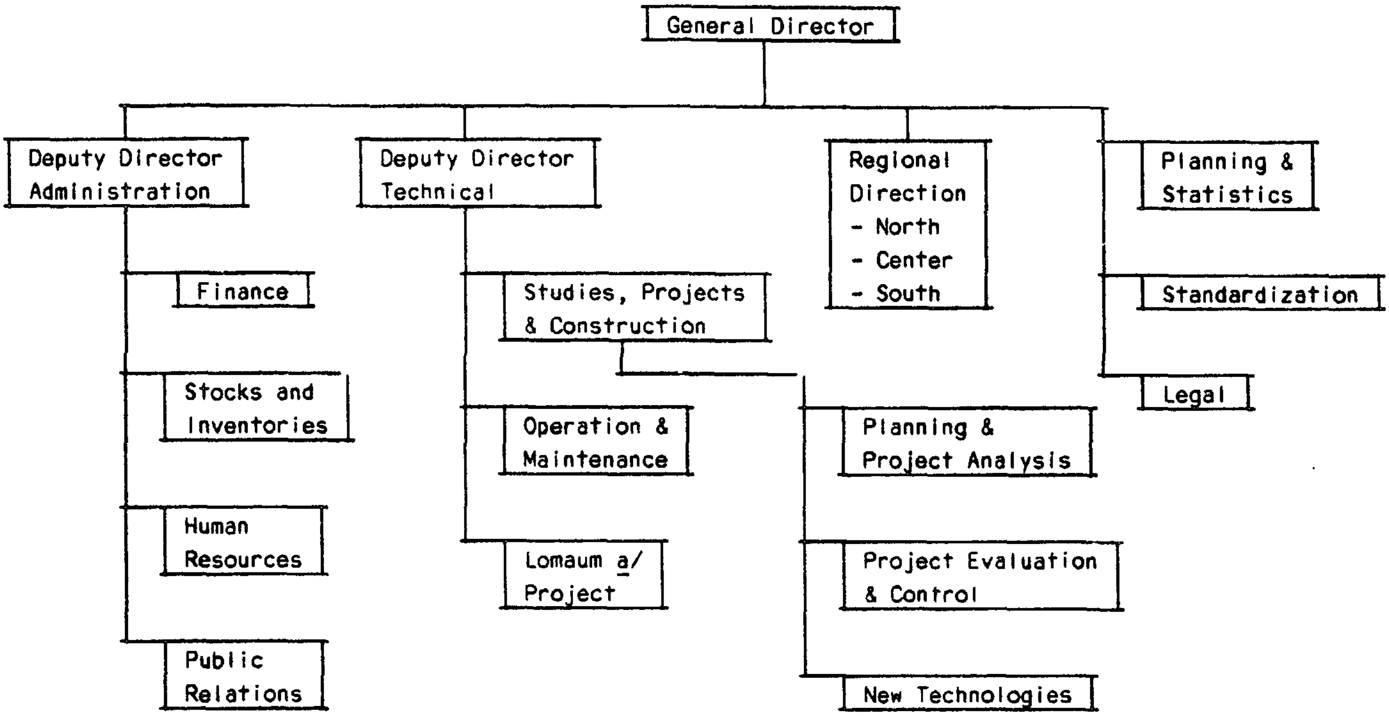
FORESTRY/WOODFUELS

The Ministry of Agriculture has a Vice Minister in charge of forestry but no separate forestry department. Within the Ministry, the National Directorate for the Conservation of Nature (DNACO) is the body responsible for regulating the exploitation of firewood. It has provincial representation and issues licences to parties wishing to engage in woodfuel production.

The Department of New and Renewable Sources of Energy (DNRFE) within the MEP was created in 1981 and is mainly a research body with no provincial representation at the field level. Its main objectives are research and transfer of technology in new, renewable, and non-conventional forms of energy.

EMPRESA NACIONAL DE ELECTRICIDADE (ENE)

Organization Chart. Present Central Structure



a/ Temporary, related to rehabilitation of the Lomaum hydro plant.

Source: ENE.

PROPOSED ORGANIZATION OF THE POWER SUBSECTOR

Organization Chart

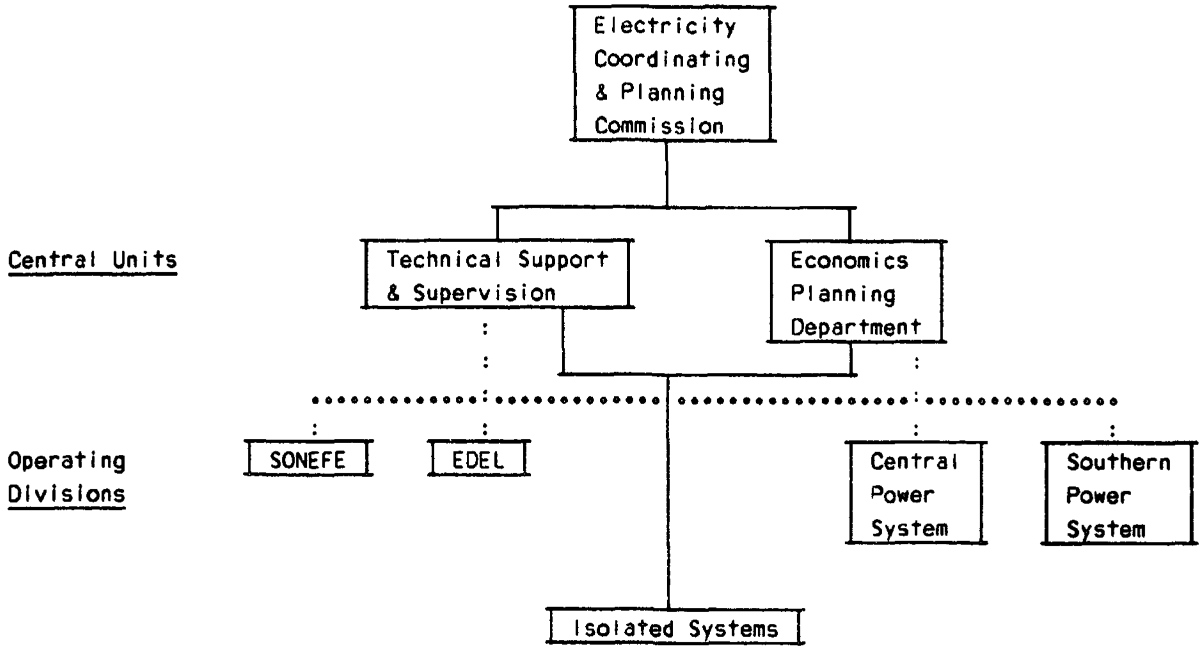


Table 1: ANGOLA ENERGY BALANCE: 1986
(In '000s toe)

	Primary Energy						Petroleum Products							
	Fuelwood	Natural Gas	Hydro Elect	Crude Oil	Char-coal	Electri-city	LPG	Gasoline/ Naphtha	Kero-sene	Aviation Fuel	Diesel Oil	Fuel Oil	Total	Line Totals
Gross Supply														
Production	2,074 a/	3,418	173	14,102									0	19,765
Imports							12			116	16		144	144
Primary Exports		(177)		(12,637)									0	(12,814)
Stock Changes b/				33			(10)	(12)	(11)	4	(7)	(34)	(48)	(15)
Total avail. supply	2,074	3,241	173	1,498	0	0	2	(12)	(11)	120	9	(34)	96	7,080
Conversion														
Petroleum refining				(1,445)			20	130	36	174	344	658	1,362	(83)
Non-energy use		(3,241) c/		(53) d/									0	(3,294)
Charcoal production	(364)				364								0	0
Electric power generation		e/	(173)			188					(15)		(15)	0
Conversion losses b/	(892) a/					(125)							0	(1,017)
Trans. & distr. losses						(14)							0	(14)
Net supply available	816	0	0	0	364	49	22	118	47	294	338	624	1,443	2,672
Secondary exports								(13)			(6)	(508)	(527)	(527)
Bunker sales										(29)	(6)	(2)	(37)	(37)
Net domestic consumption	816	0	0	0	364	49	22	105	47	265	326	114	879	2,108
Consumption by sector														
(not available)														
Industry														
Transport														
Households/Public														
Agriculture														
Other														

a/ Refer to Annex 8, Table 2, for assumptions.
b/ Includes statistical discrepancies, stock draw (or build).
c/ Either flared or reinjected. 188 MMCFD (1,695,000 toe).
d/ Includes 7,253 Tons of asphalt and 45,452 tons of crude for field use.
e/ An unknown amount of natural gas is used for generating electricity.

Source: MEP and mission estimates

COMMODITY BALANCE - FUELWOOD

FIREWOOD

	Consumption '000 tons/y	'000s toe
Urban	72	24
Periurban	190	65
Rural	1,600	544
Subtotal	1,862	633
Heating a/	360	122
Industry b/	180	61
Total	2,402	816

Conversion Factor: 0.34 toe/ton firewood.

a/ Approximately 3.0 million use 1 kg/d for 4 months.
3 x 1 x 4 x 30 = 360,000 tons.

Conversion: 360 x 0.34 toe/ton = 122,000 toe.

b/ Industrial use of firewood is equivalent to: 10% firewood in urban and periurban households and 5% firewood in rural households.

POPULATION:		
	Urban	2.5 million
	Periburban	1.5 million
	Rural	5.0 million
	Total	9.0 million

COMMODITY BALANCE - FUELWOOD

CHARCOAL

	Consumption '000 tons/y	'000s toe
Urban	115	79
Periburban	103	71
Rural	226	156
Subtotal	444	306
Heating a/	84	58
Total	528	364

Conversion Factor: 0.69 toe/ton charcoal.

a/ Approximately 1.0 million use 0.7 kg/d for 4 months
1 x 0.7 x 4 x 30 = 84,000 tons.

Conversion: 84 x 0.69 toe/ton = 58,000 toe.

For conversion of charcoal into toe of firewood, it is assumed that 7 kg of firewood is equivalent to 1.0 kg charcoal.

	CHARCOAL '000s tons	FIREWOOD '000s tons	'000s toe
Urban	115	805	273
Periurban	103	721	245
Rural	226	1,582	538
Heating	84	558	200
Total	528	3,696	1,256

Conversion factor: 0.34 toe/ton firewood. Therefore 1,256 toe are needed to produce 364 toe charcoal. Hence, total fuelwood production:

	'000s toe
Firewood	816
Charcoal	1,256
	2,072

COMMODITY BALANCE - NATURAL GAS

Production (1986): 379 MMCFD.

$$1 \text{ ft}^3 = 0.0283168 \text{ m}^3$$

Calorific content of natural gas: 8.9×10^3 kcal/m^3

$$379 \times 10^6 \text{ ft}^3 \times 365 \text{ days} = 138{,}335 \times 10^6 \text{ ft}^3/\text{y}$$

$$138{,}335 \times 10^6 \times 0.0283168 = 3{,}912.20 \times 10^6 \text{ m}^3$$

Calorific content:

$$8.9 \times 10^3 \times 3{,}912.20 \times 10^6 \text{ kcal} = 34{,}863.12 \times 10^9 \text{ kcal}$$

$$10.6 \times 10^6 \text{ kcal} = 1 \text{ toe}$$

$$\frac{1 \times 34{,}863.12 \times 10^9 \text{ kcal}}{10.2 \times 10^6 \text{ kcal}} = 3{,}417.9 \times 10^3 \text{ toe}$$

Equal to 3,418,000 toe

Consumption (1986): 191 MMCFD.

Therefore, amount of natural gas flared:

$$(379-191) \text{ MMCFD} = 188 \text{ MMCFD}$$

$$\frac{188 \text{ MMCFD} \times 10^6 \times 365 \times 0.0283168 \times 8.9 \times 10^3 \times 1}{10.2 \times 10^6} = \text{toe}$$

Equal to 1,695,000 toe

COMMODITY BALANCE - ELECTRICITY

HYDRO

Systems	GWh
North	595
Central	40
South	56
Total Generation	691

1 MWh = 859,845 kcal

Calorific content: $$\frac{691 \times 10^3 \times 859{,}845 \times 10^3 \times 1}{10.2 \times 10^6}$$

Equal to 58,250.28 toe, or 58,000 toe

THERMAL

Systems	GWh
North	21
Central	41
South	0
Total Generation	62

1 MWh = 859,845 kcal

Calorific content: $$\frac{62 \times 10^3 \times 859{,}845 \times 10^3 \times 1}{10.2 \times 10^6}$$

Equal to 5,226.51 toe, or 5,000 toe

CONVERSION INTO PRIMARY ENERGY

Hydro

Conversion factor: 0.25 toe/MWh.

$691 \times 10^3 \times 0.25 = 172.75 \times 10^3$ toe = 173,000 toe

Thermal

Conversion factor: 1 MWh = 0.248 toe at 34% efficiency in thermal (oil) generation.

$62 \times 10^3 \times 0.2248 = 15.3 \times 10^3$ toe = 15,000 toe

Total Electric Power Generation (Hydro + Thermal)

(173,000 + 15,000) toe = 188,000 toe

Conversion Losses

Conversion loss (hydro) + conversion loss (thermal):

[(173,000 - 58,000) + (15,000 - 5,000)] toe = 125,000 toe

Transmission and Distribution Losses

Total generation: 753 GWh.
22% transmission and distribution losses.

$753 \times 0.22 = 165.66$ GWh

$$\frac{165.66 \times 10^3 \text{ MWh} \times 859{,}845 \times 10^3 \text{ kcal} \times 1}{10.2 \times 10^6 \text{ kcal}}$$

Equal to 13,964.89 toe, or 14,000 toe.

COMMODITY BALANCE - PETROLEUM

	'000s tons	Conv. Factor	'000s toe
PRODUCTION			
Crude	14,102	1.00	14,102
IMPORTS			
Average Fuel	114,184	1.02	116,467
Gasoil	16,435	0.99	16,270
LPG	10,913	1.06	11,567
PRIMARY EXPORTS			
Crude	(12,637)	1.00	(12,637)
LPG	(166,782)	1.06	(176,788)
REFINING			
Average fuel	171,064	1.02	174,485
Crude	(1,452)	1.00	(1,452) a/
Fuel oil	685,767	0.96	658,336
Gasoil	347,288	0.99	343,815
Gasoline/Naphtha	126,146	1.03	129,930
Kerosene	35,637	1.01	35,993
LPG	18,690	1.06	19,810
NON-ENERGY USE			
Asphalt	7,253	0.99	7,180
Crude	45,452	1.00	45,452
SECONDARY EXPORTS			
Gasoil	5,642	0.99	5,585
Gasoline/Naphtha	11,544	1.03	11,890
Fuel oil	528,766	0.96	507,615
BUNKER SALES			
Average fuel	28,920	1.02	29,498
Fuel oil	2,600	0.96	2,496
Gasoil	5,850	0.99	5,791
STOCK CHANGES +/(-)			
Average fuel	4,222	1.02	4,306
Crude	33,277	1.00	33,277
Fuel oil	(35,201)	0.96	33,792
LPG	(9,621)	1.06	(10,198)
Gasoil	(7,461)	0.99	(7,386)
Gasoline/Naphtha	(10,492)	1.03	(10,806)
Kerosene	10,673	1.01	10,779

a/ Figure quoted is net of asphalt, i.e., (1452 - 7) = 1,445 thousand toe.

Table 1: SELECTED FIGURES ON THE PETROLEUM SECTOR a/

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Annual Growth Rate 1978-86
Crude oil production (in '000s bbl/d)	163	172	94	102	128	156	164	136	128	130	179	205	233	282	7.9%
Export revenues from crude oil (in million current US$)	233	n.a	n.a	n.a	n.a	550	902	1,391	1,357	1,234	1,526	1,749	1,896	1,150	10.1%
Deflator b/	34.7					68.9	81.4	100.0	103.4	98.7	95.1	93.2	90.5	87.6	
Deflated revenues from crude oil (in million US$)	n.a	n.a	n.a	n.a	n.a	798	1,108	1,391	1,403	1,218	1,451	1,583	1,661	976 c/	3.9%
Export revenues from crude oil as % of GDP	n.a	n.a	n.a	n.a	n.a	20.0	27.1	38.5	34.5	33.8	36.2	37.1	39.2	26.1	3.6% c/
Factor income transferred abroad d/ as % of revenue from exports	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	11.3	11.1	11.3	12.1	16.8	9.2% e/

a/ Using least square estimates.
b/ Import unit values, International Financial Statistics.
c/ Estimates.
d/ Attributable to the petroleum sector.
e/ Growth rate 1982-1986.

Source: MEP and mission estimates.

Table 2: TOTAL INVESTMENTS IN PETROLEUM SECTOR
(In million US$)

Year	Exploration	Develop	Other	Total	SONANGOL	%
1980	49.1	49.5	103.0	201.6	76.4	37.9
1981	89.0	64.6	172.7	326.3	108.9	33.4
1982	200.7	311.6	(46.5)	465.8	132.7	28.5
1983	218.8	187.7	3.2	409.7	91.2	22.3
1984	92.3	237.9	34.6	364.8	86.5	23.7
1985	186.7	292.4	43.4	522.5	100.2	19.2
1986	104.2	329.0	-	433.2	62.7	14.5
Total	940.8	1,472.7	310.4	2,723.9	658.6	24.2

Source: SONANGOL.

Table 3: TOTAL INVESTMENTS BY AREA - 1980-86
(In million US$)

	Exploration	Development	Other	Total	%
Cabinda Offshore	49.0	653.4	114.0	816.4	30.0
Onshore Angola	35.6	134.8	71.6	242.0	8.9
of which : A	11.8	34.2	6.9	52.9	
B	23.8	100.6	64.7	189.1	
Block 1	186.2	-	29.9	216.1	7.9
Block 2	195.9	270.4	26.7	493.0	18.1
Block 3	402.0	413.9	62.5	878.4	32.2
Block 4	72.1	-	5.9	78.0	2.9
Total	940.8	1,472.5	310.6	2,723.9	100.0

Source: SONANGOL

Table 4: CRUDE OIL PRODUCTION BY BASIN
(In '000s bbl/d)

	1980	1981	1982	1983	1984	1985	1986
Cabinda	90	86	80	130	159	165	190
Kwanza	3	4	5	5	4	4	3
Congo	42	40	45	43	41	63	89
Block 2	2	5	13	12	9	7	6
Block 3	-	-	-	-	-	24	50
Onshore A	2	1	1	1	1	1	1
Onshore B	38	34	31	30	31	31	32
Total	134	130	130	179	205	232	282

Source: SONANGOL.

Table 5: CRUDE OIL OPERATING COSTS a/

	1982	1983	1984	1985	1986
Total (in US$ million)					
Block 2	8.4	7.8	6.5	4.6	2.1
Block 3	-	-	-		13.036.4
Onshore A	11.1	10.8	8.1	8.9	9.8
Onshore B	20.8	24.6	18.0	17.3	14.4
Cabinda	209.0	229.6	124.6	113.6	117.1
Per barrel (US$)					
Block 2	1.8	1.8	1.9	1.8	0.9
Block 3	-	-	-	1.5	2.0
Onshore A	5.3	4.8	4.1	4.9	6.5
Onshore B	1.8	2.2	1.6	1.5	1.2
Cabinda	7.1	4.8	2.2	1.9	1.7

a/ Not including expenses for exploration and development.

Source: SONANGOL.

Table 6: SUMMARY OF MAIN OIL DISCOVERIES IN ANGOLA

Name	Discovery	Bbl/d average first 6 months	Cumulative million bbl to 01-JUL-86
Offshore Cabinda			
Takula	1982	107,350	91.3
Malongo West	1967	16,900	220.6
Malongo North	1966	14,500	203.0
Kungulo	1975	13,150	37.2
Limba	1969	12,400	79.3
Vuko	1983	10,500	2.0
Malongo South	1966	8,200	67.5
Kambala	1971	7,800	13.9
Others		2,090	6.4
TOTAL		192,890	721.1
Onshore			
N'Zombo	1973	13,000	81.1
Quinguila	1972	7,500	28.6
Quinfuquena	1975	5,100	21.7
Quenguela	1968	2,500	36.0
Ganda	1975	2,500	4.3
Lumueno	1977	2,300	2.2
Pambo	1982	850	1.6
Luango	1977	800	1.6
Other		1,334	48.0
TOTAL		35,884	224.8

		Bbl/d average 1986	Cumulative million bbl to 31-DEC-86
Block 2			
Essungo	1975	5,930	17.7
Cuntla	1978	170	2.2
Total		6,100	19.9
Block 3			
Palanca	1981	39,900	23.2
Pacaca	1982	9,700	3.5
Total		49,600	26.7

Source: SONANGOL and "Oil and Gas Journal".

Table 7: NATURAL GAS RESERVES AND PRODUCTION
Associated Gas Production (MMCFD)

Area	1984	1985	1986	1988 (Forecast)	1990 (Estimate) a/
Cabinda	280	277	305	305	335-355
Congo	12	12	13	8.5	6-7
Kwanza	5	6	5.5	3	3
Block 2	15	15	11.5	41	41
Block 3	-	23	44	100	130
TOTAL	312	333	379	458	515-536

a/ Mission estimate.

Source: SONANGOL.

Probable and possible reserves of non-associated gas or gas associated with condensates in Blocks 2 and 3.

Block 2 a/	Etele	600 BCF
	Sulele	210 BCF
	Garoupa	280 BCF
	Lua	320 BCF
	Polvo	530 BCF
Block 3 b/	Punja	4,040-650 BCF

a/ Plus Maleva North and Prata South
b/ Plus Buffalo North (minimum, 2,340-2,590 BCF)

Source: SONANGOL.

Table 8: ASSOCIATED GAS UTILIZATION
Associated Gas Utilized
(MMCFD)

Area	1984	1985	1986	1988 (Forecast)	1990 (Estimate) a/
Cabinda	135	145	180 b/	215	245-265
Congo	3.5	4.5	4	7 c/	6-7
Kwanza	1	1	1	1	1
Block 2	0.5	0.5	0.5	31	31
Block 3	-	3	4.5 a/	8 a/	70 d/
TOTAL	140	154	191	262	353-374
% Utilization	45	46	51	57	69-70

a/ Mission estimate.
b/ Breakdown: 21 for own fuel, 11.7%; 67 for reinjection, 37.2%;, 92 for gas lift, 51.1%; and others.
c/ Soyo Power Plant Project having started-up before that year.
d/ Based on assumption that the reinjection scheme for Impala South East will have started up before 1990.

Source: SONANGOL.

THE PETROLEUM LAW

On September 6, 1978 a law consisting of 30 Articles governing all petroleum activities in Angola was enacted. Petroleum Law 13/78 sets general principles rather than regulatory details and establishes that:

- Ownership of hydrocarbons, underground, is vested in the State.

- SONANGOL is the only company to whom exploration and production rights can be granted (existing concessions at the time of enactment of the Law were declared invalid).

- The Council of Ministers has approval over future concession areas.

- Exploration and production rights are granted for fixed terms on a case-by-case basis.

- Mining activities are to be carried out in accordance with modern petroleum industry practices.

- SONANGOL may enter into arrangements with financially and technically capable oil companies to carry out exploration and production activities.

- Petroleum agreements can take the form of joint ventures (associations between SONANGOL and a foreign company with each partner having rights and obligations in proportion to their participating interests in the venture), production sharing agreements (service contracts between SONANGOL and foreign companies), and commercial companies. In all cases there should be a joint management body in charge of operations, and SONANGOL will have a minimum of 51% participation except where the water depth in the contract area exceeds 150 meters.

- Where no commercial discovery is made, companies will have no right to recover investments. In other cases, they will have the right to recover expenses and realize profits in accordance with their contractual terms. Beyond the wellhead, title to their share of the oil produced will pass on to the companies.

- In exceptional cases, the Council of Ministers can authorize contractual terms different to those outlined above.

- Disputes will be solved by arbitration, in Angola, in accordance with procedures agreed upon between SONANGOL and the foreign company.

The Law is concise, yet general in nature, making it a flexible instrument in contract negotiations. A model production sharing agreement exists detailing the rights and obligations of each party, leaving only the main parameters, such as work program and financial terms, open for negotiations.

TAXATION OF THE PETROLEUM SECTOR

(a) Investment Sharing Operations (Joint Ventures)

The fiscal regime which applies to joint ventures between SONANGOL and foreign oil companies and thus mainly effects the concessions for Cabinda, was originally established by Decree No. 5/84 of March 28, 1984 and comprises:

(a) a 20% tax on production ("royalty");

(b) a 65.7% tax on income; and

(c) a 70% tax on "excess profits" (transaction tax).

Taxes on production and petroleum transactions are deductible from the tax base for income taxation. In the case of the transaction tax, provisions are made for production and investment incentives which are deductible from net revenues (profits = gross revenues minus costs) as far as they are subject to taxation. Thus, in a simplified manner, Government's total tax income, denoted as "T", accruing from joint ventures, can be broken down into the following components:

$$\text{Production tax} = t_p \, px$$

$$\text{Transaction tax} = t_t \, (px - cx - ix - zx)$$

$$\text{Income tax} = r \, [(1 - t_p) \, px - cx - t_t (px - cx - ix - zx)]$$

where:

p = price of crude oil (US$/bbl);

x = crude oil output (bbl);

c = unit production costs (US$/bbl);

i = production incentive (US$/bbl);

z = investment incentive (US$/bbl);

t_p = production tax rate (%);

t_t = transaction tax rate (%); and

r = income tax rate (%).

It is to be noted that Angola's total take is the sum of the taxes that accrue to the Government and SONANGOL's profits (net of taxes).

Assuming that the production incentive (which, in practice, is adjusted to production costs) and the investment incentive (which is a fraction of total historic investment costs) are linear in "x", then the change in total tax revenues that is due to a marginal increase in prices and/or quantities can be calculated by applying the following formula:

$$dT = x\,[(1 - r)\,(t_p + t_t) + r]\,dp +$$

$$p\,[t_p + r\,(1-t_p) - \frac{rc}{p} + t_t\,(1-r)\,(\frac{p-c-i-z}{p})]\,d\,x$$

$$\text{with } p - (\frac{c-i-z}{p}) = 0 \text{ for } (p-c-i-z) \leq 0$$

Thus, the marginal change in tax income that results from a change in gross oil revenues can be split up into:

(a) a price effect ($dp >< 0$, $dx = 0$), which is equal to a constant fraction of the price-dependent change in gross revenues (xdp); and

(b) a quantity effect ($dx >< 0$, $dp = 0$), which is equal to a constant fraction of the quantity-dependent change in gross revenues (pdx).

In particular, unless production costs are zero and "i" and "z" happen to be sufficiently small (relative to the price of oil) to be negligible, the price effect will be more pronounced than the quantity effect. In fact, at the prevailing tax rates one obtains:

$$\frac{dT}{dp} = 0.966\,.\,x \qquad \text{for } dx = 0$$

Supposing that "i" = US$8/bbl; that "z" = US$1.50/bbl; and that "c" = US$5.50/bbl (which is roughly in line with the current cost and incentive structure of the Cabinda concessions) and taking into account a per barrel price of US$17 (which is the Government projection for 1988), then the quantity effect works out at follows:

$$\frac{dT}{dx} = 0.542.\,p \qquad \text{for } dp = 0$$

Thus, if prices are declining, output must grow at a rate exceeding the rate of price erosion in order to keep the tax income at a given level. However, the higher the level of oil prices (relative to the level of costs), the more pronounced will be the quantity effect. For instance, at "p" = US$40/bbl, the quantity effect works out at 0.786.p.

While marginal tax income is linear for output and prices, the average tax income tends to increase with oil revenues (progressive tax system).

Let AT = T/px denote the average tax earnings, then

$$d\,(AT) = [\,[\,(1-r)\,t_t\,(c+i+z) + rc\,]\,p^{-2}\,]\,dp$$

Obviously, the average tax income is increasing at a decreasing rate, and the higher the level of production or the price level, the lower will be the increase in average tax income that is due to a price-dependent rise in (gross) oil revenues.

For instance, in the case of the parameter configuration presented above, one obtains:

$$d\,(AT)\,/\,dp = 0.025$$

$$\text{with } AT = 0.581$$

Thus, a doubling of the petroleum price, i.e., an increase from US17/bbl to US$34/bbl, will raise the Government's income share from gross revenues by 42.5%. In other words: Government's take will increase from a 58.1% share to an 82.8% share of total revenues.

It can therefore be concluded that, in the case of joint ventures the main objective of the taxation system is to capture windfall profits accruing from rising oil prices. On the other hand, if prices are decreasing or constant, the tax regime tends to protect the oil companies, i.e., lower prices result in a lower ($dp < 0$) or stagnant Government share ($dp = 0$) of income from oil revenues.

(b) Production Sharing Operations

Basically, the production-sharing type of agreement that has become fashionable in many countries during the last 10 years works as follows:

(a) SONANGOL subcontracts--on behalf of the Government--the operational services of a foreign oil company;

(b) exploration is financed and carried out by the foreign company at its own risk, i.e., exploration costs will be reimbursed only if there is a commercial discovery. (A commercial well is defined as being capable of producing a minimum number of bbl/d for a given water depth, i.e., 1,000 bbl/d for a depth of less than 50 meters, 1,500 bbl/d for a depth between 50 and 100 meters, etc.);

(c) in case of a commercial discovery, the foreign company finances and undertakes the development of the reserves as approved by the Government;

(d) the subcontractor recovers his costs by taking a percentage share of total production ("cost oil"), while the remainder ("profit oil") is split between the foreign oil company and SONANGOL on a sliding scale basis linked to cumulative output; and

(e) the foreign company's remuneration is taxed at special rates.

The key issues to be negotiated are the work program (tasks and finance) and the production splits. In the past, the foreign companies' exploration commitments included a minimum number of wells (e.g., six) to be drilled within a predetermined period of time (e.g., three years). Any extension of the exploration period was subject to additional drilling obligations. Fields with commercial discoveries had to be developed within another three years. Thus, SONANGOL's interest in subcontracting foreign companies is to achieve a maximum number of drillholes and discoveries within the shortest period of time, without taking any of the risk involved in the operations.

As soon as production starts the contractor is allowed to recoup his expenses from total output. Cost oil may account for up to 50% of annual production and includes:

(a) operating costs recovered on a recurrent basis;

(b) administration expenses;

(c) development costs recoverable over a period of four years with a 33.3% "uplift"; and

(d) exploration costs recovered from the unused balance of cost oil.

Excess recoverable costs are rolled over to the next year.

What is left over after costs have been recovered (including the unused share of cost oil) constitutes the annual profit oil. Clearly, once all major expenses have been reimbursed, the share of profit oil tends to exceed the 50% level. This situation generally applies to, say, the first five to six years of oil production.

In Angola profit oil splits between SONANGOL and a foreign company are based on a field-specific scale of cumulative production rates. This scheme avoids the shortcomings involved in the more common approach of fixing production thresholds on a daily or monthly basis, thus providing a disincentive to increase the production rate when a lower share in profits is entailed. A representative example of Angola's sliding scale scheme is given in the following table.

Table 1: SLIDING SCALE FOR PROFIT OIL SHARING

Cumulative Production (Million bbl)	Profit Oil (%) SONANGOL	Contractor
0-25	40	60
25-50	70	30
50-100	80	20
>100	90	10

A unique feature of Angola's production sharing agreements is the "price cap" provision which acts as a 100% tax on "excess" profits, defined by the extent to which the price of oil exceeds a particular pre-established upper limit. Initially, the price limit was set at US$13/bbl (in 1978 prices) and adjustments were to be made in accordance with changes in the U.N. index for manufactured goods. Since, in the meantime, real oil prices have declined below the 1978 level, the limit has been increased to US$26/bbl. However, under the current conditions this ceiling does not affect the oil company's profits.

If the profit sharing agreements (PSAs) were implemented in accordance with the terms set forth in the late 1970s, no tax would apply to foreign oil companies. However, in order to take advantage of U.S. tax credit laws TEXACO requested a change in the PSAs. Under the revised contractual setting, the foreign oil companies of Block 2 and 3 pay a 50% income tax to Angola on a nominal share that exceeds the initially agreed share in profit oil by 100%. The "grossing up" involved in this scheme is financed by SONANGOL out of its own share in profit oil.

Basically, this accounting system does not change the agreed split in profit oil, i.e., Angola's take from the profit oil is invariably equal to SONANGOL's share. However, it affects the Government's tax income from PSAs.

If P is the profit oil, "s" the foreign company's share in profit oil with 1>5>0, and "r" the income tax rate, then Government tax revenues from the grossing-up scheme are determined by:

$$T = (\frac{1}{1-r}) - 1)\ s\ P + r\ [\ (\frac{1}{1-s})\ P) - (1-r) - 1)\ s\ P]$$

$$= r\ P$$

It there were no income tax on the foreign companies' profit oil and, thus, no grossing-up financed by SONANGOL, the tax income would amount to

$$T = r\ (1-s)\ P$$

Thus, under the current tax-contract system, Government captures 50% of the total profit oil, while in the absence of the grossing-up scheme, Government would only receive 50% of SONANGOL's share in profit oil. In the meantime, however, the liberalization of U.S. tax laws has erased the double taxation problem so that foreign oil companies have become less interested in the option of transferring tax payments to Angola. Moreover, SONANGOL fears that it may no longer be in the position to finance the grossing-up of the foreign oil companies' share in profit oil as soon as cost oil accounts for a significantly lower share in total production than during the initial years of operation. Therefore, SONANGOL has suggested exempting foreign oil companies operating under PSAs from the Angolan income tax. Not surprisingly, Government is not very happy with the proposal. In particular, the Ministry of Finance feels that the income tax on profit oil should even be increased to 65%, a rate that would be in line with the general tax laws applying to the industrial sector (as well as to joint ventures with foreign oil companies).

In fact, the basic problem is that the very logic of PSAs does not fit well with the Government's current very pressing revenue needs. While PSAs provide an incentive framework with a progressive system of sharing that works best if the investment expenditure of foreign oil companies are reimbursed as fast as possible, Government would prefer that the PSAs work as if the initial risk in exploring and developing the oil reserves were shared as in joint ventures. Moreover, PSAs require a "strong" treasury in the host country. In the case of Angola, however, the treasury is in a comparatively weak position, struggling with fiscal legislation that is not adjusted to a modern tax-contract system like the PSAs, and relying exclusively on the supervisory function that SONANGOL has to assume towards foreign oil companies. This dependency on SONANGOL, coupled with the fact that Angola's take of the oil revenues from PSAs is not yet readily available and, in addition, has to be shared between the Government and SONANGOL, creates a potential for conflict.

FINANCIAL ANALYSIS OF THE AMMONIA/UREA PLANT

Assumptions

A. Limited absorptive capacity of the national market. In recent years not more than 10,000 t/y of nitrogen fertilizers have been consumed in Angola.

B. Prices. Angolan border prices for ammonia are assumed to develop as follows:

			Year 1995	Year 2000
Ammonia	FOB	Angola	200	215
Urea	FOB	Angola	200	210

Source: Mission estimates.

C. The economic value of gas consists of two components, the production cost and the depletion value for gas in the field. The production cost is the cost of extracting the gas and shipping it to the plant gate. In the present context, the depletion value is defined as the discounted cost of using an alternative source of energy at some future date when the currently available reserves will be depleted. The depletion value is calculated by assuming that the gas production costs of the "backstopping" fields amount to US$2.50/MMBTU. The considered range for current production cost has been allowed to vary between US$1.25 and US$2.00/MMBTU.

The domestic market could possibly absorb not more than the equivalent of the production of a 100-200 t/d ammonia plant, even taking a confirmed recovery of agriculture into account. However, economies of scale only justify setting up a plant with the minimum capacity of 1,000 t/d of ammonia. The analysis is therefore based on a layout with a nominal capacity of 1,500 t/d of ammonia and 500 t/d of urea.

The project will require an investment of a minimum of US$330 million (at 1987 prices) for the basic equipment and all surrounding facilities, excluding working capital requirements.

At best the plant could operate at a 90% capacity utilization level (329 full operating days per year) which, by international standards, is only reached in a few very well operated plants. A maximum capacity utilization of 80% would be more likely. Producing 500 t/d of urea is equal to a yearly capacity of 182,500 tons of urea. Four hundred and forty thousand tons of excess ammonia is obtained at this production level.

The Economic Rate of Return (ERR) for the project has been calculated in two ways, i.e., excluding or including the depletion value of gas. As it turns out, the depletion value has only a minor effect on the project's viability. Therefore, the sensitivity analysis can roughly be based on figures which exclude the depletion value of gas.

Assuming a low gas production cost of US$1.25/MMBTU, then the economic rate of return on investment works out as follows:

12.72% ERR	in the Base Case (no depletion costs)
8.49% ERR	in Case C (lower annual capacity utilization and lower product prices), which is the least favorable alternative to the Base Case.

Taking into account the scarcity of capital in Angola, the target discount rate should be set at 15% or higher.

The effect of lower capacity utilization on the ERR is greater than the effect of lower world market prices. Taken together the impact on the ERR is considerable.

The sensitivity analysis on product prices and/or utilization of capacity shows very low or negative economic values for gas at the wellhead (gas netback value). In particular, at discount rates of 10% and more the netback values fall below the production cost of gas.

Taking into consideration the low economic returns of the project, the probability of low capacity utilization, and the uncertainties involved in the future of product prices, the project cannot be considered economically viable.

The following cases have been analyzed:

Base Case	Maximum capacity utilization at 90% (equivalent to 329 full operating days/year), with or without depletion costs.
Case A	As Base Case with maximum capacity utilization at 80% (equivalent to 292 full operating days/year).
Case B	As Base Case with product prices decreased by US$15/t.
Case C:	Combination of Cases A and B.

Table 1: AMMONIA/UREA PROJECT
Financial Analysis

1st Year: 1988 Lifetime: 20 years
Start up: 1992 Project capacity: 182,500 tons of urea, 440,000 tons of ammonia

Year	Invest-ment	Oper. rate	UREA Output	AMMONIA Output	UREA Price	AMMONIA Price	Total Sales	Fxd.Cost 22	Var.Cost 5	Net income a/	Gas Cons
	MM US$	(%)	'000s t	'000s t	US$/t	US$/t	MM US$	MM US$	MM US$	MM US$	BCF
1988	33	0%	0.0	0.0			0.00	0.00	0.00	-33.00	0.00
1989	95	0%	0.0	0.0			0.00	0.00	0.00	-95.00	0.00
1990	123	0%	0.0	0.0			0.00	0.00	0.00	-123.00	0.00
1991	139	0%	0.0	0.0			0.00	0.00	0.00	-139.00	0.00
1992	19	65%	118.6	286.0	188	188	76.07	22.00	3.25	31.82	12.03
1993	0	85%	155.1	374.0	192	192	101.59	22.00	4.25	75.34	15.73
1994	0	90%	164.3	396.0	196	196	109.81	22.00	4.50	83.31	16.65
1995	0	90%	164.3	396.0	200	200	112.05	22.00	4.50	85.55	16.65
1996	0	90%	164.3	396.0	202	203	113.57	22.00	4.50	87.07	16.65
1997	0	90%	164.3	396.0	204	206	115.08	22.00	4.50	88.58	16.65
1998	0	90%	164.3	396.0	206	209	116.60	22.00	4.50	90.10	16.65
1999	0	90%	164.3	396.0	208	212	118.12	22.00	4.50	91.62	16.65
2000	0	90%	164.3	396.0	210	215	119.63	22.00	4.50	93.13	16.65
2001	0	90%	164.3	396.0	211	217	120.59	22.00	4.50	94.09	16.65
2002	0	90%	164.3	396.0	212	219	121.55	22.00	4.50	95.05	16.65
2003	0	90%	164.3	396.0	213	221	122.50	22.00	4.50	96.00	16.65
2004	0	90%	164.3	396.0	214	223	123.46	22.00	4.50	96.96	16.65
2005	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2006	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2007	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2008	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2009	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2010	0	90%	164.3	396.0	215	225	124.41	22.00	4.50	97.91	16.65
2011	-39	90%	164.3	396.0	215	225	124.41	22.00	4.50	136.91	16.65

a/ Not including the economic costs of gas.

Table 2: ECONOMIC RATE OF RETURN

At gas prod. cost (US$/MMBTU)	Base Case I a/	Base Case II b/	Case A b/ Lower capacity	Case B b/ Lower prices	Case C b/ Lower capacity and prices
1.25	11.52%	12.72%	10.09%	11.09%	8.49%
1.50	10.86%	11.92%	9.21%	10.24%	7.55%
1.75	10.22%	11.10%	8.30%	9.37%	6.58%
2.00	9.61%	10.26%	7.35%	8.46%	5.55%

a/ Including gross depletion costs.
b/ Excluding gross depletion costs.

Source: Mission calculations.

Gas netback value (in MM US$)

	Discount Rates				
	5%	10%	12%	15%	20%
Base Case	3.30	2.07	1.48	0.50	-1.32
Case A	2.58	1.27	0.68	-0.30	-2.12
Case B	2.88	1.52	0.97	0.00	-1.83
Case C	2.13	0.83	0.23	-0.74	-2.56

Source: Mission calculations.

FIGURES ON THE PETROLEUM PRODUCT SUBSECTOR

Table 1: ANGOLA PETROLEUM SUPPLY - DISPOSITION BALANCE - 1980-86
(In '000s tons)

		1980	1981	1982	1983	1984	1985	1986
PRODUCTION	Crude	6,710.0	6,470.0	6,520.8	8,949.6	10,228.1	11,599.6	14,101.5
	LPG	0.0	0.0	0.0	97.8	167.7	165.8	177.0
IMPORTS	LPG	6.9	6.0	9.2	6.0	6.8	11.7	10.9
	Jet fuel	0.0	7.8	39.8	24.9	62.9	102.6	114.2
	Gasoil	0.0	0.0	0.0	0.0	23.7	36.7	16.4
	Total Products	6.9	13.8	49.0	30.9	93.4	151.0	141.5
REFINING	Crude	-1,237.5	-1,240.7	-1,014.3	-1,300.6	-1,380.5	-1,451.3	-1,452.2
	LPG	11.7	12.8	13.0	17.3	17.7	18.3	18.7
	Gasoline	89.6	85.2	84.4	92.3	103.6	103.5	104.7
	Naphtha	0.0	0.0	0.0	4.6	4.0	9.9	21.5
	Kerosene	33.0	34.8	31.6	32.1	39.7	45.6	35.6
	Jet fuel	118.6	127.0	99.5	143.5	161.9	172.8	171.1
	Gasoil	294.7	308.6	243.4	316.9	344.6	353.7	347.3
	Fuel oil	609.4	604.8	479.2	606.3	636.8	679.4	685.8
	Asphalt	7.4	7.1	8.0	4.2	5.0	7.9	7.3
	Total Products	1,164.4	1,180.3	959.1	1,217.2	1,313.3	1,391.1	1,391.8
	fuel & loss	73.1	60.4	55.3	83.4	67.2	60.2	60.3
	(in %)	5.9%	4.9%	5.4%	6.4%	4.9%	4.2%	4.2%
TOTAL SUPPLY	Crude	5,472.5	5,229.3	5,506.5	7,649.0	8,847.5	10,148.3	12,649.3
	LPG	18.7	18.8	22.1	121.1	192.2	195.8	206.6
	Gasoline	89.6	85.2	84.4	92.3	103.6	103.5	104.7
	Naphtha	0.0	0.0	0.0	4.6	4.0	9.9	21.5
	Kerosene	33.0	34.8	31.6	32.1	39.7	45.6	35.6
	Jet fuel	118.6	134.7	139.3	168.5	224.8	275.4	285.2
	Gasoil	294.7	308.6	243.4	316.9	368.3	390.4	363.7
	Fuel oil	609.4	604.8	479.2	606.3	636.8	679.4	685.8
	Asphalt	7.4	7.1	8.0	4.2	5.0	7.9	7.3
	Total Products	1,171.3	1,194.0	1,008.0	1,345.9	1,574.4	1,708.0	1,710.4
FIELD USE	Crude	25.6	26.4	36.9	43.1	57.8	51.1	45.5
CARGO EXPORTS	Crude	5,576.0	5,224.9	5,378.8	7,514.2	8,789.7	10,057.3	12,637.1
	LPG	0.0	0.0	0.0	97.8	167.7	173.8	166.8
	Gasoline	2.6	5.4	7.2	16.8	8.2	3.2	2.9
	Naphtha	0.0	0.0	0.0	4.0	0.0	5.1	8.6
	Kerosene	2.4	2.1	1.9	0.0	0.0	0.0	0.0
	Jet Fuel	0.0	0.0	1.0	1.8	3.5	3.0	0.0
	Gasoil	23.8	7.8	4.5	5.6	9.7	7.3	5.6
	Fuel oil	481.6	495.6	346.2	496.7	511.3	585.9	528.8
	Total Products	510.4	510.9	360.8	622.6	700.5	778.3	712.7

Table 1: ANGOLA PETROLEUM SUPPLY - DISPOSITION BALANCE - 1980-86
(In '000s tons)
(Continued)

		1980	1981	1982	1983	1984	1985	1986
BUNKER EXPORTS	Jet Fuel	0.0	29.1	32.5	22.3	21.7	19.8	28.9
	Gasoil	0.0	37.8	35.0	38.5	11.5	11.6	5.9
	Fuel oil	0.0	2.8	4.0	21.3	4.1	3.4	2.6
	Total Products	0.0	69.6	71.5	82.1	37.3	34.8	37.4
INLAND SALES	LPG	18.7	18.8	22.1	23.3	26.5	28.7	30.2
	Gasoline	81.0	82.9	88.9	89.5	95.1	96.0	104.1
	Kerosene	29.8	32.4	36.9	39.2	40.6	43.9	46.3
	Jet fuel	114.4	105.7	106.0	144.4	184.5	235.6	260.6
	Gasoil	268.8	300.4	323.5	334.6	340.8	376.9	344.8
	Fuel oil	121.3	120.5	109.6	83.8	88.2	104.6	119.2
	Asphalt	3.2	4.5	2.6	0.4	1.7	5.6	4.2
	Total Products	637.1	665.2	689.7	715.2	777.5	891.2	909.3
TOTAL DISPOSITION	Crude	5,601.7	5,251.3	5,415.7	7,557.3	8,847.6	10,108.5	12,682.6
	LPG	18.7	18.8	22.1	121.1	194.1	202.5	197.0
	Gasoline	83.6	88.3	96.1	106.2	103.3	99.2	107.0
	Naphtha	0.0	0.0	0.0	4.0	0.0	5.1	8.6
	Kerosene	32.2	34.5	38.8	39.2	40.6	43.9	46.3
	Jet fuel	114.4	134.7	139.5	168.5	209.7	258.3	289.5
	Gasoil	292.6	308.3	328.1	340.2	350.5	384.2	356.3
	Fuel oil	602.9	616.1	455.8	580.5	599.6	690.5	650.6
	Asphalt	3.2	4.5	2.6	0.4	1.7	5.6	4.2
	Total Products	1,147.5	1,205.2	1,083.0	1,360.0	1,499.6	1,689.4	1,659.5
STOCK DRAW	Crude	129.2	22.0	-90.8	-91.7	0.0	-39.8	33.2
(BUILD) or Other Residual								
	LPG	0.0	0.0	0.0	0.0	1.9	6.7	-9.6
Imbalance	Gasoline	-6.0	3.1	11.7	13.9	-0.2	-4.3	2.3
	Naphtha	0.0	0.0	0.0	-0.6	-4.0	-4.8	-12.8
	Kerosene	-0.8	-0.3	7.2	7.2	0.9	-1.7	10.7
	Jet fuel	-4.2	0.0	0.2	0.0	-15.1	-17.1	4.2
	Gasoil	-2.1	-0.3	84.7	23.3	-17.8	-6.2	-7.4
	Fuel oil	-6.5	11.3	-23.4	-25.8	-37.2	11.1	-35.2
	Asphalt	-4.2	-2.6	-5.3	-3.8	-3.3	-2.3	-3.1
	Total Products	-23.8	11.1	75.0	14.1	-74.8	-18.6	-50.9

Source: SONANGOL and mission calculations.

SUMMARY OF PHYSICAL FACILITIES LUANDA REFINERY
FINA PETROLEOS DE ANGOLA

Nominal Capacity 1.7 Million tons/year
Actual Capacity 1.6 Million tons/year

(a) Process Units Capacity (bbl/cd) 1/

3 Topping plants	32,000
Vacuum distillation unit	1,900
Reformer	1,900
Merox	1,300
Naphtha Hydroheater	3,800
Kerosene Hydrodesurgurizer	2,800
Gas Recovery Unit	500

(b) Off-sites

(i) Electric Power: 12.5 MW gas turbine generator 2/
0.8 MW diesel drive generator (back-up)

(ii) Tankage 3/

Crude oil	-	70,460 m^3;
Slops	-	2,900 m^3;
LPG	-	1,184 m^3;
Naphtha	-	7,918 m^3;
Gasoline	-	15,000 m^3;
Jet Fuel	-	33,048 m^3;
Kerosene	-	1,700 m^3;
Gasoil	-	41,915 m^3;
Fuel Oil	-	95,616 m^3;
Asphalt	-	2,543 m^3
Total:		272,284 m^3

1/ Barrels per calendar day.

2/ The recently installed turbine naphtha-fired generator is normally not used since it is more economic for the refinery to draw hydro power from the grid to serve its total load of about 3 MW. Occasionally the turbine is run on request of the Government in order to supply the grid.

3/ The tankage capacity is now back to normal levels after the major sabotage of 1981 when 45,000 m^3 of capacity were lost.

(iii) Receiving Facilities: 4/ Oil Port - 44 feet draft; Maximum vessel size - 75,000 DWT.

(iv) Product Pipelines

No.	Services
1	LPG
1	Fuel oil
1	Clean products

4/ The oil port adjacent to the refinery is owned and operated by FPA. It has a 44 foot draft and can accomodate vessels of up to 75,000 DWT. All the Soyo crude is received through this facility and finished products are shipped to SONANGOL marine terminals and to export destinations from here. A significant number of the vessels bunkering in Luanda are handled by FPA at its facilities in the oil port.

Table 2: FPA LUANDA REFINERY PRODUCTION BALANCE - 1980-86
('000 tons)

	1980	1981	1982	1983	1984	1985	1986
Refinery Input							
Crude oil	1,237.5	1,240.7	1,014.3	1,300.6	1,380.5	1,451.3	1,452.2
Refinery Output							
LPG	11.7	12.8	13.0	17.3	17.7	18.3	18.7
Gasoline	89.6	85.2	84.4	92.3	103.6	103.5	104.7
Naphtha	0.0	0.0	0.0	4.6	4.0	9.9	21.5
Kerosene	33.0	34.8	31.6	32.1	39.7	45.6	35.6
Jet fuel	118.6	127.0	99.5	143.5	161.9	172.8	171.1
Gasoil	294.7	308.6	243.4	316.9	344.6	353.7	347.3
Fuel oil	609.4	604.8	479.2	606.3	636.8	679.4	685.8
Asphalt	7.4	7.1	8.0	4.2	5.0	7.9	7.3
Rerun slops	5.4	4.5	4.1	6.2	5.0	4.4	4.4
Total ex-loss	1,169.8	1,184.7	963.2	1,223.4	1,318.3	1,395.5	1,396.3
fuel & loss	73.1	60.4	55.3	83.4	67.2	60.2	60.3
TOTAL	1,242.9	1,245.2	1,018.4	1,306.8	1,385.5	1,455.8	1,456.6

Note: Annual growth rate of total output: 4% (least square estimate).

Source: FPA.

Table 3: ANGOLA - PRODUCT STORAGE TERMINALS
(All owned by SONANGOL)

Location/Name	Capacity m^3	Capacity % of Total	Original Owner/-Constructor
Coastal			
Luanda IBV-1	26,000		SACOR
Luanda IBV-5	51,000		MOBIL
Luanda IMUL	5,990		SHELL
Luanda TEMAR	22,300		SHELL
Subtotal	105,290	54%	
Namibe	30,000		TEXACO
Lobito	18,900		FINA
Porto Amboim	10,750		SONANGOL (USSR-built)
Tombua	1,200		FINA
Cabinda	900		SONANGOL
Soyo	435		FINA
Total Coastal	167,475	85%	
Up-Country			
Huambo II	10,120		SONANGOL (Romanian)
Huambo I	1,360		FINA
Malange III	6,600		SONANGOL (USSR-built)
Malange II	324		FINA
Malange I	330		SACOR
Jamba	3,000		FINA
Matala	2,500		FINA
Tchamutete	1,200		FINA
Kuito	800		SONANGOL
Lubango	450		FINA
Lubango	206		SACOR
Lwena	370		SACOR
Lwena	200		MOBIL
Kaala	250		MOBIL
Lucala	250		MOBIL
Cubal	125		FINA
Cubal	95		MOBIL
Menongue	160		TEXACO
Dondo	100		MOBIL
Ganda	100		FINA
Total Up-Country	28,540	15%	
TOTAL ANGOLA	196,015	100%	

Source: SONANGOL.

Table 4: ANGOLA - INLAND PETROLEUM PRODUCT CONSUMPTION (SALES) - 1980-86
(Tons)

	1980	1981	1982	1983	1984	1985	1986 a/	Annual growth rate 80-86 b/
LPG (Butane)	18,688	18,822	22,138	23,288	26,459	28,695	30,200	9.2%
Gasoline - Motor	79,567	81,794	87,814	88,722	94,252	95,004	103,680	4.3%
Aviation	1,391	1,107	1,128	744	866	987	430	-13.4%
Total Gasoline	80,958	82,901	88,942	89,466	95,118	95,991	104,110	4.1%
Kerosene	29,835	32,412	36,910	39,229	40,625	43,908	46,310	7.5%
Jet fuel	114,350	105,650	105,965	144,375	184,522	235,567	260,550	18.0%
Total Kerosene/Jet fuel	144,185	138,062	142,875	183,604	225,147	279,475	306,860	15.9%
Gasoil	268,806	300,438	323,542	334,588	340,799	376,865	344,770	4.6%
Fuel oil	121,288	120,549	109,601	83,814	88,225	104,622	119,200	-2.0%
Asphalt	3,171	4,455	2,648	426	1,708	5,593	4,200	3.1%
TOTAL All Products	637,096	665,227	689,746	715,186	777,456	891,241	909,340	6.5%

a/ 1986 estimate based on 9-months' actuals.
b/ Least square estimates.

Source: SONANGOL.

Table 5: ANGOLA - PETROLEUM PRODUCT CONSUMPTION (SALES)
Sectoral Breakdown, 1985

	LPG	Gasoline	Kerosene	Jet fuel	Gasoil	Fuel oil	Total	%
Industry	2,217	1,608	550	24,257	98,556	54,645	181,833	20.6%
Agriculture	86	484	408	0	11,578	7,115	19,670	2.2%
Transport	92	755	81	111,026	102,134	41,119	255,206	28.8%
Construction	84	600	38	0	17,937	140	18,800	2.1%
Resale	16,387	40,112	39,687	4	77,061	0	173,251	19.6%
Government	642	2,417	563	198	14,911	423	19,154	2.2%
Armed Forces	1,990	47,271	268	98,903	37,963	284	186,678	21.1%
Other	7,197	1,757	2,314	1,179	16,726	895	30,068	3.4%
Total	28,695	95,004	43,908	235,567	376,865	104,622	884,661	100.0%

Source: SONANGOL.

Table 6: SONANGOL - SALES THROUGH RESELLERS BY PROVINCE
(in cubic meters)

	1984			1985			1st 9 months of 1986		
	Gasoline	Gasoil	Kerosene	Gasoline	Gasoil	Kerosene	Gasoline	Gasoil	Kerosene
Coastal Provinces									
Luanda	36,405	37,258	20,017	40,836	51,041	23,550	37,025	44,925	19,827
Other Coastal									
Cabinda	814	931	110	396	719	152	649	607	265
Zaire	508	542	1,047	291	632	1,011	372	604	952
Bengo	69	244	227	34	198	287	7	95	1,359
Kwanza South	884	3,264	1,576	730	2,803	1,171	703	2,449	811
Benguela	6,286	13,866	9,527	6,983	16,685	12,523	4,466	10,848	8,501
Namibe	493	2,287	1,996	681	2,992	2,117	536	2,112	1,769
Subtotal Other	9,054	21,134	14,483	9,115	24,029	17,261	6,733	16,715	13,657
Total Coastal	45,459	58,392	34,500	49,951	75,070	40,811	43,758	61,640	33,484
Up-Country Provinces									
Uige	299	1,052	2,495	124	649	1,520	50	1,775	1,030
Kwanza North	1,279	5,598	3,042	906	4,537	2,632	490	2,695	1,479
Malange	697	1,539	563	194	366	265	25	132	38
Huambo	318	168	624	507	544	497	435	844	257
Bie	43	62	104	141	185	153	21	90	18
Huila	3,288	7,071	3,037	3,457	7,994	3,491	2,354	5,222	3,011
Cunene	20	24	0	9	0	25	0	53	15
Lunda North	0	0	0	0	0	0	0	0	0
Lunda South	0	0	0	0	0	0	0	0	0
Moxico	0	0	0	0	0	0	0	0	0
Kuando Kubango	0	0	0	0	0	0	0	0	0
Total Up-Country	5,944	15,514	9,865	5,338	14,275	8,583	3,375	10,811	5,848
TOTAL Angola	51,403	73,906	44,365	55,289	89,345	49,394	47,133	72,451	39,332

AS PERCENTAGES OF TOTAL ANGOLA

	1984			1985			1986		
	Gasoline	Gasoil	Kerosene	Gasoline	Gasoil	Kerosene	Gasoline	Gasoil	Kerosene
Luanda	70.8	50.4	45.1	73.9	57.1	47.7	78.6	62.0	50.4
Other Coastal	17.6	28.6	32.6	16.5	26.9	34.9	14.3	23.1	34.7
Up-Country	11.6	21.0	22.2	9.7	16.0	17.4	7.2	14.9	14.9

Source: SONANGOL.

Table 7: PROJECTED ANGOLA PETROLEUM PRODUCTS CONSUMPTION
(In tons)

	Actual 1986 a/	Est.ann. growth 1980-86	Forecast 1987	Forecast 1988	Forecast 1990	Forecast 1992	Assumed per annum 1987-92
LPG (Butane)	30,200	9.2%	31,408	32,664	35,330	38,213	4.0%
Gasoline - Motor	103,680	4.3%	107,827	112,140	121,291	131,188	4.0%
Aviation	430	-13.4%	430	430	430	430	0.0%
Total Gasoline	104,110	4.1%	108,257	112,570	121,721	131,618	4.0%
Kerosene	46,310	7.5%	49,089	52,034	58,465	65,692	6.0%
Jet fuel	260,550	18.0%	266,193	272,005	284,158	297,051	2.2%
Total Kerosene/Jet fuel	306,860	15.9%	315,282	324,039	342,623	362,743	2.8%
Gasoil	344,770	4.6%	357,874	371,481	400,284	431,346	3.8%
Fuel oil	119,200	-2.0%	122,984	126,896	135,120	143,912	3.2%
Asphalt	4,200	3.1%	4,284	4,370	4,546	4,730	2.0%
Total All Products	909,340	6.5%	940,089	972,020	1,039,624	1,112,562	3.4%

a/ Estimated from 9-months' actuals.

Source: SONANGOL Sales Department.

STRUCTURE OF PETROLEUM PRODUCT PRICES

The final price of petroleum products to consumers in Angola is affected by price controls at three different transactional levels within the downstream sector:

(a) Crude Oil to the Luanda Refinery

(b) Products to the distributor (SONANGOL)

(c) Products to the final consumer

Pricing of Crude Oil to The Luanda Refinery

The prices paid by the refinery for crude oil are established by a "Protocol" agreed upon between the Government and the refinery owner, Fina Petroleos de Angola (FPA). This document guarantees that the crude owners will receive as much revenue from a refinery sale as from an export sale of the same crude grade. The crude owners do not pay royalty on crude sold to the refinery. The royalty is deducted from the production income tax paid by crude owners. As the Government waives the royalty income on crude sales to the refinery, the refinery is paying less than economic opportunity cost for the crude.

At present the crude oil feed for the refinery comes from the following FPA-operated areas:

- Onshore Kwanza - FINA/SONANGOL joint venture

- Onshore Congo (Soyo Crude) two areas:

  (a) FINA/SONANGOL joint ventures

  (b) FINA/TEXACO/SONANGOL joint venture.

In principle, the refinery crude price formula as defined by the "Protocol" is as follows 1/:

$$P_{REF} = P_{EXP} \times (1-r) + t \times r = P_{EXP} - (P_{EXP}-t)r$$

Where, P_{REF} = price per barrel of crude to the refinery

1/ At a fixed transport cost factor of US$1.50 the formula simplifies to:

$$P_{REF} = P_{EXP} \times 0.8333 + 0.25$$

P_{EXP} = export price per barrel of crude

t = transport cost factor allowable under royalty calculations, presently US$1.5/bbl for Congo and Kwanza crudes.

r = royalty factor (0.1667).

Thus, the refinery price is equal to:

- the export equivalent price of Congo/Kwanza crude
- less the royalties, adjusted for the cost of transporting the crude to the refinery.

Currently the export equivalent price of Congo crude is set at $US2.00/bbl off the market price of "Bonny Light", while Kwanza crude is priced for export at 94.32% of Congo crude. For instance, assuming that the market price of "Bonny Light" amounts to US$20.00/bbl, then the export equivalent prices work out at $US18.00/bbl (Congo) and US$16.98/bbl (Kwanza), respectively. Thus, with **r = 0.167** and **t = US$1.50/bbl** the refinery prices are US$15.25/bbl for Congo crude and US$14.40/bbl for Kwanza crude, involving foregone tax revenues of US$2.75/bbl in the case of Congo crude and US$2.58/bbl for Kwanza crude.

Pricing of Products to the Distributor

The refinery gate prices of finished products for sale from FPA to SONANGOL are fixed by Government Decree No. 18/86 of November 1985.

The prices were based on complete refinery cost recovery including a 10% return on investment. As opposed to the price of crude to the refinery, these prices are not adjusted to changing crude oil prices or operating costs. The return on investment is fixed to 10% of refinery assets. Refinery deficits are covered by subsidies from the State budget, and surpluses are repaid to the State budget. Every year a balance is made based on verified operating costs for the previous year and any outstanding imbalance is settled.

The pricing system is a pure "cost-plus" arrangement, providing no incentives to the refinery to minimize operating costs, as any savings would revert to the Ministry of Finance. In recent years lower crude prices and higher production and sales volumes have increased the payments from the refinery to the Ministry of Finance. During 1986 approximately 2 billion Kz was returned to the Ministry of Finance out of a total refinery gross of 7.5 billion Kz for the year.

The prices of products are set mainly to attain social goals rather than to perform allocative functions. However, since prices on the world market have declined since 1985 official refinery gate prices are roughly on par with their import parity values, as shown in

Table 1. In the table, the current price structure for the major products is compared with a CIF cost arrived at on the basis of a hypothetical freight and related charges figure of US$20.00/t added to FOB Mediterranean spot. For LPG a hypothetical freight charge of US$80/t was used in addition to the FOB price.

Table 1: OFFICIAL REFINERY GATE PRICES VS INTERNATIONAL PRICES

	-- Official Structure --		FOB Mediterranean plus US$20/t a/		
		US$/t	1985	1986	1st H 1987
LPG	7.90 Kz/kg	266.54	304.58	204.75	223.67
Gasoline	5.00 Kz/litre	228.06	275.50	161.25	186.50
Kerosene/Jet fuel	5.02 Kz/litre	209.40	281.75	172.58	179.33
Gasoil	3.55 Kz/litre	140.95	255.00	151.92	171.50
Fuel oil (Heavy)	2.66 Kz/kg	89.80	167.25	87.42	121.00

Official Price as percent of International

LPG	88%	130%	119%
Gasoline	83%	141%	122%
Kerosene/Jet fuel	74%	121%	117%
Gasoil	55%	93%	82%
Fuel oil (Heavy)	54%	103%	74%

a/ Except LPG for which US$80/t is added to FOB Mediterranean.

Source: Mission estimates.

Pricing of Products to Final Consumer

The Decree which stipulates the price structure of products to the distributor also sets the structure of prices to the final consumer. Some minor adjustments have been made since the Decree came into effect in 1985.

SONANGOL is the only distributor of petroleum products and operates the distribution on a "cost-plus" basis. The price structure allows SONANGOL a 10% profit margin plus a distribution cost allowance and import differential. The latter element is intended to cover the difference between the landed cost of the imported product and the refinery gate cost for domestic products. The difference between these allowable costs and the final selling price is made up of a tax to or subsidy from the Ministry of Finance. An illustration of the price buildup for the major products is shown in Table 2.

Table 2: OFFICIAL PRICE STRUCTURE INCLUDING REVISIONS

	Gasoline	Kerosene	Jet B	Jet A	Gasoil	LPG	LFO	HFO
	---------------- Kz/litre				----------------	---------Kz/k---------		
Refinery Gate	5.00	5.02	3.75	5.02	3.55	7.90	3.93	2.66
Tax	6.64	0.50	0.11	0.32	1.43	1.96	0.07	0.07
SONANGOL Costs	2.83	1.79	1.01	1.09	1.72	11.22	1.58	0.15
SONANGOL Profit	0.73	0.68	0.48	0.60	0.53	1.92	0.55	0.28
Reseller Margin	0.34	0.70	0.00	0.00	0.16	1.08	0.00	0.00
Import Differential	0.00	0.00	0.00	(0.07)	0.00	0.07	0.00	0.00
Margin	9.46	(1.70)	0.94	0.53	(0.38)	(9.14)	(1.33)	0.04
Final Price	25.00	7.00	6.29	7.50	7.00	15.00	4.80	3.20
Net Margin	16.10	(1.20)	1.06	0.78	1.05	(7.25)	(1.26)	0.11

Source: MEP.

Looking at cost recovery on individual products, based on official prices and the current SONANGOL cost/profit structure, kerosene, LPG, and light fuel oil are the only products which receive a payment from the State budget.

The total payment owing to the Ministry of Finance on the margins on petroleum product distribution was projected at Kz 877 million in 1987. SONANGOL is permitted to deduct its costs for transporting Soyo crude to the refinery. These were budgeted at Kz 111 million for 1987. Therefore the net payment to the Ministry of Finance in 1987 would have been Kz 766 million. Adding Kz 1,735 million of total projected revenue accruing from product taxes, total government revenue from SONANGOL sales can be estimated at Kz 2,501 million for 1987.

ECONOMICS OF THE LUANDA REFINERY USING ACTUAL HISTORICAL VALUES

In order to evaluate the economics of the Luanda refinery a simplified model was developed. The revenues and costs per ton of crude run are calculated using typical plant yields for crude multiplied by product values based on FOB Mediterranean plus US$20/t plus a charge for terminalling, in these cases assumed to be US$40/t for liquid products, and US$20/t for LPG. The model is designed to allow a selected proportion of the total fuel oil yield to be sold to export at low sulfur fuel oil (LSFO) prices with a deduction for freight. Cabinda crude with a discount is used as the price basis for the Soyo FOB export price. Three cases were run using actual crude and product values for three different periods: 1985, 1986, and the first six months of 1987. The model and results for each period are illustrated in Tables 1, 2, and 3.

As indicated with these opportunity values assumed for crude costs and product values, the gross refining margin is sufficient in all cases to cover "efficient" cash operating costs of US$10.95/t (US$1.50 per barrel) and earn a substantial operating profit.

The model was set up so that the values of a few basic parameters could be varied in order to check the sensitivity of the economies to these variations.

For example, as more LSFO is sold to export the operating profit declines since a lower netback value is obtained on this than on local sales at border prices. Also, the smaller the discount assumed for Soyo crude off Cabinda "marker" the lower the operating profit.

A summary of the base case operating profits and assumptions and aforementioned sensitivity results is provided in the following tables.

Table 1: ECONOMICS OF THE LUANDA REFINERY - RUNNING SOYO CRUDE
1985 OPPORTUNITY VALUES

Assumptions

LSFO to export	80.0% Total production
Terminalling Liq. Products	US$ 4.00 per ton
Terminalling LPG	US$ 20.00 per ton
LSFO Freight etc. USNE	US$ 22.00 per ton
Cabinda Crude FOB	US$ 188.76 per ton
Soyo Discount	US$ 3.65 per ton
Soyo FOB	US$ 185.11 per ton
Local Crude Transport	US$ 3.00 per ton

	Ton	Crude & Product Values per ton (US$)	Cost/Revenue per ton Crude run (US$)	FOB MED (US$)	NYH
Crude	('000s)	188.11	(188.11)	+20	LSFO
Production					
LPG	0.014	324.58	4.54	304.58	
Gasoline	0.103	279.50	28.79	275.50	
Kerosene/jet fuel	0.110	285.75	31.43	281.75	
Gasoil	0.248	259.00	64.23	255.00	
Fuel oil inland	0.097	171.25	16.54	167.25	
LSFO export	0.386	159.75	61.73	167.25	181.75
Total products	0.958		207.27		
Gross Refinery Margin			19.16		
"Efficient" Cash Operating Costs			(10.95)		
Operating - Profit			8.21		

Source: Mission calculations.

Table 2: ECONOMICS OF THE LUANDA REFINERY - RUNNING SOYO CRUDE
1986 OPPORTUNITY VALUES

Assumptions

LSFO to export	80.0% Total production
Terminalling Liq. Products	US$ 4.00 per ton
Terminalling LPG	US$ 20.00 per ton
LSFO Freight etc. USNE	US$ 22.00 per ton
Cabinda Crude FOB	US$ 96.92 per ton
Soyo Discount	US$ 3.65 per ton
Soyo FOB	US$ 93.27 per ton
Local Crude Transport	US$ 3.00 per ton

	Ton	Crude & Product Values per ton (US$)	Cost/Revenue per Ton crude run (US$)	FOB MED (US$)	NYH
Crude	('000s)	96.27	(96.27)	+20	LSFO
Production					
LPG	0.014	224.75	3.15	204.75	
Gasoline	0.103	165.25	17.02	161.25	
Kerosene/jet fuel	0.110	176.58	19.42	172.58	
Gasoil	0.248	155.92	38.67	151.92	
Fuel oil inland	0.097	91.42	8.83	87.42	
LSFO export	0.386	77.17	29.82		99.17
Total products	0.958		116.91		
Gross Refinery Margin			20.64		
"Efficient" Cash Operating Costs			(10.95)		
Operating - Profit			9.69		

Source: Mission calculations.

Table 3: ECONOMICS OF THE LUANDA REFINERY - RUNNING SOYO CRUDE
1st Half 1987 OPPORTUNITY VALUES

Assumptions

LSFO to export	80.0% Tota production
Terminalling Liq. Products	US$ 4.00 per ton
Terminalling LPG	US$ 20.00 per ton
LSFO Freight etc. USNE	US$ 22.00 per ton
Cabinda Crude FOB	US$ 123.18 per ton
Soyo Discount	US$ 3.65 per ton
Soyo FOB	US$ 119.53 per ton
Local Crude Transport	US$ 3.00 per ton

	Ton	Crude & Product Values per ton (US$)	Cost/Revenue per ton Crude run (US$)	FOB MED (US$)	NYH
Crude	('000s)	122.53	(122.53)	+20	LSFO
Production					
LPG	0.014	243.67	3.41	223.67	
Gasoline	0.103	190.50	19.62	186.50	
Kerosene/jet fuel	0.110	183.33	20.17	179.33	
Gasoil	0.248	175.50	43.52	171.50	
Fuel oil inland	0.097	125.00	12.07	121.00	
LSFO export	0.386	101.18	39.10	167.25	123.18
Total products	0.958		137.89		
Gross Refinery Margin			15.36		
"Efficient" Cash Operating Costs			(10.95)		
Operating - Profit			4.41		

Source: Mission calculations.

HUMAN RESOURCES IN THE DOWNSTREAM PETROLEUM SECTOR

Refinery

1. There are presently about 450 refinery employees, about 70 of whom are expatriates. Six of the expatriates are in top management while 65 are skilled laborers (first-class operators, senior mechanics, mechanical foremen, etc.). The total number of expatriates is down from about 100 three years ago and is continuing to decline through attrition. FPA is engaged in extensive training of Angolans. They have relied heavily on the Instituto Nacional de Petroleo (INP) at Sumbe (para. 4) for training operators and at present have about 20 trainees there. They are sufficiently encouraged by the good results obtained from the training of operators at Sumbe that they are now starting to send trainees in more specialized areas such as instrument mechanics and general mechanics. They have also regularly sent people abroad for two-month training courses at PETROFINA refineries, but this program has been constrained by Government authorities of late due to foreign exchange limitations. They also have some refinery on-site training run by an Italian firm, IDEAS.

SONANGOL: Distribution and Marketing

2. There are some 3,000 employees in SONANGOL'S distribution and marketing division. This does not include service station staff who operate as independent dealers on a reseller margin. About half of SONANGOL's employees are attached to the storage installations while the rest are drivers, mechanics, accountants, sales agents, etc. There are several hundred employees at the 20-odd empty inland terminals. Even if the distribution system were running properly it is apparent that with the present work force there would be overstaffing in relation to volume distributed. Excessive staff, buildings, and facilities are the result of SONANGOL's taking over the old private companies. This led to duplication, overstaffing, and higher overheads than necessary. SONANGOL recognizes that it must rationalize inherited staff and facilities. With the strategic/military situation as it is, however, it is difficult to propose a major rationalization study and program at this time. SONANGOL has made some progress in this regard and will continue to do so--perhaps in smaller steps and in more gradual fashion than would be ideal in a "normal" environment.

3. In summary, SONANGOL has trained a total of about 100 operators at INP, Sumbe, in the past five years. This may seem large in relation to the total staff complement but turnover at SONANGOL is extremely high. SONANGOL must train many just to have an available pool as many are lost to other enterprises. One of the causes of the high turnover or drop-out rate is the low trainee pay. Trainees receive about Kz 8,000/month during training and no food benefits except for use of the refinery cafeteria while within the plant. Even a trained operator receives no more than about Kz 12,000 to Kz 15,000/month, some of it in food.

4. Petroleum Training Center (PTC) - Sumbe. The information available on the PTC 1/ at Sumbe suggests that the preparation/-feasibility stage for this center was insufficient, start-up difficulties were greater than expected (16-month delay from early 1984 to late 1985) and training objectives are not being attained. UNDP/UNIDO (the United Nations Development Programme/United Nations International Development Organization), contrary to its practice, did not assign a project manager so that decision-making and problem-solving were a slow and cumbersome process. The PTC did not have the support of its main designated beneficiaries (the oil companies) in part because training programs were not designed in consultation with or to satisfy the oil companies. Naturally enough, the oil companies preferred to use their own training facilities. More recently, however, they are showing more active interest and support, to the extent of sending their own instructors to the center together with training equipment. The Government (Ministry of Education and the MEP) and the international partners (UNDP, UNIDO, NORAD, and Italy) should perhaps reconsider the scale of this project and, possibly, restart it under the firm control of the oil industry but with assistance from any of the present partners willing to continue helping Angola train people for its most important industry. The interests of the oil companies in Angola probably do not extend to other SADCC (Southern African Development Coordination Conference) countries. If so, training of nationals of other SADCC countries should still be possible, but could probably not be the main task of the PTC.

5. The greatest shortfall in meeting objectives has been in the training of instructors. Reportedly, only ten instructors were trained and only five remain at the PTC. 2/ Obviously, this is the highest priority for future action if the PTC is ever going to become even partly self-sustaining.

6. No financial information at all was available to the mission. Therefore, it is impossible to comment on the cost-effectiveness of the PTC. However, operating the PTC is clearly very expensive. Before making a decision either to continue using or stop using the center, objectives and achievements need to be compared to costs. The PTC represents a considerable claim on the scarce resources of Angola which contributed US$2-3 million/y to the operation of the center. This amount is in addition to the many millions supplied by other donors.

1/ A member of the Energy Assessment Mission visited Sumbe but this report benefitted from consulting a UNDP report entitled: UNDP: Evaluation Mission on RAF/83/22 - Assistance to the Petroleum Training Center, UNDP/UNIDO, Luanda, Final Report, 25 April, 1987.

2/ Ten other instructors from other SADCC countries were also trained and returned home. Between late 1985 and early 1987, 311 trainees attended courses or seminars.

PETROLEUM PRODUCT TRADING

Middle Distillate Imports

1. SONANGOL procures its imports of jet fuel and gasoil through its U.K. subsidiary, SONANGOL LIMITED. SONANGOL LIMITED is a joint venture with the large West German trading company, STINNES, which assists in arrangements related to external product trading--both imports and exports. Before the SONANGOL-STINNES joint venture arrangement was promulgated about a year ago, SONANGOL LIMITED tried to handle middle distillates imports on an as-needed, ad hoc cargo-by-cargo basis. The sporadic nature of the demand, long distance from major supply sources, and foreign exchange/letter of credit problems all combined to make the attempt at importing in 10,000 DWT vessels somewhat complicated. With the joint venture arrangement a steady import pattern of 5,000-ton parcels roughly every month from Tenerife, Canary Islands has been established. The joint venture partnership has a 5,000 DWT tanker on time-charter which can be out-chartered to earn revenues when not required for the Angola import chartering. For instance, at present Angola via SONANGOL pays the joint venture Platt's Mediterranean plus US$39.00/t CIF Luanda for A-1 jet fuel. This covers FOB cost of acquiring the product, marine insurance, marine loss, letter of credit arrangements, necessary financing and management of the entire acquisition, and chartering operations. One half of the profits on this and other partnership activities flow back to SONANGOL LIMITED through its joint venture share. Currently, these profits on product trading are financing the entire SONANGOL LIMITED London office, whose principal activity is crude oil trading.

2. The mission has undertaken an analysis of the middle distillates procurement arrangement. Small tanker freight quotations for service from the major supply sources of Tenerife, the Canaries, and Augusta, Italy, are illustrated in Table 1. These figures result in a calculated freight cost of US$26.91/t for Tenerife-Luanda and US$39.64/t for Augusta-Luanda. If a trading commission (for chartering, financing, and general "implementation" function of the joint venture) is included in the total, CIF-FOB differential works out at US$33.62/t for Tenerife-Luanda and US$46.81/t for Augusta-Luanda as shown in Table 1.

3. Since the existing arrangement incorporates a total differential of US$39.00/t above Platt's Mediterranean spot price, Angola pays an "excess margin" of about US$5/t on a Tenerife sourcing. Procuring in Augusta would clearly be too costly.

These calculations call for two comments:

(a) assuming that the 5,000-ton shipment is correct, then even a high cost (i.e., distant) source of supply such as Tenerife apparently costs less than present arrangements (by about US$5/t);

Table 1: DERIVED CIF-FOB DIFFERENTIAL FOR MIDDLE DISTILLATES REPLENISHMENT-LUANDA

	Tenerife-Luanda	Augusta-Luanda	Bases
	US$/t	US$/t	
FOB Cost	159.51	159.51	Average Med PIW 1st 6 months, 1987
Ocean Freight	26.91	39.64	
	186.42	199.15	
Marine loss, insurance,	1.12	1.20	0.6% FOB plus freight
Commission	5.59	5.97	3.0% FOB plus freight
CIF Luanda	193.13	206.32	
CIF-FOB differential	33.62	46.81	

Source: SONANGOL and Annex 9, Table 1.

(b) it seems evident that a 10,000 DWT vessel is much more appropriate given that total imports exceed 100,000 t/y and Tenerife is an unnecessarily distant source of supply.

	US$/t
Acquisition cost FOB Luanda	108.00
Ocean freight Luanda-New York	11.25
	119.25
Marine loss 0.3%	0.36
Marine insurance 0.2%	0.24
Trading commission 3%	3.58
Landed cost New York	123.19

4. Assuming that SONANGOL-STINNES could actually sell the fuel oil at New York Harbor spot cargo prices and get a 3% trading commission for managing all "implementation" functions, it would make an "excess margin" of about US$7/t under the current arrangement. At present export levels this amounts to some US$3.5 million/y. It appears that some profits which could go to SONANGOL (and the Government) thus accrue to SONANGOL LIMITED. Even if half the profits flow back to SONANGOL LIMITED it might be worth discussing with STINNES whether a better deal could be struck. Alternatively, SONANGOL would probably do better by returning to its 1981-82 practices of opening tenders in the international fuel oil markets. In the past, offers received were about New York Harbor less US$2.40/bbl or US$16.80/t. Adding other incidentals, this would give

Angola a netback fuel oil price of about US$115/t rather than US$108/t which may be the case under present arrangements.

Fuel Oil Imports

5. The fuel oil produced in Angola is low sulfur (0.3%), high-pour material. The refinery sells it at official refinery gate prices to SONANGOL who then sells it to the SONANGOL-STINNES joint venture. The present contract arrangement provides for SONANGOL to receive New York Harbor cargo prices less US$22.00/t. The U.S. Northeast coast is the prime disposition for this low-sulfur product. It generally moves from Luanda in 50,000-ton shipments.

6. A typical freight rate (average spot 1st 6 months 1986) for transporting this type of cargo in 50,000 DWT vessels is about 110% WS or US$11.25/t for the Luanda-New York voyage. Recent quoted New York Harbor spot cargo prices for 0.3% high-pour LSFO have averaged about US$130/t. On this basis SONANGOL-STINNES would pay SONANGOL US$108/t, which is about US$15/t less than the landed cost at New York.

International Bunker Sales

7. International bunker sales fell by about 50% in the period 1981-1986. Airline bunkers have recuperated and fuel oil bunkering is also stable but there has been a marked decline in gasoil bunkers, probably because Angola became a net importer over this period. Table 2 summarizes the trends.

Table 2: INTERNATIONAL BUNKER SALES 1981-86

	1981	1985	1986
Jet fuel	29,074	19,827	28,920
Gasoil	37,760	11,555	5,850
Fuel oil	2,771	3,379	2,600
Total Bunkers	69,605	34,761	37,370

Source: Angolan authorities.

FIGURES ON THE POWER SUBSECTOR

Table 1: INSTALLED AND AVAILABLE GENERATING CAPACITY (1987)

System and Province	Name of Plant	Type a/	Number of units and unit power (MW)	Capacity (MW) Installed	Capacity (MW) Available	Date of Commissioning Month/year	Date of Unavailability Month/year
North							
Kuanza N.	Cambambe	H	2 x 45 & 2 x 45	180.0	135.0	1963,1973	
Bengo	Mabubas	H	2 x 3 & 2 x 5.9	17.8	-	1953,1959	2/1986
Luanda	Luanda, GT1	GT	1 x 25.6	25.6	25.6	1980	
"	Luanda, GT2	GT	1 x 31.2	31.2	31.2	8/1985	
Subtotal				254.6	191.8		
Central							
Benguela	Lomaum	H	2 x 10 & 1 x 15	35.0	-	1964-1972	3/1983
"	Biopio	H	4 x 3.6	14.4	7.2	1957	
"	Biopio	GT	1 x 22.8	22.8	22.8	2/1974	
"	Biopio	D	2 x 1.5	3.0	1.5	1982	
"	Lobito	D	4 x 5 b/	20.0	10.0	1986	
Huambo	Huambo	GT	1 x 10 c/	10.0	-	1981	2/1985
"	Huambo	D	5 x 0.8 & 2 x 0.85	6.0	5.2	1953-1986	
Subtotal				111.2	46.7		
South							
Huila	Matala	H	2 x 13.6	27.2	13.6	1959	
"	Lubango	D	3 x 0.4 & 12 x 0.2	3.6	3.6	n.a.	
"	Namibe	D	2 x 5.75	11.5	11.5	1980	
"	Tombwe	D	1 x 1.6	1.6	-	1970	
"	Jamba	D	3 x 1.9	5.7	-	1968	
"	Saco	D	2 x 1.45	2.9	-	n.a	
Subtotal				52.5	28.7		
Isolated Systems							
Cabinda	Malongo	GT	1 x 12.3	12.3	-	1980	1985
"	"	D	3 x 1.5	4.5	-	8/1971	
"	"	D	4 x 0.3	1.2	1.2	n.a	
Uige	Luquixe	H	3 x 0.36	1.1	1.1	1957,1968,1971	
"	Uige	D	3 x 06	1.8	1.8	n.a	
"	"	D	1 x 1.5	1.5	1.5	1982	

a/ H = Hydroelectric; D = Diesel; GT = Gas Turbine.
b/ Railway carriage mounted.
c/ ISO rating 13.5 MW. Derating of 22% due to altitude.

Source: SADCC, SONEFE, and ENE.

Table .: INSTALLED AND AVAILABLE GENERATING CAPACITY (1987)
(Continued)

System and Province	Name of Plant	Type a/	Number of units and unit power (MW)	Capacity (MW) Installed	Available	Date of Commissioning Month/year	Date of Unavailability Month/year
Lunda N	Luaximo	H	4 x 2.4	9.6	-	1957	
"	Luxilo	D	1 x 1.5	1.5	-	n.a	
"	Lucapa	D	2 x 3.2	6.4	-	n.a	
Bie	Andulo	H	2 x 0.05	0.1	0.1	n.a	
"	Kunje	H	3 x 0.54	1.6	1.1	1/1971	
"	Coemba	H	2 x 0.1	0.2	0.1	n.a	
"	Kuito	D	1 x 0.8 & 1 x 0.5	1.3	0.5	n.a	
Moxico	Luena	D	2 x 0.6	1.2	-	1974	
Huila	Kubango	H	2 x 0.15	0.3	-	8/1972	
	Subtotal		44.6	7.4			
Total Angola				462.9	274.5		

a/ H = Hydroelectric; D = Diesel; GT = Gas Turbine.
b/ Railway carriage mounted.
c/ ISO rating 13.5 MW. Derating of 22% due to altitude.

Source: SADCC, SONEFE, and ENE.

Table 2: TOTAL GENERATION BY TYPE OF PLANT
(GWh)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Hydro																	
Cabinda	255.7	303.2	370.7	502.6	552.2	421.4	338.6	394.7	419.4	465.0	489.9	506.7	545.0	674.4	565.6	544.2	590.4
Mabubas	46.7	72.5	67.4	27.7	15.2	6.3	0.3	1.3	2.9	1.3	2.4	1.6	1.9	4.1	3.6	4.7	1.3
Lomaum	81.9	97.9	109.9	120.8	125.8	92.4	63.4	72.4	90.4	85.3	112.4	99.4	112.5	2.4	0.0	0.0	0.0
Biopio	37.2	34.9	34.1	43.1	37.6	42.7	14.4	24.0	16.0	39.0	22.6	32.1	38.3	34.5	16.4	12.0	35.1
Matala	91.5	61.8	67.5	77.8	62.1	69.3	9.6	10.8	8.7	10.5	10.5	10.7	8.6	10.9	8.0	9.6	8.1
Other hydro	91.5	61.8	67.5	77.8	62.1	69.3	9.6	10.8	8.7	10.5	10.5	10.7	8.6	10.9	8.0	9.6	8.1
Total Hydro	543.7	605.0	680.3	814.1	858.1	705.1	460.7	529.4	568.1	636.4	675.3	688.1	748.4	674.3	634.7	621.0	691.1
Gas turbines																	
Luanda	-	-	-	-	-	-	-	-	-	-	0.1	0.0	0.3	0.1	0.5	6.2	14.2
Biopio	-	-	-	-	8.0	0.0	0.0	0.0	0.1	0.0	1.8	8.8	0.7	60.0	61.9	49.7	15.5
Huambo	-	-	-	-	-	-	-	-	-	-	1.8	1.7	0.1	11.0	7.1	2.9	0.0
Cabinda	-	-	-	-	-	-	-	-	-	-	6.0	9.9	18.8	14.2	13.6	18.1	5.7
Total Gas turbines	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.1	0.0	9.7	20.4	19.9	85.3	88.1	76.3	35.4
Diesel Generation																	
	100.0	137.0	158.5	170.2	162.7	133.2	71.4	28.8	15.0	13.0	5.3	8.0	10.3	4.2	8.6	7.5	27.0
Total Angola	643.7	742.0	838.8	984.3	1023.8	838.3	532.1	558.2	588.2	649.4	690.3	716.5	778.6	763.8	726.4	704.8	753.5
Average growth rate																	
% p.a.		15.3	13.0	17.3	4.5	-18.5	-36.5	4.9	4.5	11.4	6.3	3.8	8.7	-1.9	-4.9	-3.0	6.9
Percentage of Total																	
Hydro	84.46	81.54	81.10	82.71	88.41	84.11	86.58	94.84	97.41	98.00	97.83	96.04	96.12	88.28	87.98	88.11	91.72
Gas turbines	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.02	0.00	1.41	2.85	2.56	11.17	11.44	10.83	4.70
Diesel	15.54	18.46	18.90	17.29	15.81	15.89	13.42	5.16	2.57	2.00	0.77	1.12	1.32	0.56	1.18	1.06	3.58

Source: SADCC, SONEFE, and ENE.

Table 3: BREAKDOWN OF GENERATION BY SYSTEM AND POWER PLANT
(GWh)

System/Plant	Type a/	1982	1983	1984	1985	1986
Northern						
Cambambe	H	544,964	574,256	555,642	544,156	590,448
Mabubas	H	1,851	4,113	3,572	4,660	1,266
Luanda	GT	272	55	496	6,208	14,234
Sub-total		547,087	578,424	559,710	555,024	605,948
Central						
Lomaum	H	112,500	2,428	0	0	0
Biopio	H	38,300	34,516	16,408	12,801	35,114
Biopio	GT	700	60,042	61,896	49,746	15,531
Huambo	GT+D	70	11,000	7,106	2,275	2,021
Biopio	D	0	0	3,932	1,822	10,615
Blackstone sets	D	0	0	0	505	11,948
Sub-total		151,570	107,986	89,342	67,149	75,229
Southern						
Matala	H	42,127	48,104	51,113	49,698	56,212
Namibe	D	1,253	0	0	3,178	118
Sub-total		43,380	48,104	51,113	52,876	56,330
Total Interconnected		742,037	734,514	700,165	675,049	737,507
Cabinda						
Malongo	GT+D	187,681	14,240	13,618	18,029	5,690
Uige						
Luquixe	H	5,000	5,323	3,360	4,533	2,891
Uige	D	787	927	3,092	502	919
Subtotal		5,787	6,250	6,452	5,035	3,810
Bie						
Kunje	H	5,310	5,338	3,555	4,795	4,751
Andulo	H	270	289	150	257	245
Coemba	H	235	228	152	228	182
Kuito	D	1,400	985	1,698	1,277	1,197
Chinguar	D	....	....	26	98	....
N'harea	D	....	11	....	....	....
Subtotal		7,215	6,851	5,581	6,655	6,375
Moxico						
Luena	D	4,679	1,907	590	122	90
Total Isolated		36,449	29,248	26,241	29,841	15,965
TOTAL ANGOLA		778,486	763,762	726,406	704,890	753,472

a/ H = Hydroelectric; D = Diesel; GT = Gas Turbine
Source: ENE, SONEFE, MEP reports, and mission estimates.

Table 4: TOTAL ELECTRICITY GENERATION, DISTRIBUTION AND LOSSES
(1967-1986)

	Generation			Distribution a/			Losses	
Year	GWh	Base 100	Growth rate % p.a.	GWh	Base 100	Growth rate % p.a.	GWh	% of Generation
1967	390.8	38.0	-	372.8	40.6	-	18.0	4.6
1968	456.8	44.4	16.9	433.2	47.1	16.2	23.6	5.2
1969	541.5	52.6	18.5	519.0	56.5	19.8	22.5	4.2
1970	643.8	62.6	18.9	618.9	67.3	19.2	24.9	3.9
1971	741.9	72.1	15.3	702.0	76.4	13.4	39.9	5.4
1972	838.8	81.5	13.0	787.2	85.6	12.1	51.6	6.2
1973	984.3	95.7	17.3	914.5	99.5	16.2	69.8	7.1
1974	1,028.8	100.0	4.5	919.2	100.0	0.5	109.6	10.7
1975	838.8	81.5	-18.5	768.6	83.6	-16.4	69.7	8.3
1976	532.1	51.7	-36.5	487.9	53.1	-36.5	44.2	8.3
1977	558.8	54.3	4.9	511.9	55.7	4.9	46.3	8.3
1978	583.2	56.7	4.5	540.6	58.8	5.6	42.6	7.3
1979	649.4	63.1	11.4	596.8	64.9	10.4	53.5	8.3
1980	690.3	67.1	6.3	626.1	68.1	4.9	63.8	9.2
1981	716.5	69.6	3.8	644.0	70.1	2.9	72.5	10.1
1982	778.6	75.7	8.7	712.6	77.5	10.7	66.0	8.5
1983	763.8	74.2	-1.9	686.6	74.7	-3.6	77.2	10.1
1984	726.4	70.6	-4.9	634.3	69.0	-7.6	92.1	12.7
1985	7804.8	68.5	-3.0	605.0	65.8	-4.6	99.8	14.2
1986	753.5	73.2	6.9	636.2	69.2	5.2	117.3	15.6

Average Annual growth rates (%) calculated using least square estimates:

	Generation	Distribution
1967 - 1973	16.6	16.2
1977 - 1982	6.9	6.6
1977 - 1986	3.1	2.1

a/ "Distribution" figures apparently include losses in MV (60 kV and lower) distribution networks.

Source: Industrial Statistics (INE: 1967-1973); ENE, SONEFE, MEP reports, and mission estimates.

Table 5: TOTAL LENGTH OF TRANSMISSION LINES - 1987

Voltage	North system	Central system	South system	Isolated systems	Total
kV	(km)	(km)	(km)	(km)	(km)
220	548	-	-	-	548
150	-	281	288	-	569
100	159	-	-	-	159
60	223 a/	62 b/	496	228 c/	1,009

a/ Includes 109 km of new line Mabubas-Quibaxe (Dembos electrification).
b/ Currently operated at 30 kV.
c/ ENDIAMA system, province of Lunda N.

Source: SADCC, SONEFE, and ENE.

Table 6: MAIN TRANSMISSION LINES - CHARACTERISTICS

System Line	No. of Circuits	kV	km	Conductors	Commiss. Year	Comments
North						
Cambambe-Luanda	1	220	175.0	ACSR Crow	1963	
Cambambe-Viana	1	220	158.0	"	1984 a/	
Viana-Luanda	1	220	17.0	"	1984	Currently at 60 kV
Cambambe-N'Dalatando	1	220	73.0	"	1970	
Cambambe-Gabela	1	220	125.0	"	1974	Out of order since 1984
N'Dalatando-Cacuso	1	100	97.0	ACSR 30/7	1974	
Cacuso-Malange	1	100	62.0	"	1974	
Mabubas-Luanda	2	60	57.0	Cu 50mm 2	1953	
Mabubas-Quibaxe	1	60	109.0	n.a.	1987 b/	
Center						
Biopio-Quileva	1	150	17.5	ACSR Panther	n.a.	
Biopio-Lomaum	1	150	96.5	"	1964	
Lomaum-A. Catumbela	1	150	48.5	"	1964	
A. Catumbela-Huambo	1	150	118.5	"	1964	
Huambo-Chinguar	1	60	n.a.	n.a.	n.a.	Operated at 30 kV
South						
Matala-Lubango	1	150	168.0	ACSR Panther	1959	
Matla-Jamba	1	150	120.0	"	1973	
Lubango-Namibe	2	60	162.0	(i) Cu 70mm2	1960	
				(ii) ASCSR Partridge	1974	
Namibe-Tombwa	1	60	94.5	ACSR Civetta	1974	Highly corroded
Namibe-Saco	1	60	9.0	"	1973	
Jamba-Tchamutete	1	60	68.0	ACSR 26/7	1973	Out of order

a/ Inactive due to works in Viana substation.
b/ Dembos electrification. To be commissioned in July 1987.

Source: "Estudo da Interligacao das Redes de Angola", EDP; Lisbon 1984.

Table 7: BREAKDOWN OF DISTRIBUTION BY SYSTEM AND PROVINCE
(MWh)

System/Province	1982	1983	1984	1985	1986
Northern					
Luanda & Bengo	440,750	475,893	453,115	459,763	491,920
Kuanza N+Malange	35,190	23,159	22,596	16,256	13,260
Kuanza S	19,980	17,946	10,322	308	925
Subtotal	495,920	516,998	486,033	476,336	506,105
Central					
Benguela	113,400	73,252	68,123	52,252	61,018
Huambo	33,254	30,278	17,719	10,895	11,563
Subtotal	146,654	103,530	85,842	63,147	72,581
Southern					
Huila	20,392	22,697	21,957	21,292	21,501
Namibe	15,787	14,328	18,038	16,960	21,789
Subtotal	36,179	37,025	39,995	38,252	43,290
TOTAL INTERCONNECTED	678,753	657,553	611,870	577,735	621,976
Isolated					
Cabinda	17,401	14,225	11,516	16,943	4,744
Uige	5,281	6,249	5,386	4,064	3,458
Bie	6,808	6,639	5,007	6,116	5,920
Moxico	4,397	1,907	590	121	90
Total Isolated	33,387	29,021	22,499	27,244	14,212
TOTAL ANGOLA	712,640	686,574	634,369	604,979	636,188

Source: ENE, SONEFE, MEB reports, and mission estimates.

Table 8: REGIONAL BREAKDOWN OF ELECTRICITY DISTRIBUTION a/ IN SELECTED YEARS
(In GWh and Percentage)

Province	Electricity Distribution (GWh) 1967	1970	1972	1974	1982	1986	Percentage of total (%) 1974	1986
Luanda & Bengo b/	172.8	285.6	409.0	478.8	440.8	491.9	52.1	77.3
Benguela c/	93.5	124.4	137.8	147.2	113.4	61.0	16.0	9.6
Huila & Namibe d/	20.6	69.3	78.2	95.5	36.2	43.3	10.4	6.8
Huambo e/	16.6	30.3	32.1	40.1	33.3	11.6	4.4	1.8
Sub total	303.5	509.6	657.1	761.6	623.7	607.8	82.9	95.5
Others	69.3	109.3	130.1	157.6	88.9	28.4	17.1	4.5
Total	372.8	618.9	787.2	919.2	712.6	636.2	100.0	100.0

a Distribution includes customer consumption and MV and LV distribution losses.
b/ Includes the city and greater Luanda.
c/ Includes the urban areas of Benguela and Lobito.
d/ Includes the urban areas of Lubango and Namibe.
e/ Includes the urban area of Huambo.

Source: Industrial Statistics (INE), ENE, and mission estimates.

Table 9: FOREIGN BORROWINGS AND FOREIGN DEBT SERVICE OF THE POWER SUBSECTOR - EXCLUDING GAMEK
(In '000s units)

Borrowers	Currency (a)	Loan amounts contracted (b)	Av. int. rate %	Av. grace period-year	Av. repmnt period-year	Debt incurred 1-DEC-86	Debt Service: repayment and interest ('000s) 1987	1988	1989	1990
ENE	US$	21,951	9.2	1.8	5.7	10,733	929	1,805	4,907	4,810
							574	1,463	1,488	1,027
							1,503	3,268	6,395	5,837
	FRF	109,361	8.9	3.8	4.9	46,285	7,382	26,610	26,610	26,125
							3,444	8,640	6,145	3,660
							10,826	35,250	32,755	29,785
	GBP	10,323	9.2	0.0	6.9	5,907	1,493	1,493	1,493	1,429
							872	653	433	214
							2,365	2,146	1,926	1,643
	BEF	351,098	8.4	2.0	7.4	325,333	35,939	54,835	54,835	54,835
							14,956	31,146	19,935	13,633
							50,895	85,981	74,770	68,468
	US$ equivalents (a):	63,279	9.0	1.9	6.0	34,935	7,999	14,149	16,277	14,673
SONEFE	US$	29,237	7.4	3.6	6.6	20,603	4,242	4,125	3,298	1,941
							1,696	1,093	774	577
							5,938	5,218	4,072	2,518
	CHF	14,581	6.9	2.0	3.0	7,401	4,860	2,541	-	-
							426	91	-	-
							5,286	2,632	-	-
	US$ equivalents (a):	38,277	7.3	3.2	5.7	25,192	9,215	6,850	4,072	2,518
	TOTALS US$ equivalents (a):	101,556	8.4	2.4	5.9	60,127	17,214	20,999	20,349	17,191

(a) Exchange rates: French FR = US$0.157; Sterling Pound = US$1.49; Belgian FR = US$0.025; Swiss FR = US$0.62.

(b) In 1981 23.4 million US$ equivalent; 1983, 1.3 million; 1984, 44.9 million; 1985, 12.0 million; 1986, 0.7 million; 1987, 19.2 million; total, 101.5 million.

Source: ENE and mission estimates.

ELECTRICITY DEMAND PROJECTIONS - MAIN ASSUMPTIONS BEP, THEMAG, AND MISSION STUDIES

1. Since the early 1970s international consultants have tried at least four different approaches to electricity demand projections. The first was prepared by SOFRELEC in 1971, for the Junta Provincial de Electrificao de Angola (JPEA). 1/ In 1984 a technical study was presented by Electricidade de Portugal (EDP). Recently, two studies aiming to define a minimum cost expansion plan and interconnection facilities were undertaken. Both studies covered the planning period 1986-2005. The first was financed by the Banque Africaine de Développement (BAD) and prepared by Belgian Engineering Promotion (BEP) 2/, the second was prepared within the framework of the Southern African Development Coordination Conference (SADCC) by the Brazilian consulting firm THEMAG 3/.

2. The demand forecasts of these two studies are not immediately comparable. BEP presented its forecasts by province, using the annual reports and plans' outline of the Ministry of Energy and Petroleum's (Ministerio de Energia e Petroleos, MEP). THEMAG defined 20 major "load-centers" (corresponding to 20 main regions) to concentrate load for the purpose of studies and simulations. Connection criteria of new municipalities were also different. Angolan technicians contributed very little to the BEP study, while that of THEMAG was based on existing SONEFE and ENE approximations. Both studies assumed that either no price-elasticity measure existed or that it would have no effect in spite of the urgent need for tariff increases all over the country. BEP used a sectoral approach, analyzing the development of the three main sectors: industry, services, and residential, but used outdated industrial statistics (1967-72) complemented by recent Governmental intentions. Some assumptions were also made on the rate of replacement of other energy sources by electricity. BEP distributed aggregate demand forecasts by province and municipality. THEMAG used a global approach, preparing demand scenarios on the basis of present demand in the main substation and applying growth rates in agreement with "optimistic" and "pessimistic" market expectations. Each main substation, or "load center" was characterized by two components: one corresponding to the

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1/ "Etude de l'Interconnexion des Principaux Systèmes de Production d'Energie", SOFRELEC, 1971.

2/ "Etude d'un Plan Directeur de Développement du Réseau Electrique National d'Angola"; Brussels, August 1986.

3/ "Interligacao dos Sistemas Norte/Centro/Sul em Angola. Possibilidades de Interligacao com a Namibia"; Preliminary Report; S. Paulo, October 1986.

"natural" consumption growth of existing consumers and the other resulting from the extension of electrification to new areas.

3. To overcome the uncertainties on the rehabilitation and development of the productive system and urban infrastructure, the studies assumed that the general rehabilitation of the socio-economic framework could start by the end of 1986. "Natural" consumption would experience moderate growth until 1989 when supply conditions should be back to normal. Then five years of accelerated development would follow, re-establishing full use of productive capabilities. The second half of the planning period (1995-2005) would be characterized by stable conditions of economic development and lower growth rates for electricity consumption. In addition to a "Base" scenario, THEMAG used "Low" and "High" scenario projections which concerned only the "Natural" component of consumption and resulted from "Base" projections -8% and +8% respectively. THEMAG used the same annual growth rates within each system for the three scenarios. Resulting demand differences among scenarios for that study are an outcome of distinct "starting" values.

4. In order to compare both forecasts, BEP projections were rearranged into regions to match load centers used by THEMAG. Additionally, all values were converted into consumption (energy) and demand at the HV busbars of HV/MV substations.

5. Energy and demand forecasts for the three systems made by BEP, THEMAG, and IBRD/UNDP are detailed in Tables 1 through 21.

Table 1: NORTHERN SYSTEM - CASE 1 (BEP STUDY)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	474.8		84.5		6.0	8.0	505.1	91.8	5,499	62.8
1987	520.9	9.7	94.1	11.3	6.0	8.0	554.2	102.3	5,420	61.9
1988	571.6	9.7	104.7	11.3	6.0	8.0	608.1	113.8	5,342	61.0
1989	627.1	9.7	116.6	11.3	6.0	8.0	667.2	126.7	5,264	60.1
1990	688.1	9.7	129.8	11.3	6.0	8.0	732.0	141.1	5,188	59.2
1991	769.3	11.8	144.8	11.6	6.0	8.0	818.4	157.4	5,198	59.3
1992	860.0	11.8	161.6	11.6	6.0	8.0	914.9	175.7	5,209	59.5
1993	961.5	11.8	180.3	11.6	6.0	8.0	1,022.8	196.0	5,219	59.6
1994	1,047.9	11.8	201.2	11.6	6.0	8.0	1,143.5	218.7	5,229	59.7
1995	1,201.7	11.8	224.5	11.6	6.0	8.0	1,278.4	244.0	5,239	59.8
1996	1,297.5	8.0	242.0	7.8	6.0	8.0	1,380.3	263.0	5,248	59.9
1997	1,400.9	8.0	260.8	7.8	6.0	8.0	1,490.3	283.5	5,257	60.0
1998	1,512.5	8.0	281.1	7.8	6.0	8.0	1,609.1	305.6	5,266	60.1
1999	1,633.1	8.0	303.0	7.8	6.0	8.0	1,737.3	329.4	5,275	60.2
2000	1,763.2	8.0	326.6	7.8	6.0	8.0	1,875.7	355.0	5,284	60.3

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: BEP.

Table 2: NORTHERN SYSTEM - CASE 2 (THEMAG "LOW" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	537.0		94.4		6.0	8.0	571.3	102.6	5,568	63.6
1987	599.5	11.6	104.7	10.9	6.0	8.0	637.8	113.8	5,604	64.0
1988	669.7	11.7	116.6	11.4	6.0	8.0	712.4	126.7	5,621	64.2
1989	748.1	11.7	130.2	11.7	6.0	8.0	795.9	141.5	5,624	64.2
1990	815.5	9.0	141.9	9.0	6.0	8.0	867.6	154.2	5,625	64.2
1991	898.7	10.2	157.1	10.7	6.0	8.0	956.1	170.8	5,599	63.9
1992	1,011.1	12.5	179.3	14.1	6.0	8.0	1,075.6	194.9	5,519	63.0
1993	1,102.1	9.0	195.4	9.0	6.0	8.0	1,172.4	212.4	5,520	63.0
1994	1,201.2	9.0	213.0	9.0	6.0	8.0	1,277.9	231.5	5,519	63.0
1995	1,309.3	9.0	232.2	9.0	6.0	8.0	1,392.9	252.4	5,519	63.0
1996	1,414.0	8.0	250.7	8.0	6.0	8.0	1,504.3	272.5	5,520	63.0
1997	1,527.2	8.0	270.8	8.0	6.0	8.0	1,624.7	294.3	5,520	63.0
1998	1,649.4	8.0	292.5	8.0	6.0	8.0	1,754.7	317.9	5,519	63.0
1999	1,781.3	8.0	315.8	8.0	6.0	8.0	1,895.0	343.3	5,521	63.0
2000	1,923.8	8.0	341.1	8.0	6.0	8.0	2,046.6	370.8	5,520	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: THEMAG.

Table 3: NORTHERN SYSTEM - CASE 3 (THEMAG "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	583.7		102.6		6.0	8.0	621.0	111.5	5,568	63.6
1987	651.6	11.6	113.8	10.9	6.0	8.0	693.2	123.7	5,604	64.0
1988	727.9	11.7	126.7	11.3	6.0	8.0	774.4	137.7	5,623	64.2
1989	813.2	11.7	141.5	11.7	6.0	8.0	865.1	153.8	5,625	64.2
1990	886.3	9.0	154.2	9.0	6.0	8.0	942.9	167.6	5,625	64.2
1991	976.8	10.2	170.8	10.8	6.0	8.0	1,039.1	185.7	5,597	63.9
1992	1,099.0	12.5	194.9	14.1	6.0	8.0	11,69.1	211.8	5,519	63.0
1993	1,197.9	9.0	212.4	9.6	6.0	8.0	1,274.4	230.9	5,520	63.0
1994	1,305.7	9.0	231.5	9.0	6.0	8.0	1,389.0	251.6	5,520	63.0
1995	1,423.2	9.0	252.4	9.0	6.0	8.0	1,514.0	274.3	5,519	63.0
1996	1,537.0	8.0	272.5	8.0	6.0	8.0	1,635.1	296.2	5,520	63.0
1997	1,660.0	8.0	294.4	8.0	6.0	8.0	1,766.0	320.0	5,519	63.0
1998	1,792.8	8.0	317.9	8.0	6.0	8.0	1,907.2	345.5	5,520	63.0
1999	1,936.2	8.0	343.3	8.0	6.0	8.0	2,059.8	373.2	5,520	63.0
2000	2,091.2	8.0	370.8	8.0	6.0	8.0	2,224.7	403.0	5,520	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: THEMAG.

Table 4: NORTHERN SYSTEM - CASE 4 (THEMAG "HIGH" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	630.4		110.8		6.0	8.0	670.6	120.4	5,568	63.6
1987	703.7	11.6	122.9	10.9	6.0	8.0	748.6	133.6	5,604	64.0
1988	786.1	11.7	136.8	11.3	6.0	8.0	836.3	148.7	5,624	64.2
1989	878.3	11.7	152.8	11.7	6.0	8.0	934.4	166.1	5,626	64.2
1990	957.3	9.0	166.5	9.0	6.0	8.0	1,018.4	181.0	5,627	64.2
1991	1,054.9	10.2	184.5	10.8	6.0	8.0	1,122.2	200.5	5,596	63.9
1992	1,186.9	12.5	210.5	14.1	6.0	8.0	1,262.7	228.8	5,519	63.0
1993	1,293.7	9.0	229.4	9.0	6.0	8.0	1,376.3	249.3	5,520	63.0
1994	1,410.2	9.0	250.0	9.0	6.0	8.0	1,500.2	271.7	5,521	63.0
1995	1,537.1	9.0	272.6	9.0	6.0	8.0	1,635.2	296.3	5,519	63.0
1996	1,660.0	8.0	294.3	8.0	6.0	8.0	1,766.0	319.9	5,520	63.0
1997	1,792.8	8.0	318.0	8.1	6.0	8.0	1,907.2	345.7	5,518	63.0
1998	1,936.2	8.0	343.3	8.0	6.0	8.0	2,059.8	373.2	5,520	63.0
1999	2,091.1	8.0	370.8	8.0	6.0	8.0	2,224.6	403.0	5,519	63.0
2000	2,258.4	8.0	400.5	8.0	6.0	8.0	2,402.6	435.3	5,519	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: THEMAG.

Table 5: NORTHERN SYSTEM - CASE 5 (MISSION "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	569.5		101.0		6.0	8.0	605.9	109.8	5,519	63.0
1987	580.9	2.0	103.0	2.0	6.0	8.0	618.0	112.0	5,519	63.0
1988	592.5	2.0	105.1	2.0	6.0	8.0	630.3	114.2	5,519	63.0
1989	604.4	2.0	107.2	2.0	6.0	8.0	642.9	116.5	5,519	63.0
1990	616.4	2.0	109.3	2.0	6.0	8.0	655.8	118.8	5,519	63.0
1991	628.8	2.0	111.5	2.0	6.0	8.0	668.9	121.2	5,519	63.0
1992	647.6	3.0	114.9	3.0	6.0	8.0	689.0	124.8	5,519	63.0
1993	680.0	5.0	120.6	5.0	6.0	8.0	723.4	131.1	5,519	63.0
1994	734.4	8.0	130.2	8.0	6.0	8.0	781.3	141.6	5,519	63.0
1995	807.9	10.0	143.3	10.0	6.0	8.0	859.4	155.7	5,519	63.0
1996	904.8	12.0	160.5	12.0	6.0	8.0	962.6	174.4	5,519	63.0
1997	1,013.4	12.0	179.7	12.0	6.0	8.0	1,078.1	195.3	5,519	63.0
1998	1,135.0	12.0	201.3	12.0	6.0	8.0	1,207.4	218.8	5,519	63.0
1999	1,259.8	11.0	223.4	11.0	6.0	8.0	1,340.3	242.9	5,519	63.0
2000	1,373.2	9.0	243.5	9.0	6.0	8.0	1,460.9	264.7	5,519	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 6: NORTHERN SYSTEM - CASE 6 (MISSION "INTERMEDIATE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	569.5		101.0		6.0	8.0	605.9	109.8	5,519	63.0
1987	580.9	2.0	103.0	2.0	6.0	8.0	618.0	112.0	5,519	63.0
1988	592.5	2.0	105.1	2.0	6.0	8.0	630.	114.2	5,519	63.0
1989	610.3	3.0	108.2	3.0	6.0	8.0	649.2	117.6	5,519	63.0
1990	640.8	5.0	113.6	5.0	6.0	8.0	681.7	123.5	5,519	63.0
1991	672.8	5.0	119.3	5.0	6.0	8.0	715.8	129.7	5,519	63.0
1992	719.9	7.0	127.7	7.0	6.0	8.0	765.9	138.8	5,519	63.0
1993	777.5	8.0	137.9	8.0	6.0	8.0	827.2	149.9	5,519	63.0
1994	855.3	10.0	151.7	10.0	6.0	8.0	909.9	164.9	5,519	63.0
1995	957.9	12.0	169.9	12.0	6.0	8.0	1,019.1	184.7	5,519	63.0
1996	1,072.9	12.0	190.3	12.0	6.0	8.0	1,141.3	206.8	5,519	63.0
1997	1,201.6	12.0	213.1	12.0	6.0	8.0	1,278.3	231.6	5,519	63.0
1998	1,333.8	11.0	236.5	11.0	6.0	8.0	1,418.9	257.1	5,519	63.0
1999	1,453.8	9.0	257.8	9.0	6.0	8.0	1,546.6	280.3	5,519	63.0
2000	1,570.1	8.0	278.5	8.0	6.0	8.0	1,670.4	302.7	5,519	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 7: NORTHERN SYSTEM - CASE 7 (MISSION "HIGH SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	569.5		101.0		6.0	8.0	605.9	109.8	5,519	63.0
1987	590.9	2.0	103.0	2.0	6.0	8.0	618.0	112.0	5,520	63.0
1988	592.5	2.0	105.1	2.0	6.0	8.0	630.3	114.2	5,520	63.0
1989	610.3	3.0	108.2	3.0	6.0	8.0	649.2	117.6	5,520	63.0
1990	659.1	8.0	116.9	8.0	6.0	8.0	701.2	127.0	5,520	63.0
1991	725.0	10.0	128.6	10.0	6.0	8.0	771.3	139.7	5,520	63.0
1992	812.0	12.0	114.0	12.0	6.0	8.0	863.8	156.5	5,520	63.0
1993	909.5	12.0	161.3	12.0	6.0	8.0	967.5	175.3	5,520	63.0
1994	1,019.6	12.0	180.6	12.0	6.0	8.0	1,083.6	196.3	5,520	63.0
1995	1,130.6	11.0	200.5	11.0	6.0	8.0	1,202.8	217.9	5,520	63.0
1996	1,232.4	9.0	218.5	9.0	6.0	8.0	1,211.1	237.5	5,520	63.0
1997	1,331.0	8.0	236.0	8.0	6.0	8.0	1,415.9	256.5	5,520	63.0
1998	1,437.5	8.0	254.9	8.0	6.0	8.0	1,529.2	277.0	5,520	63.0
1999	1,552.5	8.0	275.3	8.0	6.0	8.0	1,651.6	299.2	5,220	63.0
2000	1,676.7	8.0	297.3	8.0	6.0	8.0	1,783.7	323.1	5,520	63.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 8: CENTRAL SYSTEM - CASE 1 (BEP STUDY)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	191.0		37.2		6.0	8.0	203.2	40.4	5,025	57.4
1987	203.7	6.7	39.8	6.9	6.0	8.0	216.7	43.2	5,014	57.2
1988	217.3	6.7	42.5	6.9	6.0	8.0	231.2	46.2	5,003	57.1
1989	231.8	6.7	45.5	6.9	6.0	8.0	246.6	49.4	4,991	57.0
1990	247.3	6.7	48.6	6.9	6.0	8.0	263.1	52.8	4,980	56.9
1991	284.2	14.9	55.6	14.3	6.0	8.0	302.4	60.4	5,006	57.1
1992	326.7	14.9	63.5	14.3	6.0	8.0	347.6	69.1	5,032	57.4
1993	375.5	14.9	72.7	14.3	6.0	8.0	399.5	79.0	5,058	57.7
1994	431.6	14.9	83.1	14.3	6.0	8.0	459.0	90.3	5,085	58.0
1995	496.1	14.9	95.0	14.3	6.0	8.0	527.8	103.3	5,111	58.3
1996	531.3	7.1	101.5	6.9	6.0	8.0	565.2	110.4	5,121	58.5
1997	568.9	7.1	108.5	6.9	6.0	8.0	605.2	118.0	5,131	58.6
1998	609.3	7.1	116.0	6.9	6.0	8.0	648.1	126.1	5,141	58.7
1999	652.4	7.1	124.0	6.9	6.0	8.0	694.1	134.8	5,151	58.8
2000	698.7	7.1	132.5	6.9	6.0	8.0	743.3	144.0	5,161	58.9

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 9: CENTRAL SYSTEM - CASE 2 (THEMAG "LOW" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	143.0		29.6		6.0	8.0	152.1	32.2	4,728	54.0
1987	151.5	5.9	31.4	6.1	6.0	8.0	161.2	34.1	4,722	53.9
1988	160.6	6.0	33.3	6.1	6.0	8.0	170.9	36.2	4,720	53.9
1989	182.3	13.5	38.3	15.0	6.0	8.0	193.9	41.6	4,659	53.2
1990	210.7	15.6	44.7	16.7	6.0	8.0	224.1	48.6	4,612	52.7
1991	229.6	9.0	48.8	9.0	6.0	8.0	244.3	53.0	4,610	52.6
1992	250.3	9.0	53.1	9.0	6.0	8.0	266.3	57.7	4,612	52.6
1993	272.9	9.0	57.9	9.0	6.0	8.0	290.3	62.9	4,613	52.7
1994	297.4	9.0	63.1	9.0	6.0	8.0	316.4	68.6	4,613	52.7
1995	324.2	9.0	68.8	9.0	6.0	8.0	344.9	74.7	4,615	52.7
1996	350.2	8.0	74.2	8.0	6.0	8.0	372.6	80.7	4,617	52.7
1997	378.1	8.0	80.2	8.0	6.0	8.0	402.2	87.2	4,614	52.7
1998	408.4	8.0	86.7	8.1	6.0	8.0	434.5	94.2	4,610	52.6
1999	441.0	8.0	93.6	8.0	6.0	8.0	469.1	101.7	4,611	52.6
2000	476.4	8.0	101.1	8.0	6.0	8.0	506.8	109.9	4,612	52.6

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 10: CENTRAL SYSTEM - CASE 3 (THEMAG "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	155.4		32.2		6.0	8.0	165.3	35.0	4,723	53.9
1987	164.7	6.0	34.1	5.9	6.0	8.0	175.2	37.1	4,727	54.0
1988	174.6	6.0	36.2	6.2	6.0	8.0	185.7	39.3	4,721	53.9
1989	198.2	13.5	41.6	14.9	6.0	8.0	210.9	45.2	4,663	53.2
1990	228.9	15.5	48.6	16.8	6.0	8.0	243.5	52.8	4,610	52.6
1991	249.6	9.0	53.0	9.1	6.0	8.0	265.5	57.6	4,609	52.6
1992	272.1	9.0	57.7	8.9	6.0	8.0	239.5	62.8	4,613	52.7
1993	296.6	9.0	62.9	9.0	6.0	8.0	315.5	68.4	4,615	52.7
1994	323.3	9.0	68.6	9.1	6.0	8.0	343.9	74.6	4,613	52.7
1995	352.3	9.0	74.8	9.0	6.0	8.0	374.8	81.3	4,612	52.6
1996	380.6	8.0	80.7	8.0	6.0	8.0	404.9	87.8	4,614	52.7
1997	411.0	8.0	87.2	8.0	6.0	8.0	437.2	94.8	4,613	52.7
1998	443.9	8.0	94.2	8.0	6.0	8.0	472.2	102.4	4,612	52.6
1999	479.4	8.0	101.7	8.0	6.0	8.0	510.0	110.5	4,614	52.7
2000	517.8	8.0	109.9	8.1	6.0	8.0	550.9	119.5	4,611	52.6

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 11: CENTRAL SYSTEM - CASE 4 (THEMAG "HIGH" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	167.8		34.8		6.0	8.0	178.5	37.8	4,719	53.9
1987	177.9	6.0	36.8	5.7	6.0	8.0	189.3	40.0	4,731	54.0
1988	188.6	6.0	39.1	6.3	6.0	8.0	200.6	42.5	4,721	53.9
1989	214.1	13.5	44.9	14.8	6.0	8.0	227.8	48.8	4,667	53.3
1990	247.3	15.5	52.5	16.9	6.0	8.0	263.1	57.1	4,610	52.6
1991	269.6	9.0	57.2	9.0	6.0	8.0	286.8	62.2	4,613	52.7
1992	293.9	9.0	62.3	8.9	6.0	8.0	312.7	67.7	4,617	52.7
1993	320.3	9.0	67.9	9.0	6.0	8.0	340.7	73.8	4,617	52.7
1994	349.2	9.0	74.1	9.0	6.0	8.0	371.5	80.5	4,612	52.7
1995	380.6	9.0	80.8	9.0	6.0	8.0	404.9	87.8	4,610	52.6
1996	411.0	8.0	87.2	7.9	6.0	8.0	437.2	94.8	4,613	52.7
1997	443.9	8.0	94.2	8.0	6.0	8.0	472.2	102.4	4,612	52.6
1998	479.4	8.0	101.7	8.0	6.0	8.0	510.0	110.5	4,614	52.7
1999	517.8	8.0	1098	8.0	6.0	8.0	550.9	119.3	4,616	52.7
2000	559.2	8.0	118.7	8.1	6.0	8.0	594.9	129.0	4,611	52.6

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 12: CENTRAL SYSTEM - CASE 5 (MISSION "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	90.0		17.0		6.0	8.0	95.7	18.5	5,181	59.1
1987	91.8	2.0	17.3	2.0	6.0	8.0	97.7	18.8	5,181	59.1
1988	94.6	3.0	17.9	3.0	6.0	8.0	100.6	19.4	5,181	59.1
1989	99.3	5.0	18.6	4.0	6.0	8.0	105.6	20.2	5,231	59.7
1990	108.2	9.0	20.1	8.0	6.0	8.0	115.1	21.8	5,280	60.3
1991	118.0	9.0	21.7	8.0	6.0	8.0	125.5	23.5	5,329	60.8
1992	129.8	10.0	23.4	8.0	6.0	8.0	138.0	25.4	5,427	52.0
1993	142.7	10.0	25.7	10.0	6.0	8.0	151.8	28.0	5,427	62.0
1994	159.9	12.0	28.6	11.0	6.0	8.0	170.1	31.1	5,476	62.5
1995	183.8	15.0	32.9	15.0	6.0	8.0	195.6	35.7	5,476	62.5
1996	211.4	15.0	37.8	15.0	6.0	8.0	224.9	41.1	5,476	62.5
1997	236.8	12.0	42.3	12.0	6.0	8.0	251.9	46.0	5,476	62.5
1998	262.8	11.0	47.0	11.0	6.0	8.0	279.6	51.1	5,476	62.5
1999	286.5	9.0	51.2	9.0	6.0	8.0	304.8	55.7	5,476	62.5
2000	309.4	8.0	55.3	8.0	6.0	8.0	329.1	60.1	5,476	62.5

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 13: CENTRAL SYSTEM - CASE 6 (MISSION "INTERMEDIATE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	90.0		17.0		6.0	8.0	95.7	18.5	5,181	59.1
1987	91.8	2.0	17.3	2.0	6.0	8.0	97.7	18.8	5,181	59.1
1988	94.6	3.0	17.9	3.0	6.0	8.0	100.6	19.4	5,181	59.1
1989	101.2	7.0	18.9	6.0	6.0	8.0	107.6	20.6	5,230	59.7
1990	112.3	11.0	20.8	10.0	6.0	8.0	119.5	22.6	5,278	60.3
1991	125.8	12.0	22.9	10.0	6.0	8.0	133.8	24.9	5,374	61.3
1992	142.1	13.0	25.9	13.0	6.0	8.0	151.2	28.1	5,374	61.3
1993	163.4	15.0	29.3	13.0	6.0	8.0	173.9	31.8	5,469	62.4
1994	188.0	15.0	33.6	15.0	6.0	8.0	200.0	36.6	5,469	62.4
1995	216.2	15.0	38.7	15.0	6.0	8.0	230.0	42.0	5,469	62.4
1996	242.1	12.0	43.3	12.0	6.0	8.0	257.6	47.1	5,469	52.4
1997	271.2	12.0	48.5	12.0	6.0	8.0	288.5	52.7	5,469	62.4
1998	303.7	12.0	54.3	12.0	6.0	8.0	323.1	59.1	5,469	62.4
1999	337.1	11.0	60.3	11.0	6.0	8.0	358.6	65.6	5,469	62.4
2000	367.4	9.0	65.8	9.0	6.0	8.0	390.9	71.5	5,469	62.4

Note: *Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.*

Source: Mission estimates.

Table 14: CENTRAL SYSTEM - CASE 7 (MISSION "HIGH" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	90.0		17.0		6.0	8.0	95.7	18.5	5,181	59.1
1987	91.8	2.0	17.3	2.0	6.0	8.0	97.7	18.8	5,181	59.1
1988	94.6	3.0	17.9	3.0	6.0	8.0	100.6	19.4	5,181	59.1
1989	105.9	12.0	19.8	11.0	6.0	8.0	112.7	21.5	5,228	59.7
1990	125.0	18.0	22.8	15.0	6.0	8.0	132.9	24.8	5,365	61.2
1991	152.5	22.0	27.4	20.0	6.0	8.0	162.2	29.7	5,454	62.3
1992	179.9	18.0	32.3	18.0	6.0	8.0	191.4	35.1	5,454	62.3
1993	206.9	15.0	37.1	15.0	6.0	8.0	220.1	40.4	5,454	62.3
1994	237.9	15.0	42.7	15.0	6.0	8.0	253.1	46.4	5,454	62.3
1995	266.5	12.0	47.8	12.0	6.0	8.0	283.5	52.0	5,454	62.3
1996	298.4	12.0	53.6	12.0	6.0	8.0	317.5	58.2	5,454	62.3
1997	331.3	11.0	59.4	11.0	6.0	8.0	352.4	64.6	5,454	62.3
1998	361.1	9.0	64.8	9.0	6.0	8.0	384.1	70.4	5,454	62.3
1999	390.0	8.0	70.0	8.0	6.0	8.0	414.9	76.1	5,454	62.3
2000	421.2	8.0	75.6	8.0	6.0	8.0	448.0	82.2	5,454	62.3

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 15: SOUTHERN SYSTEM - CASE 1 (BEP STUDY)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	50.2		10.3		6.0	8.0	53.4	11.2	4,770	54.5
1987	53.1	5.8	10.9	5.8	6.0	8.0	56.5	11.8	4,769	54.4
1988	56.1	5.8	11.5	5.8	6.0	8.0	59.7	12.5	4,767	54.4
1989	59.4	5.8	12.2	5.8	6.0	8.0	63.2	13.3	4,766	54.4
1990	62.8	5.8	12.9	5.8	6.0	8.0	66.8	14.0	4,765	54.4
1991	72.0	14.6	14.7	13.9	6.0	8.0	76.6	16.0	4,796	54.7
1992	82.5	14.6	16.7	13.9	6.0	8.0	87.8	18.2	4,827	55.1
1993	94.5	14.6	19.0	13.9	6.0	8.0	100.6	20.7	4,858	55.5
1994	103.4	14.6	21.7	13.9	6.0	8.0	115.3	23.6	4,890	55.8
1995	124.2	14.6	24.7	13.9	6.0	8.0	132.1	26.8	4,921	56.2
1996	133.9	7.8	26.6	7.5	6.0	8.0	142.5	28.9	4,936	56.3
1997	144.4	7.8	28.6	7.5	6.0	8.0	153.6	31.0	4,950	56.5
1998	155.7	7.8	30.7	7.5	6.0	8.0	165.7	33.4	4,964	56.7
1999	167.9	7.8	33.0	7.5	6.0	8.0	178.7	35.9	4,978	56.8
2000	181.1	7.8	35.5	7.5	6.0	8.0	192.7	38.6	4,993	57.0

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 16: SOUTHERN SYSTEM - CASE 2 (THEMAG "LOW" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	65.9		13.9		6.0	8.0	70.1	15.1	4,640	53.0
1987	69.8	5.9	14.7	5.8	6.0	8.0	74.3	16.0	4,647	53.1
1988	74.0	6.0	15.6	6.1	6.0	8.0	78.7	17.0	4,643	53.0
1989	78.5	6.1	16.6	6.4	6.0	8.0	83.5	18.0	4,628	52.8
1990	88.5	12.7	18.8	13.0	6.0	8.0	94.1	20.4	4,617	52.7
1991	96.4	8.9	20.5	9.0	6.0	8.0	102.6	22.2	4,614	52.7
1992	105.1	9.0	22.3	9.0	6.0	8.0	111.8	24.2	4,615	52.7
1993	114.5	8.9	24.3	9.0	6.0	8.0	121.8	26.4	4,612	52.6
1994	124.8	9.0	26.5	9.1	6.0	8.0	132.8	28.8	4,607	52.6
1995	136.1	9.1	28.9	9.0	6.0	8.0	144.8	31.4	4,609	52.6
1996	147.0	8.0	31.2	8.0	6.0	8.0	156.4	33.9	4,611	52.6
1997	158.8	8.0	33.7	8.0	6.0	8.0	168.9	36.6	4,612	52.6
1998	171.5	8.0	36.4	8.0	6.0	8.0	182.4	39.6	4,611	52.6
1999	185.2	8.0	39.3	8.0	6.0	8.0	197.0	42.7	4612	52.7
2000	200.0	8.0	42.5	8.0	6.0	8.0	212.8	46.1	4,611	52.6

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 17: SOUTHERN SYSTEM - CASE 3 (THEMAG "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	71.6		15.1		6.0	8.0	76.2	16.4	4,641	53.0
1987	75.9	6.0	16.0	6.0	6.0	8.0	80.7	17.4	4,643	53.0
1988	80.4	5.9	17.0	6.3	6.0	88.0	85.5	18.5	4,629	52.8
1989	85.3	6.1	18.0	5.9	6.0	8.0	90.7	19.6	4,638	52.9
1990	96.2	12.8	20.4	13.3	6.0	8.0	102.3	22.2	4,615	52.7
1991	104.8	8.9	22.2	9.0	6.0	8.0	111.5	24.2	4,614	52.7
1992	114.2	9.0	24.2	9.0	6.0	8.0	121.5	26.3	4,613	52.7
1993	124.5	9.0	26.4	9.0	6.0	8.0	132.4	28.7	4,616	52.7
1994	135.7	9.0	29.8	9.0	6.0	8.0	144.4	31.3	4,615	52.7
1995	147.9	9.0	31.4	9.0	6.0	8.0	157.3	34.1	4,613	52.7
1996	159.8	8.0	33.9	8.0	6.0	8.0	170.0	36.8	4,614	52.7
1997	172.6	8.0	36.6	8.0	6.0	8.0	183.6	39.8	4,616	52.7
1998	186.4	8.0	39.5	8.0	6.0	8.0	198.3	43.0	4,616	52.7
1999	201.3	8.0	42.7	8.0	6.0	8.0	214.1	46.4	4,614	52.7
2000	217.4	8.0	46.1	8.0	6.0	8.0	231.3	50.1	4,615	52.7

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 18: SOUTHERN SYSTEM - CASE 4 (THEMAG "HIGH" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	77.3		16.3		6.0	8.0	82.2	17.7	4,614	53.0
1987	82.0	6.1	17.3	6.1	6.0	8.0	87.2	18.8	4,639	53.0
1988	86.8	5.9	18.4	6.4	6.0	8.0	92.3	20.0	4,617	52.7
1989	92.1	6.1	19.4	5.4	6.0	8.0	98.0	21.1	4,646	53.0
1990	103.9	12.8	22.0	13.4	6.0	8.0	110.5	23.9	4,622	52.8
1991	113.2	9.0	24.0	9.0	6.0	8.0	120.4	26.1	4,620	52.7
1992	123.3	8.9	26.1	9.0	6.0	8.0	131.2	28.4	4,617	52.7
1993	134.5	9.1	28.5	9.0	6.0	8.0	143.1	31.0	4,621	52.7
1994	146.6	9.0	31.1	9.1	6.0	8.0	156.0	33.8	4,615	52.7
1995	159.7	8.9	33.9	9.0	6.0	8.0	169.9	36.8	4,611	52.6
1996	172.6	8.1	36.6	8.0	6.0	8.0	183.6	39.8	4,616	52.7
1997	186.4	8.0	39.5	8.0	6.0	8.0	198.3	43.0	4,616	52.7
1998	201.3	8.0	42.7	8.0	6.0	8.0	214.1	46.4	4,614	52.7
1999	217.4	8.0	46.1	8.0	6.0	8.0	231.3	50.1	4,615	52.7
2000	234.8	8.0	49.8	8.0	6.0	8.0	249.8	54.1	4,615	52.7

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 19: SOUTHERN SYSTEM - CASE 5 (MISSION "BASE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	50.0		9.5		8.0	10.0	54.3	10.6	5,149	58.8
1987	50.5	1.0	9.7	2.0	8.0	10.0	54.9	10.8	5,098	58.2
1988	51.0	1.0	10.0	3.0	8.0	10.0	55.4	11.1	4,999	57.1
1989	52.0	2.0	10.2	2.0	8.0	10.0	56.5	11.3	4,999	57.1
1990	53.6	3.0	10.5	3.0	8.0	10.0	58.2	11.7	4,999	57.1
1991	56.3	5.0	11.0	5.0	8.0	10.0	61.2	12.2	4,999	57.1
1992	59.1	5.0	11.6	5.0	8.0	10.0	64.2	12.8	4,999	57.1
1993	63.8	8.0	12.5	8.0	8.0	10.0	69.4	13.9	4,999	57.1
1994	71.5	12.0	14.0	12.0	8.0	10.0	77.7	15.5	4,999	57.1
1995	77.9	9.0	15.2	9.0	8.0	10.0	84.7	16.9	4,999	57.1
1996	84.1	8.0	16.5	8.0	8.0	10.0	91.4	18.3	4,999	57.1
1997	90.9	8.0	17.8	8.0	8.0	10.0	98.8	19.8	4,999	57.1
1998	98.1	8.0	19.2	8.0	8.0	10.0	106.7	21.3	4,999	57.1
1999	106.0	8.0	20.7	8.0	8.0	10.0	115.2	23.0	4,999	57.1
2000	114.5	8.0	22.4	8.0	8.0	10.0	124.4	24.9	4,999	57.1

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 20: SOUTHERN SYSTEM - CASE 6 (MISSION "INTERMEDIATE" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	50.0		9.5		8.0	10.0	54.3	10.6	5,149	58.8
1987	50.5	1.0	9.7	2.0	8.0	10.0	54.9	10.8	5,098	58.2
1988	51.0	1.0	10.0	3.0	8.0	10.0	55.4	11.1	4,999	57.1
1989	52.5	3.0	10.3	3.0	8.0	10.0	57.1	11.4	4,999	57.1
1990	55.2	5.0	10.8	5.0	8.0	10.0	60.0	12.0	4,999	57.1
1991	59.6	8.0	11.7	8.0	8.0	10.0	64.8	13.0	4,999	57.1
1992	65.5	10.0	12.8	10.0	8.0	10.0	71.2	14.2	4,999	57.1
1993	73.4	12.0	14.4	12.0	8.0	10.0	79.8	16.0	4,999	57.1
1994	84.4	15.0	16.5	15.0	8.0	10.0	91.7	18.4	4,999	57.1
1995	93.7	11.0	18.3	11.0	8.0	10.0	101.8	20.4	4,999	57.1
1996	101.2	8.0	19.8	8.0	8.0	10.0	110.0	22.0	4,999	57.1
1997	109.3	8.0	21.4	8.0	8.0	10.0	118.8	23.8	4,999	57.1
1998	118.0	8.0	23.1	8.0	8.0	10.0	128.3	35.7	4,999	57.1
1999	127.5	8.0	24.9	8.0	8.0	10.0	138.5	27.7	4,999	57.1
2000	137.7	8.0	26.9	8.0	8.0	10.0	149.6	29.9	4,999	57.1

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

Table 21: SOUTHERN SYSTEM - CASE 7 (MISSION "HIHJ" SCENARIO)
Energy and demand forecasts, 1986-2000

	Energy		Peak demand		Transmission losses		Generation requirements		Load factor at Generation	
	Consum at HV	Annu Grow	at HV	Annu Grow	Energy	Demand	Energy	Demand		
Year	GWh	%	MW	%	%	%	GWh	MW	Hours	%
1986	50.0		9.5		8.0	10.0	54.3	10.6	5,149	58.8
1987	50.5	1.0	9.7	2.0	8.0	10.0	54.9	10.8	5,098	58.2
1988	51.0	1.0	10.0	3.0	8.0	10.0	55.4	11.1	4,999	57.1
1989	54.1	6.0	10.6	6.0	8.0	10.0	58.8	11.8	4,999	57.1
1990	57.3	6.0	11.2	6.0	8.0	10.0	62.3	12.5	4,999	57.1
1991	65.9	15.0	12.9	15.0	8.0	10.0	71.6	14.3	4,999	57.1
1992	75.8	15.0	14.8	15.0	8.0	10.0	82.4	16.5	4,999	57.1
1993	87.2	15.0	17.1	15.0	8.0	10.0	94.7	19.0	4,999	57.1
1994	96.7	11.0	18.9	11.0	8.0	10.0	105.2	21.0	4,999	57.1
1995	105.5	9.0	20.6	9.0	8.0	10.0	114.6	22.9	4,999	57.1
1996	113.9	8.0	22.3	8.0	8.0	10.0	123.8	24.8	4,999	57.1
1997	123.0	8.0	24.1	8.0	8.0	10.0	133.7	26.7	4,999	57.1
1998	132.8	8.0	26.0	8.0	8.0	10.0	144.4	28.9	4,999	57.1
1999	143.5	8.0	28.1	8.0	8.0	10.0	155.9	31.2	4,999	57.1
2000	154.9	8.0	30.3	8.0	8.0	10.0	168.4	33.7	4,999	57.1

Note: Annu: Annual; Consum: Consumption; Grow: Growth; HV: High voltage.

Source: Mission estimates.

BEP and THEMAG Studies

6. Projections for the period 1986-2005 made by both consultant groups are based on the following assumptions:

(a) BEP assigns an important consumption to the Viana substation (increasing from 9% to 16% of Luanda consumption over the 1986-2005 period) while for THEMAG such consumption is negligible;

(b) demand at the Mabubas substation is neglible for BEP and about 10% of that of Luanda in the THEMAG projection;

(c) THEMAG allows for an increase in the demand connected to Malanga between 1986 and 1990, due to a requirement of 15 MW at the Capanda site during building. BEP does not consider such a requirement;

(d) BEP assumes Uige is supplied by the Southern System from 1986 while THEMAG considers its connection in 1995, with a nigher demand;

(e) BEP assumes a doubling of consumption by Lobito and Benguela between 1990 and 1995. THEMAG limits the increase to 55% for the same period; and

(f) THEMAG assumes a significant consumption at Jamba (Matala) corresponding to a resumption of iron-mining activities in Cassinga from 1986.

7. Up to the year 2000, the mission has outlined three scenarios for the evolution of demand on the three main Systems: "Base", "High", and "Intermediate". As no substantial changes are expected in the short-term, all scenarios use MEP projections for 1987 and 1988 (with minor corrections). After that date, the "Base" scenario assumes a decrease of acts of sabotage but the continuation of economic difficulties, with economic recovery beginning in 1993. The "High" scenario assumes a cessation of sabotage in 2-3 years with improved economic conditions facilitating a quicker recovery with high growth rates of electricity consumption. The "Intermediate" scenario assumes a restoration of peace before 1990 with a slower rate of economic recovery than in the "High" scenario.

8. Different rates of growth as well as load factors were assumed for the three systems to take into account different load characteristics, the relative predominance of industrial loads and higher-income residential loads, existing trends and, absolute values in

1974 (just before independence), present constraints on supply facilities and realistic schedules for their rehabilitation and, when available, potential demand of previously high industrial load whose resumption is linked to the general economic recovery by Angolan authorities. With no reliable information existing on realistic operational investment programs, the scenarios do not anticipate new, sizeable, discrete industrial loads.

9. Mission projections were based on overall general assumptions and on assumptions for each of the three main systems:

General Assumptions

(i) No significant load increase, under all scenarios, until 1989. The general disarray of the economy, particularly foreign currency constraints, prevents industrial recovery on the demand side as well as rehabilitation or extension of the distribution networks. Repressed residential demand will not be met until that date.

(ii) Load (Energy and Demand) is calculated and projected at HV busbars of main substations and includes losses in MV distribution networks.

(iii) Losses in transmission systems (220, 150 and 150 kV and 60 kV in the Southern System) are arbitrarily set at 6% for energy and 8% for peak demand (% of generation) for all the systems.

(iv) Influence of possible HV interconnections among systems is not considered.

(v) Supply constraints are assumed to be only those existing in 1987. The timing of rehabilitation projects to reduce these constraints has been tentatively scheduled. No additional major supply constraint is envisaged.

Northern System

(i) Load factor at generation assumed to be around 0.63 (5,500 hours).

(ii) Energy and Demand, at HV level, have the same annual growth rates.

(iii) "Low" scenario assumes a low capacity of EDEL to develop the Luanda distribution network and no further HV transmission net extensions until 1992. Load grows at 2% until 1991 with substantial growth rates of 8% taking place only after 1994.

(iv) "High" scenario is associated with high growth rates, starting with 8% in 1990, increasing to 12% between 1992-94 and stabilizing at 8% from 1997 onwards. It assumes development and rehabilitation of the Luanda network, recovery of industrial loads, and the possibility of a gradual supply of repressed demand.

Central System

(i) Energy growth rates in initial years are higher than those of demand due to a normalization of supply from the system. Annual load factor increases from 0.59 (in 1986) to nearly 0.625 in a variable number of years depending on the scenario.

(ii) Energy consumption and generation value for 1986 and 1987 are higher than those presented by MEP. A large share of captive diesel sets (about 15 GWh) is considered.

(iii) "Low" scenario implies a slow recovery of consumption and longer supply constraints. Pre-independence levels of 1974 are obtained only by 1994.

(iv) "High" scenario assumes supply constraints are overcome by 1990 and consumption resumes quickly with growth rates of between 18-22% for the 1990-92 period.

(v) The "Intermediate" scenario assumes recovery beginning in 1990, developing at a slower pace than in the "High" scenario, and lasting longer.

Southern System

(i) Load factor remains constant around 0.57 (5,000 hours).

(ii) Energy and Demand growth rates are similar.

(iii) Different assumptions on the resumption of iron-mining activities at Cassinga account for notable distinctions among the three scenarios. In the "Base" scenario, recovery starts in 1991 with increases of 1.2 MW per year. Recovery also begins in 1991 for the "High" scenario and increases by about 2 MW per year. The "Intermediate" scenario accounts for a similar development but at a slower pace. Iron mining in Cassinga may not resume, in which case all scenarios are over-estimated. The mines have been depleted of higher quality ores. A "resumption" would essentially mean a fresh mining venture utilizing new installations yielding a different output.

10. A comparison of Energy and Peak Demand generation requirements for typical years for the seven scenarios presented is shown in Table 22.

Table 22: ENERGY DEMAND FORECASTS (1986-2000)
Comparison of Generation Requirements in 7 Scenarios

	Energy (GWh)							Peak Demand (MW)						
		THEMAG			Mission				THEMAG			Mission		
Year	BEP	Low	Base	High	Base	Interm	High	BEP	Low	Base	High	Base	Interm	High
NORTHERN SYSTEM														
1986	505	571	621	671	606	606	606	91.8	102.6	111.5	120.4	109.8	109.8	109.8
1987	554	638	693	749	618	618	618	102.3	113.8	123.7	133.6	112.0	112.0	112.0
1990	732	868	943	1,018	656	682	701	141.1	154.2	167.6	181.0	118.8	123.5	127.0
1995	1,278	1,393	1,514	1,635	859	1,019	1,203	244.0	252.4	274.3	296.3	155.7	184.7	217.9
2000	1,876	2,047	2,225	2,403	1,461	1,670	1,784	365.0	370.8	403.0	436.3	264.7	302.7	323.1
CENTRAL SYSTEM														
1986	203	152	165	179	96	96	96	40.4	32.2	35.0	37.8	18.5	18.5	18.5
1987	217	161	175	189	98	98	98	43.2	34.1	37.1	40.0	18.8	18.8	18.8
1990	263	224	244	263	115	120	135	52.8	48.6	52.8	57.1	21.8	22.6	24.8
1995	528	345	375	405	196	230	284	103.3	74.7	81.3	87.8	35.7	42.0	52.0
2000	743	507	551	595	329	391	448	144.0	109.9	119.5	129.0	60.1	71.5	82.2
SOUTHERN SYSTEM														
1986	53	70	76	82	54	54	54	11.2	15.1	16.4	17.7	10.6	10.6	10.6
1987	57	74	81	87	55	55	55	11.8	16.0	17.4	18.8	10.8	10.8	10.8
1990	67	94	102	111	58	60	62	14.0	20.4	22.2	23.9	11.7	12.0	12.5
1995	132	145	157	170	85	192	115	26.8	31.4	34.1	36.8	16.9	20.4	22.9
2000	193	213	231	250	124	150	168	38.6	46.1	50.1	54.1	24.9	29.9	33.7

Source: BEP, THEMAG, and mission estimates.

ANGOLA - ELECTRICITY TARIFF SYSTEM

1. Since the 1960s, electricity tariffs in Angola have changed only in newly electrified urban areas. In these areas of the country rates have not altered since the initiation of service. As a result, variation in tariffs of the order of 3:1 can often be observed in areas served by the same interconnected system. High levels of demand from existing consumers in traditional urban centers are derived from what are perceived as low price levels.

Low-voltage Tariffs

2. A complex and widely varying declining block structure prevails for low-voltage tariffs with higher rates for residential consumers than for industrial ones. In greater Luanda, low-voltage tariffs, set in 1962, discriminate between residential, commercial, industrial, and public lighting uses, as follows:

(a) residential and commercial tariffs have a declining block structure with block sizes (12 classes) related to house sizes or floor area and minimum monthly bills related to meter caliber (9 classes). The average price of electricity sold is Kz 0.87/kWh;

(b) low-voltage industrial tariffs cover 2% of sales and are three-period, time-of-day tariffs with energy rates declining with load factor and meter caliber. The average price of electricity sold is Kz 0.55/kWh; and

(c) a flat rate of about one-half the average of other low-voltage sales is charged for public lighting.

High-voltage Tariffs

3. High-voltage tariffs include block rates sized as a function of non-coincident peak demand, leading to a decline in average prices with load factor. The billing variables used are non-coincident peak demand and active and reactive energy. The tariffs function as follows:

(a) demand rates increase with load factor;

(b) in Luanda, the marginal price for active energy declines from Kz 1.1/kWh (load factor of 12.5%) to Kz 0.85/kWh (load factor of 25%), and Kz 0.505/kWh (load factor of 100%); and

(c) reactive energy is charged through a monthly bill multiplier-free up to 60% of active energy (cos Ø = 0.8) and charged at a price rising to 63% of the normal rate upon reaching 92% of active energy.

4. Marginal costs in the Northern System are determined by generation and transmission capacity requirements to meet peak demand, and by local grid capacity requirements determined by maximum demand. The present tariff structure cannot be adjusted to the pattern of marginal costs and a step-by-step process is suggested to attain a structure of tariffs more closely related to the Long-Run Marginal Cost (LRMC).

5. To illustrate the complexity of the tariff system, data collected from the Empresa Nacional de Electricidade (ENE), the Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos (SONEFE), and the Empresa de Electricidade de Luanda (EDEL) on tariffs in force in May 1987 is summarized in Tables 1 (LV Residential tariffs), 2 (LV Industrial tariffs), 3 (LV tariffs in EDEL distribution area), and 4 (HV tariffs in the Northern System). Although incomplete, the data cover more than 70% of sales and are adequate to identify the major issues.

Table 1: RESIDENTIAL TARIFFS - 1987

	(1)	(2)	(3)	(4)	(5)
Province	Cabinda	Uige	Malanga	Kwanza Norte	Luanda
Municipality	Cabinda	Cangola	Malanga	Bula Atumba	Luanda, Viana
Interconnected system	-	-	Northern	-	Northern
Number of consumers	5,993 a/	....	....	....	55,551 b/
Enforced since	Before 1965	1973	....	....	1962
Tariff structure	Declining block	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block, block size related to house size (12 classes); monthly fixed rate related to meter size (up to 9 classes)
Block sizes kWh/ Energy rates Kz/kWh					
1	100/6.00	30/5.00	30/5.00	15/6.00	8 to 54/2.50
2	100/3.00	70/4.00	70/4.00	15/5.00	14 to 82/1.50
3	/2.00	150/3.50	150/3.50	70/4.00	/0.70
4		/3.00	/3.00	150/3.50	
5				/3.00	
6					
Minimum monthly demand kWh		15	10	15	3 to 10
Notes		Applicable to non-industrial consumers	Applicable to non-industrial consumers	Applicable to non-industrial consumers	Monthly fixed rate 0.12 to 5 Kz/kVA Average price Kz 0.83/kWh 58% of EDEL energy sales

a/ Total number of LV consumers (1986).
b/ 1983.

Source: ENE, SONEFE, EDEL.

Table 2: RESIDENTIAL TARIFFS - 1987

	(6)	(7)	(8)	(9)	(10)
Province	Kwanza Sul	Benguela	Benguela	Huambo	Bie
Municipality	Libolo	Bolambo	Cubalga	Caala	....
Interconnected system	....	-	-	Central	-
Number of consumers	....	....	....	680 a/	3,300 a/
Enforced since	1973	1973	1974	....	Before 1971
Tariff structure	Declining block with minimum monthly bill	Declining block	Declining block	Declining block with minimum monthly bill	Declining block with minimum monthly bill
Block sizes kWh/ Energy rates Kz/kWh					
1	20/4.50	30/6.00	30/4.00	25/4.00	20/5.00
2	30/3.00	70/4.00	/3.50	25/3.50	20/4.80
3	/2.00	150/3.00		50/3.20	20/4.60
4		/1.50		/2.20	20/4.40
5					20/4.20
6					/4.00
Minimum monthly demand kWh	20		-	10	5
Notes	Applicable to non-industrial consumers. Non-profit institutions and other at Kz 1/kWh	Applicable to non-industrial consumers	Applicable to non-industrial consumers	Applicable to non-industrial consumers; off-peak (18 hours) available at 1.50 to Kw 1.20/kWh Advertising uses charged at Kz 1.00/kWh	Applicable to non-industrial off-peak (18 hours) available Kz 1.50 to 1.20/kWh

a/ Total number of LV consumers (1986).

Source: ENE, SONEFE, EDEL.

Table 3: RESIDENTIAL TARIFFS - 1987

	(11)	(12)	(13)	(14)	(15)
Province	Moxico	Namibe	Huila	Cunene	Lunda Sul
Municipality	Lwena	Namibe	.....	N'Giva	....
Interconnected system	-	Southern	Southern	-	-
Number of consumers	....	3,074 a/	....	....	....
Enforced since	1974	....	1975	1972	1975
Tariff structure	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block with minimum monthyly bill	Declining block wiith minimum monthly bill
Block sizes kWh/ Energy rates Kz/kWh					
1	30/5.00	30/3.50	30/3.50	30/5.00	30/5.00
2	70/4.00	50/2.75	70/2.50	70/4.00	30/4.50
3	150/3.50	/1.25	/1.50	150/3.50	/4.00
4	/3.00			/3.00	
5					
6					
Minimum monthly demand kWh	15	10	15	15	10
Notes	Applicable to non-industrial consumers	Business rate Kz 2.00/kWh; consumers Agriculture Kz 2.00-0.80/kWh; Advertising Kz 1.00/kWh	Applicable to non-industrial consumers Kz 0.83/kWh; Administrations and non-profit organizations entitled to 20% rebate	Applicable to non-industrial consumers	Applicable to non-industrial consumers

a/ Total number of LV consumers (1986).
Source: ENE, SONEFE, EDEL.

Table 4: LOW-VOLTAGE INDUSTRIAL TARIFFS - 1987

	(1)	(2)	(3)	(4)	(5)
Province	Cabinda	Uige	Malange	Kwanza Norte	Kwanza Norte
Municipality	Cabinda	Cangola	Malange	Bula Atumba	N'Dalatando
Interconnected system	-	-	Northern	-	Northern
Number of consumers	....	....	....	....	....
Enforced since	Before 1965	1973	....	....	....
Tariff structure	Declining block	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Time of day energy rates, with declining blocks related to load factor; monthly fixed rated to meter size
Block sizes kWh/ Energy rates Kz/kWh					
1	100/3.00	250/3.00	250/3.00	250/3.00	-
2	400/1.50	/2.50	/2.50	/2.50	
3	/1.00				
4					
5					
6					
Minimum monthly demand kWh	-	100	100	100	
Notes					Energy rates: peak 3 hours: Kz 3.00; off-peak, 8 hours: Kz 0.80; other hours: K2.00-0.85

Source: ENE, SONEFE, EDEL.

Table 5: LOW-VOLTAGE INDUSTRIAL TARIFFS - 1987

	(6)	(7)	(8)	(9)	(10)
Province	Luanda	Kwanza Sul	Benguela	Benguela	Benguela
Municipality	Luanda, Viana	Libolo	-	Balombo	Cubal
Interconnected system	Northern	....	Central	-	-
Number of consumers	333 a/	....	....	....	....
Enforced since	1962	1973	1960	1973	1974
Tariff structure	Time of day energy rates, with declining blocks related to load factor monthly fixed rate related to meter size	Declining block with minimum monthly bill	Declining blocks determined by peak demand (6 classes) and load factor (4 classes)	Declining block with minimum monthly bill	Declining block
Block sizes kWh/ Energy rates Kz/kWh					
1	-	20/4.50	.../1.40 to 0.43	250/3.00	1,000/2.50
2		30/3.00		/1.50	/1.60
3		/2.00			
4					
5					
6					
Minimum monthly demand kWh		20		100	-
Notes	Energy rates: peak, 3 hours: Kz 3.00; off-peak, 9 hours: Kz 0.70; other: Kz 1.80-0.75; average price Kz 1.10-1.20. 2% of EDEL energy sales		Rates applied by CELB		

a/ 1983.

Source: ENE, SONEFE, EDEL.

Table 6: LOW-VOLTAGE INDUSTRIAL TARIFFS - 1987

	(11)	(12)	(13)	(14)	(15)
Province	Huambo	Huambo	Moxico	Namibe	Huila
Municipality	Caala	Caala	Lwena	Namibe	....
Interconnected system	Central	Central	-	Southern	Southern
Number of consumers	....	....	....	....	....
Enforced since	....	....	1974	....	1975
Tariff structure	Declining block with minumum monthly bill	Declining block	Declining block with minimum monthly bill	Declining block with minimum monthly bill	Declining block, with minimum monthly bibill
Block sizes kWh/ Energy rates Kz/kWh					
1	100/2.50	500/2.00	250/3.00	200/2.00	250/1.20
2	/2.00	500/1.80	/2.50	300/1.50	/1.00
3		500/1.50		/1.00	
4		/1.30			
5					
6					
Minimum monthly demand kWh	50	-	100	100	100
Notes	Small industry supplies from 7.00 to 18.00 hr	Other industry supplies from 7.00 to 18.00 hr		HV at Kz 0.80/kWh	

Source: ENE, SONEFE, EDEL.

Table 7: LOW-VOLTAGE INDUSTRIAL TARIFFS - 1987

	(16)	(17)
Province	Cunene	Lunda Sul
Municipality	N'Giva	Saurimo
Interconnected system	-	-
Number of consumers	....	....
Enforced since	1972	1975
Tariff structure	Declining block with minimum monthly bill	Declining block with minimum monthly bill
Block sizes kWh/ Energy rates Kz/kWh		
1	250/3.00	300/4.00
2	/2.50	300/3.00
3		/2.80
4		/3.00
5		
6		
Minimum monthly demand kWh	100	100
Notes		

Source: ENE, SONEFE, EDEL.

Table 8: LOW-VOLTAGE TARIFFS IN EDEL DISTRIBUTION AREA - 1987 (ENFORCED SINCE 1962)

	(1)	(2) a/	(3)	(4)
Tariff designation	General domestic	Lighting and other uses	Industrial power	Public lighting
Consumer type	Residential	Offices, shops	Industry	-
Share in EDEL energy sales b/	58.0%	15.0%	2.0%	2.2%
Number of consumers b/	55,551	6.642	333	737
Tariff structure c/	Declining block, block size related to house size (12 classes); monthly fixed rate related to meter size (up to 9 classes)	Declining block, bloch size related to floor area (6 classes); monthly fixes rate related to meter size (up to 9 classes)	Time of day enery rates: peak: 3 hr, Kz 2.00/kWh; off-peak: 9 hr. Kz 0.70 per kWh; other hours Kz 1.80-0.75/kWh declining with load factor and meter size	Flat rate Kz 0.50 per kWh
Block size range kWh/ Energy rates Kz/kWh:				
1	8 to 54/2.50	30 to 150/2.50	-	-
2	14 to 82/1.50	220 to 350/1.50		
3	/0.70	/0.70		
Minimum monthly demand kWh	3 to 10	Related to meter sixe	....	-
Average price b/ in Kz/kWh	0.83	1.06	1.01	0.50

a/ Shop window lighting and advertising uses may be charged by a declining block tariff: 3 consumers, average price Kz 0.88/kWh. Water heating and cooking and air conditioning uses with dedicated meter may be charged by a tariff close to industrial power tariff: 7 consumers, average price Kz 0.88/kWh.

b/ 1983.

c/ Monthly fixed rate Kz 0.12 to 5.00/kVA of meter caliber.

Source: ENE, SONEFE, EDEL.

Table 9: HIGH-VOLTAGE TARIFFS IN THE NORTHERN SYSTEM

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Utility	SONEFE	SONEF	SONEFE	SONEFE	SONEFE	SONEFE, EDEL	SONEFE
Consumer/s	EDEL	Fina Petroleos	SECIL Nacional Steel Furnace	Siderurgia Nacional Other uses	Siderurgia Benco, and Kwanza Norte	Other in Luanda, Malenga, Uige	Other, Kwanza Sul
Enforced since	....	....	....	....	....	1965	....
Billing variables	12 month, 15 minute peak demand kW; active P, kW; active energy; W, kW; reactive energy. ?	12 month, 15-minute demand: P, kW; active energy: W, kW; reactive energy. ?	12 month, 15-minute peak demand: P, kW; active energy: W, kWh.	Active energy: W, kWh.	12 month, coincident peak demand: P1, kW peak and off-peak energy demand: W1, W2 kWh.	12 month, 15-minute peak demand: P, kW; active energy: W, kWh; utilisation of P: H, hr; reactive energy - Cos Ø	Declining block rates related to 12 month, 15-minute peak demand (6 classes) and load factor (4 classes); reactive energy Cos Ø
Rates (in Kz)	P: 55.8 W: 0.369	P: 62.0 W: 0.410	P: 56.4 W: 0.373	W: 0.163	P1: 0, MAY/OCT P1: 62 NOV/APR W1= W2:0.410 MAY/OCT W1: 0.07 NOV/APR W1: 0.41 NOV/APR -	H ≤ 30: P: 39 W: 0 H < 90: P: 3 W: 1 H < 180: P: 45 W: 0.6 H > 180: P: 45 W: 0.39	P < 50 kW and H < 30 hr: 1.40/kWh .... P > 2,000 kW and H > 90 hours: 0.43/kWh
Reactive energy multipliers for monthly bills						Cos Ø = 0.8.1.000 .... Cos Ø = 0.4:1,573	Cos Ø = 0.8:1,000 .... Cos Ø = 0.4:1,573
Notes			25% rebate on energy input to exported cement.	Interruptible 4 hours November to April		Demand rate increasing and energy rate decreasing with load factor. Average price for EDEL Kz 1.2 to to 1.4, 25 to 28% of EDEL sales.	

Source: ENE, SONEFE, EDEL.

SUMMARY OF THE CAPANDA HYDRO PROJECT

1. In 1982 the Government reached an agreement with a U.S.S.R./Brazilian consortium for the development of a hydroelectric plant at Capanda on the Kwanza River about 400 km southwest of Luanda. In December of that year, a contract was signed and GAMEK, the Office for the Harnessing of the Middle Kwanza, was created to coordinate and supervise the work. GAMEK was placed under the direct supervision of the Minister of Energy and Petroleum (MEP) and is in charge of coordinating and supervising the project.

2. The main contractors for the Project are the Soviet firm TECHNOPROMEXPORT (TPE) and the Brazilian firm, N. ODEBRECHT. TPE, the team-leader, supervises construction. It also supervises related Soviet firms and institutes responsible for geological prospecting, dam design, and equipment supply. N. ODEBRECHT is in charge of the civil works and support infrastructure.

3. Future activities to be carried out under the Project are regulated by "Partial Supplement of Services" agreements consisting of additional contracts. From 1985 to mid-1987, ten "supplements" have been signed--one with the Soviet group and nine with the Brazilian group.

4. The Brazilian utility, FURNAS CENTRAIS ELECTRICAS (FURNAS), holds a contract signed in November 1984, estimated at US$65 million for the provision (on secondment) of higher-level staff to GAMEK to deal with administrative, managerial, and technical issues. In mid-1987, FURNAS had 55 persons seconded to GAMEK, and, by end-1988, about half of the contract value was to have been completed.

5. Large infrastructures were required. With the exception of those in Luanda, those at the work sites are required to counter serious security problems. Access to the site required 75 km of paved roads from Cacuso, with a 100-meter strip cleared on either side for security reasons. Two 30 kV lines from Cacuso were also required for energy supply during construction. In addition to normal facilities, heavy investments were required for transport (airports), health and communications. GAMEK estimated that 2,500 people were working on the site in July 1988 and that 4,200 would by the end of 1989. The shortage of housing in Luanda, and the large numbers of foreign technicians, workers and family members required the construction, in the capital city, of a complete residential and administrative center.

6. Work on the project, on site, started in February 1987 and excavations (deviation tunnel) started in April 1988 with deviation of the river scheduled for July 1989. The dam itself would be built after this date and the first group would come on stream in January 1993. It should be noted that measurements show that the high flow always exceeds 1500 m^3/s, which requires particular care in building the deviation

tunnel (and its not being lined could prove risky). Scheduling would also need to be very careful to avoid forced interruption of work during the high flow period. When Cambambe was built, and in spite of the many precautions taken, the work site was flooded three times.

7. Until recently, feasibility studies undertaken within the framework of the old SONEFE expansion plan offered the only available data on the characteristics of the Project and its position in the development of the Northern System. The plan outlined the building of the Capanda hydroelectric plant in three stages interwoven with developments in Cambambe (150 km downstream).

(a) a "low" dam only for regulatory purposes, creating a reservoir with a total volume of 900 million m^3, and raising the minimum guaranteed flow at Cambambe from 130 to 250 m^3/s;

(b) a "high" dam (height raised roughly 30 meters) creating a reservoir with a total volume of 3,400 million m^3 and guaranteeing a minimum flow in Cambambe of around 350 m^3/s; and

(c) a power plant with an installed capacity of 440 MW (4 x 110 MW).

8. The Government's ostensible decision to develop the middle course of the Kwanza River took priority over the further development of Cambambe. Under the present Project, the three stages are combined. A dam and power plant are to be built at the same time as the dam is being raised to its final height. Finally, and without the help of optimization studies, the capacity to be installed was raised to 520 MW (4 x 130 MW). According to information received from GAMEK in October 1988, the dam will be of gravity type, 110 m high, with a storage capacity of 3700 million m^3 (live storage of 2200 m^3), a regularized annual flow of 500 m^3/s and an average energy output of 2400 GWh.

Project Costs and Investment Program

9. When the decision to proceed with the project was taken, there existed no reasonably firm, recent estimate of the costs of the investment. A figure of about US$1000 million was often quoted for direct costs based on rough updates of old studies without even a design for the dam (which was under discussion at the time}.

10. Only in 1987 did the studies carried out by TPE permitted a decision as to the type of dam and a first estimate of costs. The total direct costs at 1987 prices are estimated at US$1250 million or about $1600 million including financial charges (interest during construction). This total also most probably understates costs as it

allows neither for physical contingencies nor for the high sums needed for certain costs (food, transport, infrastructures) imposed by the difficult conditions under which the project is being executed.

11. The investment program is described in Table 1. Of the US$1246 million of direct costs, at end-1988 about US$500 million had been spent, or about 40% of the total. By the end of 1989, more than 50% of the funds would have been spent. Total financial charges (including interest during construction) amount to about $360 million and average about US$40 million p.a. in the period 1988-1992, a sum which exceeds all other investments in the power subsector over the same period. Including financial charges, total expenditures at end-1988 would have reached US$570 million, US$750 million by end-1989.

12. The project is being financed essentially from external commercial loans as described below:

(a) US$408 million from Banco do Brasil (CACEX) in two tranches, the first tranche of US$308 million granted in December 1984 with a disbursement period of 6.5 years (interest rate of 8%, 7.5 years repayment period starting in June 1991) and a second tranche of $100 million granted in July 1988 to be disbursed before December 1990 (interest rate of 7.15%, a flat, up-front insurance fee of 2%, 7.5 years' repayment period starting in June 1991). Both tranches are guaranteed by petroleum exports under the terms of a contract between SONANGOL and PETROBRAS. Indications in early 1989 were that Banco do Brasil was granting an additional US$120 million and that an additional US$162 million was to be negotiated. Thus, expected financing from Brazil would reach US$690 million.

(b) The U.S.S.R. approved a loan of US$275 million to cover engineering design, manufacturing and installation of Soviet-supplied electromechanical equipment. The loan carries an interest rate of 3% and a repayment period of nine years, including three years of grace.

(c) Other (unidentified) countries were expected to provide US$105 million through supplies' credits. Until mid-1989, only US$8 million had been obtained, from Finland, on hard commercial terms (3 years).

(d) The Government of Angola/State Budget was to provide US$170 million, theoretically in domestic currency--however, as financier of last resort, the Angolan State would have to make up any shortfall.

13. So, theoretically, a financing plan exists for the estimated US$1240 million of direct costs (even though there are unfunded financial

charges during construction of US$360 million). However, as at the end of 1988 only US$691 million was firmly committed, which means that there is a financial gap of US$912 million (or US$555 million, excluding interest during construction). Excluding Soviet financing, cumulative expenditures at the end of 1988 exceeded firm commitments, thereby raising serious questions as to the feasibility of continuing the work on the current schedule.

Alternate Expansion Programs

14. Energy production costs at Capanda cannot be assessed precisely because of insufficient and unreliable information. However, based on optimistic forecasts for demand expansion, (requiring 915 GWh in 1992 and 1280 GWh in 1995, in the Northern Grid), the BEP study recommends developing hydro resources according to either of the two following strategies:

Strategy 1: Priority to Northern Region; development of Cambambe and Capanda.

Strategy 2: Priority to the Central and Southern Regions; development of Lomaum (Units Nos. 4 and 5), Cacombo, Jamba-la-Mina, and Gove.

15. Simultaneous development of both strategies was not recommended as the systems were assumed to be interconnected by 1992. Strategy No. 1 would require two units in Capanda in 1995, followed by small additional capacity in the Central System by the year 2000. Strategy No. 2 would require a simultaneous development of Lomaum and Gove in the Central System and Jamba-la-Mina in the Southern System. The "high" dam in Cambambe would be required in 1995 and only the two first units of Capanda by the year 2005. Strategy No. 2 leads to a net present value of investment and operating costs below that of Strategy No. 1. The relative position of the two strategies is not necessarily robust if demand were significantly lower, especially in the Central Grid (BEP projects a demand of 528 GWh while the mission's "high" scenario is only 284 GWh).

16. The comparison of SONEFE's expansion plan with alternative options done by BEP suggests that the following sequence may be the most economic:

(a) "High" dam in Cambambe. A total capacity increase from 180 to 260 MW (due to head increase). The plant is provided with weekly regulating capability while its minimum flow remains 130 m^3/s and its firm energy rises from 700 GWh to 1000 GWh.

(b) "Low" dam in Capanda, and first stage of second power plant at Cambambe (2 x 110 MW). Cambambe is provided with monthly regulating capability and its minimum flow rises to 250 m^3/s.

(c) "High" dam in Capanda and second-stage of second power plant at Cambambe (2 x 110 MW); minimum flow at Cambambe rises to 350 m^3/s.

(d) power plant at Capanda (4 x 110 MW in old studies or 4 x 130 MW in more recent ones).

The above sequencing could be modified to ensure that generation could always, simultaneously satisfy the requirements for firm power (firm energy at the critical day) and for useful power for covering the peak.

17. BEP estimated the investment costs for the above sequence at US$1,030/kW for Cambambe as compared with US$1,800 for Capanda (in 1986 prices). Firm energy capabilities are not accounted for and discounting heightens the relative costs of Capanda if projects are considered alternative rather than complementary. Thus the comparison should not be carried too far. Moreover, unit turbine plus generator costs were rated by BEP, with no explanation, at US$500/kW for Cambambe and at only US$345/kW for Capanda.

Estimated Costs of Energy Production at Capanda

18. The cost of energy produced in a power plant within a system can only be estimated correctly by analyzing the whole system and optimizing its operation. In spite of this, order of magnitude estimates of LRMC at Capanda can be obtained. To do this, the investment program (of Table 1) was used, with the addition of a 10% margin on the activities of TPE and ODEBRECHT to account for physical contingencies. A useful life of 50 years was hypothesized (30 years for the equipment and 75 years for the dam might be more appropriate), together with operation and maintenance costs of 2% of baseline investment costs. The first unit is assumed to come on stream January 1, 1993 and the other three at six-month intervals (the last one, on July 1, 1994). Firm energy production of 2400 GWh was assumed (prorated as to entry on stream of units). Discount rate sensitivity analysis was done using 10%, 12% and 15% together with the three demand scenarios developed by the mission. It was assumed that the demand to be satisfied would be that of the Northern Grid alone (which reduces the market for Capanda power over some years). Finally, three levels of generation were assumed at Cambambe, namely 200 GWh/year, 500 GWh/year and 780 GWh/year. The last figure is the sum of the firm energy produced by Cambambe and Mabubas. In the average year, this easily exceeds 1000 GWh which means that if this energy were given priority, it would postpone even further the possibility of placing Capanda's entire output.

19. The values obtained are shown in Tables 2 to 7. If Cambambe were to generate 780 GWH using a discount rate of 10%, this would result in LRMC varying between $0.176 and $0.234 per kWh, depending on the demand scenario (the lower the demand growth, the higher the LRMC, given the discount rate). Using a discount rate of 15% would increase these costs to between $0.365 and $0.547 per kWh. It is obvious that the LRMC of energy at Capanda can be lowered artificially by keeping output at Cambambe artificially low, especially in conjunction with the higher demand growth scenario. In any case, covering costs would require a substantial tariff increase, thereby slowing the growth demand.

Supply-Demand Balance

20. The need for higher generation capacity in the Northern Grid-- which would be met from Capanda-- depends on the evolution of demand. Since this is a predominantly hydro system, constraints will arise first in firm energy and then in peak power. Mission demand projections were used to estimate the behavior of the present system, the need for thermal support from the two gas turbines available in Luanda, and the size of the gap between demand and supply. It was assumed that Cambambe's four units would be overhauled and that the rehabilitated Mabubas plant would add 10 MW of firm power, corresponding to 7.2 GWh per month of energy.

21. Studies of the Kwanza River flows show that the low flow (exceeded 95% of the time) is about 130-135 m^3/s. In its present state, Cambambe allows for good daily regulation on the basis of its flow of 130 m^3/s on the critical day. So, average firm power on the critical day would be 90 MW and adding 10 MW from Mabubas, firm power of 100 MW is available in permanence. The critical period is really very short (at Cambambe) and the flow normally allows for much higher power than on the critical day. Therefore, a very small thermal supplement would allow the system to maintain much higher firm power 1/.

22. Assuming, conservatively, that one of Cambambe's units is always unavailable (reserve), useful power would be 3 x 45 MW = 135 MW. Thermal generation might therefore be needed for one of two reasons, either to cover a deficit of firm power (daily flow not sufficient to generate energy required that day) or to cover a deficit of useful power (useful available hydro power is not sufficient to cover the daily peak).

23. Thus, without loss of reliability, it would seem logical not to add hydro capacity until total useful power (hydro and thermal) approach system peak. Any energy shortfalls could be covered by generation from the Luanda gas turbines. As shown in Tables 8-11, additional hydro capacity would only become necessary in 1997 (Base Scenario), in 1996

1/ In fact, only in 1958, a very dry year, did the low flow fall lower, to 122 m^3/s. It would not be unrealistic to use a higher figure, say, 140 m^3/s for the 95% guarantee.

(Intermediate Scenario) or in 1994 (High Scenario). Thermal support would be needed briefly during the four years before the commissioning of new hydro capacity. This support would vary between 80 and 120 GWh per year (depending on demand) and would cost (1987 prices, no discounting) between $6.1 million and $9.1 million.

24. Under the same assumptions, the maximum requirements for power and energy to satisfy demand to the year 2000 would be 170 MW and 520 GWh (under the high demand growth scenario). Heightening the Cambambe dam inthe early 1990's and a low dam at Capanda around 2000 would amply cover the demand with a high margin of reserve and without thermal support. The investments required would be substantially lower than the cost of Capanda and would allow greater flexibility for matching investments to the actual growth of demand (i.e., reducing the uncertainty and the possibility of making costly mistakes). On the contrary, the Capanda project makes investments long before the emergence of actual demand, with adjustments limited to the timing of commissioning of the generating units. Consequently, all this causes higher costs which will need to be reflected in higher electricity tariffs.

Interconnection

25. Under present security conditions, the construction of new transmission lines between systems is impossible. The existing line between Cambambe and Gabela (125 km, 220 KV) is the first stage of a future link between the Northern and Central Systems. It has been out of service since 1984 and security conditions have allowed neither its restoration nor the maintenance of important Central and Southern lines (creating supply difficulties for Porto Amboim). In the meantime regional power supply (Lomaum, Biopio, Huambo, Matala, Namibe) will be rehabilitated and expanded to meet potential demand. The three systems would remain self-sufficient and would have to provide for their own reserve margin. If a protracted war were to continue it would suppress demand growth and prevent construction of interconnections. Thus, a larger electrical market for Capanda would not develop. A short-term cease-fire followed by quick economic recovery would allow and possibly require electrical interconnections, but the least-cost expansion plan would postpone these until near the year 2000, giving preference to previously proposed supply sources in the Central and Southern systems, whose requirements are modest in absolute terms. If an interconnected system with Capanda were to be considered in the short run, problems of reliability, operations, and on-line dispatching could arise.

Conclusions

26. At the present stage of development of the power systems of Angola, the construction of the dam and power plant at Capanda would be, at best, a project of marginal economic interest and, at worst, a very heavy financial burden without contribution to resolving the problems of the subsector and the country. Several major issues arise:

(a) the Project represents an important departure from the least-cost expansion path;

(b) the huge capacity (4 x 130 MW) will probably not be needed until the late 1990s (10 to 12 years after project completion) and no additional capacity will be required in the Northern System until then;

(c) building the Capanda dam will neither improve the reliability of supply in the Northern System, nor mitigate the problems of the other two systems; and

(d) investment in Capanda will substantially add to the public external debt burden and could undermine the financing of the vital petroleum development program, on which future export earnings depend.

22. The Government's goal of taking advantage of Angola's hydro assets cannot be reached without large additional investments in transmission and distribution (together with investments in generation which are the only ones being consdiered under the Capanda Project). Only two alternatives seem open for the utilization of Capanda power earlier than presently foreseeable demand would justify. These are:

(a) attract foreign investment in power-intensive industries that do not require significant developments in the distribution network; and

(b) provide generalized access to electricity to a larger proportion of Luanda's population and provide incentives to industrial rehabilitation.

The first alternative is practically open but a relatively long period of stability is needed for it to materialize. The second alternative would require enormous investments in distribution networks (from HV to LV) that neither the utilities nor the Government can afford. Therefore, the whole issue of Capanda remains closely tied to the absence of a market that could justify the investment and the difficulty of predicting how and where such a market could develop.

Table 1: CAPANDA HYDROELECTRIC PROJECT: INVESTMENT PROGRAM
($ million)

Ref	Description	1985-87	88	89	90	91	92	93	94	95-2003	Total
	N. ODEBRECHT										
1	Labor	73,740	40,854	47,960	57,963	59,630	37,253	0	0	0	317,400
2	Materials	89,064	20,530	23,934	26,841	26,754	14,123	0	0	0	201,246
3	Food	12,760	8,236	11,386	11,500	10,748	9,169	0	0	0	63,799
4	Equipment	35,698	8,898	8,900	0	0	0	0	0	0	53,496
5	Freight	41,516	13,212	5,916	5,973	5,973	4,790	0	0	0	77,380
6	Subcontracts	28,109	3,679	7,511	5,150	5,155	2,137	0	0	0	51,741
7	Travel	26,642	8,284	6,223	6,715	6,715	5,244	0	0	0	59,722
8	Other	20,395	6,630	5,313	5,453	5,287	4,515	0	0	0	46,483
9	Subtotal	327,924	109,112	117,143	119,595	120,262	77,231	0	0	0	871,267
10	Cumulative	327,924	437,036	554,179	673,774	794,036	871,267	0	0	0	871,267
	TPE										
11	Eng. Design	4,156	7,464	7,460	3,240	3,180	3,160	4,090	3,450	0	36,200
12	Equipment	0	0	130	4,760	65,640	72,000	27,110	140	0	7,177
13	Installation	0	0	5,210	13,280	9,220	14,210	11,200	4,720	0	57,840
14	Supervision	0	920	1,500	1,780	1,780	1,780	1,780	1,640	0	11,180
15	Subtotal	4,156	8,384	14,300	23,060	79,820	91,150	44,180	9,950	0	275,000
16	Cumulative	4,156	12,540	26,840	49,900	129,720	220,870	265,050	275,000	0	275,000
	FURNAS										
17	Services	18,981	8,984	6,616	6,616	6,150	5,238	5,238	0	0	57,283
18	Other Exp.	4,424	1,181	348	348	324	276	276	0	0	7,177
19	Subtotal	23,405	10,165	6,964	6,964	6,474	5,514	5,514	0	0	65,000
20	Cumulative	23,405	33,570	47,498	47,498	53,972	59,486	65,000	0	0	65,000
	GAMEK										
21	Insurance	6,047	3,966	3,993	3,505	3,505	3,505	3,505	3,020	0	31,046
22	Other Exp.	3,500	0	0	0	0	0	0	0	0	3,500
23	Subtotal	9,547	3,966	3,993	3,505	3,505	3,505	3,502	3,020	0	34,546
24	Cumulative	9,547	13,513	17,506	21,011	24,516	28,021	31,526	34,546	0	34,546
25	Direct Costs	365,032	131,627	142,400	153,124	210,061	177,400	53,199	12,970	0	1,245,813
26	Cumulative	365,032	496,659	639,059	792,183	1,002,244	1,179,644	1,232,843	1,245,813	0	1,245,813
27	Interest	17,045	37,284	34,248	42,822	41,610	38,086	34,512	29,818	62,406	337,861
28	Commission	75	42	109	83	57	44	38	29	0	477
29	Exch. Variation	0	18,733	0	0	0	0	0	0	0	18,733
30	Fin. Charges	17,120	56,059	34,357	42,905	41,667	38,130	34,550	29,877	62,406	357,071
31	Cumulative	17,120	73,179	107,536	150,441	192,108	230,238	264,788	294,665	357,071	357,071
32	Grand Total	382,152	187,686	176,757	196,029	251,728	215,530	87,749	42,847	62,406	1,602,884
33	Cumulative	382,152	569,838	746,595	942,624	1,194,352	1,409,882	1,497,631	1,540,478	1,602,884	1,602,884

Source: GAMEK.

Table 2: CAPANDA: TOTAL COSTS (1987 PRICES) AND YEARLY OUTPUT

(Output of Cambambe: 200 GWh)

Year Nr	Year	Expenditures (million US$) Invest	O&M	Total	Annual Generation (GWh) Scenarios Base	Intermediate	High
-8	1985	64	0	64	-	-	-
-7	1986	116	0	116	-	-	-
-6	1987	185	0	185	-	-	-
-5	1988	159	0	159	-	-	-
-4	1989	155	0	155	-	-	-
-3	1990	163	0	163	-	-	-
-2	1991	227	0	227	-	-	-
-1	1992	191	0	191	-	-	-
0	1993	58	26	84	523	(a)614	(a)684
1	1994	14	26	40	581	710	884
2	1995	0	26	26	659	819	1,103
3	1996	0	26	26	763	941	1,111
4	1997	0	26	26	876	1,078	1,216
5	1998	0	26	26	1,008	1,219	1,329
6	1999	0	26	26	1,140	1,346	1,451
7	2000	0	26	26	1,263	1,470	1,584
8	2001	0	26	26	1,384	1,594	1,706
9	2002	0	26	26	1,504	1,715	1,828
10	2003	0	26	26	1,606	1,830	1,949
11	2004	0	26	26	1,714	1,952	2,078
12	2005	0	26	26	1,829	2,081	2,215
13	2006	0	26	26	1,931	2,195	2,336
14	2007	0	26	26	2,037	2,315	2,400
15	2008	0	26	26	2,149	2,400	2,400
16	2009	0	25	26	2,266	1,400	2,400
17	2010	0	26	26	2,390	2,400	2,400
18	2011	0	26	26	2,400	2,400	2,400
19	2012	0	25	26	2,400	2,400	2,400
20	2013	0	26	26	2,400	2,400	2,400
21	2014	0	26	25	2,400	2,400	2,400
:	:	:	:	:	:	:	:
49	2042	0	26	26	2,400	2,400	2,400
50	2043	0	26	26	2,400	2,400	2,400

(a) Output of Cambambe should exceed 200 GWh in that year.

Notes:
(1) Economic life of project : 50 years,
(2) Entry on stream, 1993 (1 unit/six months).
(3) 1987 prices.
(4) Maximum yearly output of Capanda: 240 GWh.
(5) Total investment $1331 million (information provided GAMEK, 1988).
(6) Yearly O&M : 2% of total investment.

Source: Mission estimates.

Table 3: CAPANDA: TOTAL COSTS (1987 PRICES) AND YEARLY OUTPUT
(Output of Cambambe: 500 GWh)

Year Nr	Year	Expenditures (Million US$) Invest	O&M	Total	Annual Generation (GWh) Scenarios Base	Intermediate	High
-8	1985	64	0	64	-	-	-
-7	1986	116	0	116	-	-	-
-6	1987	185	0	185	-	-	-
-5	1988	159	0	159	-	-	-
-4	1989	155	0	155	-	-	-
-3	1990	163	0	163	-	-	-
-2	1991	227	0	227	-	-	-
-1	1992	191	0	191	-	-	-
0	1993	58	26	84	223	327	468
1	1994	14	26	40	281	410	584
2	1995	0	26	26	359	519	703
3	1996	0	26	26	463	641	811
4	1997	0	26	26	576	778	916
5	1998	0	26	26	708	919	1,029
6	1999	0	26	26	840	1,046	1,151
7	2000	0	26	26	963	1,170	1,284
8	2001	0	26	26	1,084	1,294	1,406
9	2002	0	26	26	1,204	1,415	1,528
10	2003	0	26	26	1,306	1,530	1,649
11	2004	0	26	26	1,414	1,652	1,778
12	2005	0	26	26	1,529	1,781	1,915
13	2006	0	26	26	1,631	1,895	2,036
14	2007	0	26	26	1,737	2,015	2,162
15	2008	0	26	26	1,849	2,140	2,295
16	2009	0	26	26	1,966	2,272	2,400
17	2010	0	26	26	2,090	2,400	2,400
18	2011	0	26	26	2,219	2,400	2,400
19	2012	0	26	26	2,355	2,400	2,400
20	2013	0	26	26	2,400	2,400	2,400
21	2014	0	26	26	2,400	2,400	2,400
22	2015	0	26	26	2,400	2,400	2,400
:	:	:	:	:	:	:	:
49	2042	0	26	26	2,400	2,400	2,400
50	2043	0	26	26	2,400	2,400	2,400

Notes: (1) Economic life of project . 50 years,
(2) Entry on stream, 1993 (1 unit/six months).
(3) 1987 prices.
(4) Maximum yearly output of Capanda: 2400 GWh.
(5) Total investment $1331 million
(information provided GAMEK, 1988).
(6) Yearly O&M : 2% of total investment.

Source: Mission estimates.

Table 4: CAPANDA: TOTAL COSTS (1987 PRICES) AND YEARLY OUTPUT
(Output of Cambambe: 780 GWh)

Year Nr	Year	Expenditures (Million US$) Invest	O&M	Total	Annual Generation (GWh) Scenarios Base	Intermediate	High
-8	1985	64	0	64	-	-	-
-7	1986	116	0	116	-	-	-
-6	1987	185	0	185	-	-	-
-5	1988	159	0	159	-	-	-
-4	1989	155	0	155	-	-	-
-3	1990	163	0	163	-	-	-
-2	1991	227	0	227	-	-	-
-1	1992	191	0	191	-	-	-
0	1993	58	26	84	0	47	188
1	1994	14	26	40	1	130	304
2	1995	0	26	26	79	239	423
3	1996	0	26	26	183	361	531
4	1997	0	26	26	296	498	636
5	1998	0	26	26	428	639	749
6	1999	0	26	26	560	766	871
7	2000	0	26	26	683	890	1,004
8	2001	0	26	26	804	1,014	1,126
9	2002	0	26	26	924	1,135	1,248
10	2003	0	26	26	1,026	1,250	1,369
11	2004	0	26	26	1,134	1,372	1,498
12	2005	0	26	26	1,249	1,501	1,635
13	2006	0	26	26	1,351	1,615	1,756
14	2007	0	26	26	1,457	1,735	1,882
15	2008	0	26	26	1,569	1,860	2,015
16	2009	0	26	26	1,686	1,992	2,155
17	2010	0	26	26	1,810	2,131	2,302
18	2011	0	26	26	1,939	2,276	2,400
19	2012	0	26	26	2,075	2,400	2,400
20	2013	0	26	26	2,218	2,400	2,400
21	2014	0	26	26	2,368	2,400	2,400
22	2015	0	26	26	2,400	2,400	2,400
:	:	:	:	:	:	:	:
49	2042	0	26	26	2,400	2,400	2,400
50	2043	0	26	26	2,400	2,400	2,400

Notes: (1) Economic life of project : 50 years,
(2) Entry on stream, 1993 (1 unit/six months).
(3) 1987 prices.
(4) Maximum yearly output of Capanda: 2400 GWh.
(5) Total investment $1331 million (information provided GAMEK, 1988).
(6) Yearly O&M : 2% of total investment.

Source: Mission estimates.

Table 5: CAPANDA: LONG RUN MARGINAL COSTS (LRMC)
(Yearly output of Cambambe: 200 GWh)

	Discount Rate			Annuities (50 years)		
	i=10%	i=12%	i=15%	i=10%	i=12%	i=15%
Discounted expenditures (US$ Million)						
Investment	1,946.4	2,102.3	2,361.1	196.3	253.2	354.5
Operation and maintenance	283.6	241.8	199.1	28.6	29.1	29.9
Total	2,230.0	2,344.2	2,560.2	224.9	282.3	384.4
Discounted energy (GWh)						
Base scenario	14,869.9	11,772.7	8,784.4	1,499.8	1,417.6	1,318.9
Intermediate scenario	16,514.0	13,231.9	10,023.4	1,665.6	1,593.9	1,504.9
High scenario	17,598.6	14,224.6	10,902.8	1,775.0	1,712.9	1,636.9
Long Range Marginal Costs (US$/kWh)						
Base scenario	0.150	0.199	0.291			
Intermediate scenario	0.135	0.177	0.255			
High scenario	0.127	0.165	0.235			
Long Range Marginal Costs (Kz/kWh)						
Base scenario	4.50	5.97	8.74			
Intermediate scenario	4.05	5.31	7.66			
High scenario	3.80	4.94	7.04			

Notes: (1) Project economic lifetime: 50 years.
(2) First year of operation: 1993.
(3) Base year for discounting/compounding: 1993.
(4) Discount rates: 10%, 12%, and 15%.
(5) 1987 prices.
(6) Installed capacity at Capanda: 4 x 130 MW = 520 MW
(First Unit 1.1.1993; other units installed every six months).
(7) Calculated on the basis of Table 2.

Source: Mission estimates.

Table 6: CAPANDA: LONG RUN MARGINAL COSTS (LRMC)
(Yearly output of Cambambe: 500 GWh)

	Discount Rate			Annuities (50 years)		
	i=10%	i=12%	i=15%	i=10%	i=12%	i=15%
Discounted expenditures (US$ Million)						
Investment	1,946.4	2,102.3	2,361.1	196.3	253.2	354.5
Operation and maintenance	283.6	241.8	199.1	28.6	29.1	29.9
Total	2,230.0	2,344.2	2,560.2	224.9	282.3	384.4
Discounted energy (GWh)						
Base scenario	12,123.6	9,308.1	6,652.5	1,222.8	1,120.9	998.8
Intermediate scenario	13,927.0	10,888.2	7,973.5	1,404.7	1,311.1	1,197.1
High scenario	15,164.0	12,013.8	8,965.4	1,529.4	1,446.7	1,346.6
Long Range Marginal Costs (US$/kWh)						
Base scenario	0.184	0.252	0.385			
Intermediate scenario	0.169	0.215	0.321			
High scenario	0.147	0.195	0.286			
Long Range Marginal Costs (Kz/kWh)						
Base scenario	5.52	7.56	11.55			
Intermediate scenario	4.05	6.46	9.63			
High scenario	3.80	5.85	8.57			

Notes:
(1) Project economic lifetime: 50 years.
(2) First year of operation: 1993.
(3) Base year for discounting/compounding: 1993.
(4) Discount rates: 10%, 12%, and 15%.
(5) 1987 prices.
(6) Installed capacity at Capanda: 4 x 130 MW = 520 MW
(First Unit 1.1.1993; other units installed every six months).
(7) Calculated on the basis of Table 3.

Source: Mission estimates.

Table 7: CAPANDA: LONG RUN MARGINAL COSTS (LRMC)
(Yearly output of Cambambe: 780 GWh)

	Discount Rate			Annuities (50 years)		
	i=10%	i=12%	i=15%	i=10%	i=12%	i=15%
Discounted expenditures (US$ Million)						
Investment	1,946.4	2,102.3	2,361.1	196.3	253.2	354.5
Operation and maintenance	283.6	241.8	199.1	28.6	29.1	29.9
Total	2,230.0	2,344.2	2,560.2	224.9	282.3	384.4
Discounted energy (GWh)						
Base scenario	9,527.1	7,009.2	4,681.1	960.9	844.0	702.8
Intermediate scenario	11,380.9	8,608.5	5,991.3	1,147.9	1,036.6	899.5
High scenario	12,681.6	9,780.8	7,012.8	1,279.1	1,177.8	1,052.9
Long Range Marginal Costs (US$/kWh)						
Base scenario	0.234	10.03	16.41			
Intermediate scenario	0.196	8.17	12.82			
High scenario	0.176	7.19	10.95			
Long Range Marginal Costs (Kz/kWh)						
Base scenario	4.[illegible]	5.97	8.74			
Intermediate scenario	4.05	5.31	7.66			
High scenario	3.80	4.94	7.04			

Notes: (1) Project economic lifetime: 50 years.
(2) First year of operation: 1993.
(3) Base year for discounting/compounding: 1993.
(4) Discount rates: 10%, 12%, and 15%.
(5) 1987 prices.
(6) Installed capacity at Capanda: 4 x 130 MW = 520 MW
(First Unit 1.1.1993; other units installed every six months).
(7) Calculated on the basis of Table 4.

Source: Mission estimates.

Table 8: NORTHERN SYSTEM: ENERGY AND POWER BALANCE, 1988-2000
BASE SCENARIO

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
System Needs														
(1) Generation	(GWh)	630.3	642.9	655.8	668.9	689.0	723.4	781.3	859.4	962.6	1078.1	1207.4	1340.3	1460.9
(2) Peak Power Equivalent Needs	(MW)	114.2	116.5	118.8	121.2	124.8	131.1	141.6	155.7	174.4	195.3	218.8	242.9	264.7
(3) Critical Day Generation (313 days)	(MWh)	2014	2054	2095	2137	2201	2311	2496	2746	3075	3444	3858	4282	4667
(4) Firm Power Required (7500 hours)	(MW)	84.0	85.7	87.4	89.2	91.9	96.5	104.2	114.6	128.3	143.7	161.0	178.7	194.8
(5) Average Daily Flow at Cambambe	(m^3/s)	121	124	126	129	133	139	151	166	185	208	233	258	281
Total Capacity (Hydro and Thermal)														
(6) Installed (MW)	236.8	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6
(7) Useful	(MW)	191.8	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6
(8) Firm	(MW)	135.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4
Hydro Capacity														
(9) Installed	(MW)	180.0	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
(10) Useful	(MW)	135.0	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8
(11) Firm	(MW)	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Energy Balance														
(12) Deficit of Firm Hydro Power	(MW)	-	-	-	-	-	-	4.2	14.6	28.3	43.7	61.0	78.7	94.8
(13) Thermal Base Energy Required	(GWh)	-	-	-	-	-	-	0.2	2.6	9.3	17.1	25.7	35.2	43.6
(14) Deficit of Useful Hydro Power	(MW)	-20.8	-36.3	-34.0	-31.6	-28.0	-21.7	-11.2	2.9	21.6	42.5	66.0	90.1	111.9
(15) % of Deficit (Pdef/Peak)	(%)	-	-	-	-	-	-	-	1.9	12.4	21.8	30.2	37.1	42.3
(16) % Peak Energy	(%)	-	-	-	-	-	-	-	(0)	0.9	3.4	6.9	10.6	14.9
(17) Thermal Energy Required (Peak)	(GWh)	-	-	-	-	-	-	-	(0)	8.7	36.7	83.3	142.1	217.7
(18) Total Thermal Energy Required (Base + Peak)	(GWh)	-	-	-	-	-	-	0.2	2.6	18.0	53.8	109.0	177.3	261.3
Balance of Peak Power														
(19) Total Deficit of Useful Capacity	(MW)	-77.6	-93.1	-90.8	-88.4	-84.8	-78.5	-68.0	-53.9	-35.2	-14.3	9.2	33.3	55.1

Source: 1973 SONEFE Study; Mission estimates.

Table 9: NORTHERN SYSTEM: ENERGY AND POWER BALANCE, 1988-2000
INTERMEDIATE SCENARIO

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
System Needs														
(1) Generation	(GWh)	630.3	649.2	681.7	715.8	765.9	827.2	909.9	1019.1	1141.3	1278.3	1418.9	1546.6	1670.4
(2) Peak Power Equivalent Needs	(MW)	114.2	117.6	123.5	129.7	138.8	149.9	164.9	184.7	206.8	231.6	257.1	280.3	302.7
(3) Critical Day Generation (313 days)	(MWh)	2014	2074	2178	2287	2447	2643	2907	3256	3646	4084	4533	4941	5337
(4) Firm Power Required (7500 hours)	(MW)	84.0	86.6	90.9	95.4	102.1	110.3	121.3	135.9	152.2	170.4	189.2	206.2	222.7
(5) Average Daily Flow at Cambambe	(m^3/s)	121	125	131	138	148	159	175	196	220	246	273	298	322
Total Capacity (Hydro and Thermal)														
(6) Installed (MW)	236.8	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6
(7) Useful	(MW)	191.8	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6
(8) Firm	(MW)	135.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4
Hydro Capacity														
(9) Installed	(MW)	180.0	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
(10) Useful	(MW)	135.0	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8
(11) Firm	(MW)	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Energy Balance														
(12) Deficit of Firm Hydro Power	(MW)	-	-	-	-	2.1	10.3	21.3	35.9	52.2	70.4	89.2	106.2	122.7
(13) Thermal Base Energy Required	(GWh)	-	-	-	-	(0)	1.4	5.8	13.2	21.6	30.9	40.7	49.5	58.1
(14) Deficit of Useful Hydro Power	(MW)	-20.8	-35.2	-29.3	-23.1	-14.0	-2.9	12.1	31.9	54.0	78.8	104.3	127.5	149.9
(15) % of Deficit (Pdef/Peak)	(%)	-	-	-	-	-	-	7.3	17.3	26.1	34.0	40.6	45.5	49.5
(16) % Peak Energy	(%)	-	-	-	-	-	-	0.3	1.9	4.9	9.2	12.9	18.0	21.5
(17) Thermal Energy Required (Peak)	(GWh)	-	-	-	-	-	-	2.7	19.4	55.9	117.6	183.0	278.4	359.1
(18) Total Thermal Energy Required (Base + Peak)	(GWh)	-	-	-	-	(0)	1.4	8.5	32.6	77.5	148.5	223.7	327.9	417.2
Balance of Peak Power														
(19) Total Deficit of Useful Capacity	(MW)	-77.6	-92.0	-86.1	-79.9	-70.8	-59.7	-44.7	-24.9	-2.8	22.0	47.5	70.7	93.1

Source: 1973 SONEFE Study; Mission estimates.

Table 10: NORTHERN SYSTEM: ENERGY AND POWER BALANCE, 1988-2000
HIGH SCENARIO

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
System Needs														
(1) Generation	(GWh)	630.3	649.2	701.2	771.3	863.8	967.5	1083.6	1202.8	1311.1	1415.9	1529.2	1651.6	1783.7
(2) Peak Power Equivalent Needs	(MW)	114.2	117.6	127.0	139.7	156.5	175.3	196.3	217.9	237.5	256.5	277.0	299.2	323.1
(3) Critical Day Generation (313 days)	(MWh)	2014	2074	2240	2464	2760	3091	3462	3843	4189	4524	4886	5277	5699
(4) Firm Power Required (7500 hours)	(MW)	84.0	86.6	93.5	102.8	115.2	129.0	144.5	160.4	174.8	188.8	203.9	220.2	237.8
(5) Average Daily Flow at Cambambe	(m^3/s)	121	125	135	149	166	186	209	232	253	273	295	318	344
Total Capacity (Hydro and Thermal)														
(6) Installed (MW)	236.8	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6	254.6
(7) Useful	(MW)	191.8	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6	209.6
(8) Firm	(MW)	135.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4	145.4
Hydro Capacity														
(9) Installed	(MW)	180.0	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
(10) Useful	(MW)	135.0	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8
(11) Firm	(MW)	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Energy Balance														
(12) Deficit of Firm Hydro Power	(MW)	-	-	-	2.8	15.2	29.0	44.5	60.4	74.8	88.8	103.9	120.2	137.8
(13) Thermal Base Energy Required	(GWh)	-	-	-	(0)	2.8	9.6	17.4	25.6	33.2	40.5	48.3	56.8	66.0
(14) Deficit of Useful Hydro Power	(MW)	-20.8	-35.2	-25.8	-13.1	3.7	22.5	43.5	65.1	84.7	103.7	124.2	146.4	170.3
(15) % of Deficit (Pdef/Peak)	(%)	-	-	-	-	2.4	12.8	22.2	29.9	35.7	40.4	44.8	48.9	52.7
(16) % Peak Energy	(%)	-	-	-	-	(0)	1.0	3.5	6.7	9.8	12.7	17.1	20.2	25.0
(17) Thermal Energy Required (Peak)	(GWh)	-	-	-	-	(0)	9.7	37.9	80.6	128.5	179.8	261.5	333.6	445.9
(18) Total Thermal Energy Required (Base + Peak)	(GWh)	-	-	-	(0)	2.8	19.3	55.3	106.2	161.7	220.3	309.8	390.4	511.9
Balance of Peak Power														
(19) Total Deficit of Useful Capacity	(MW)	-77.6	-92.0	-82.6	-69.9	-53.1	-34.3	-13.3	-8.3	-27.9	-46.9	67.4	89.6	113.5

Source: 1973 SONEFE Study; Mission estimates.

Table 11: NORTHERN SYSTEM : ENERGY AND POWER BALANCE, 1988-2000

Notes to Tables 8, 9, 10

(1) : Demand projections.

(2) : Demand projections.

(3) = (1) * 1000/313 output on critical day (working day in October).

(4) = (3)/24 or (4) = (1) * 1000/7500 average power on critical day (working day in October).

(5) : Average daily flow of Cambambe to guarantee critical day output.

(6) = 4 * 45 MW (Cambambe) + 1 * 25.6 MW (GT1 Luanda) = 1 * 31.2 MW (GT2 Luanda) from 1989)
17.8 MW (mabubas) available starting 1989.

(7) = (6) - 45 MW : Reserve = 1 unit of Cambambe.

(8) = 90 MW (Cambambe) + 45.4 MW (80% of GT1+GT2 Luanda) + 10 MW (Mabubas, from 1989)

(9) = 4 * 45 MW (Cambambe) + 17.8 MW (Mabubas, from 1989).

(10) = (9) - 45 MW: Reserve = 1 unit of Cambambe.

(11) : 90 MW = power corresponding to minimum yearly flow of 130 m^3/s in Cambambe.
10 MW = assumed firm power for Mabubas from 1989.

(12) = (4) - (11)

(13) : taken from 1973 Sonefe study according to (12).

(14) = (2) - (10).

(15) = (14) * 100/ (2).

(16) taken from the Energy/Power load curve in the 1973 SONEFE Study.

(17) = (16) * (1)/100

(18) = (13) + (17)

(19) = (2) - (7)

Source: 1973 Sonefe study; mission estimates.

DRAFT TERMS OF REFERENCE:
PREPARATION OF A PILOT PROJECT IN HUILA-NAMIBE

Background

The provinces of Huila and Namibe are in a more favorable position to be able to undertake forest operations than most other provinces in Angola. The military situation is much better, with most of the two provinces safe. The economy in the two provinces seems to be functioning better than in most of the country. Also, the two provinces do not have large population concentrations in areas far from the forests. It is true that the coastal towns of Namibe and Tombwa have virtually no wood resources close by, but the fact that the towns are fairly small makes the problem more easily managed than in the cases of Luanda and Benguela/Lobito. The supply of woodfuels is also better organized than elsewhere. Considering the above facts, a pilot project in the provinces of Huila and Namiba would seem to be feasible.

The pilot project would contain the following items:

(a) increased efficiency of stoves (coast and inland);

(b) improved woodfuel supply system (coast and inland);

(c) fuel substitution (coast); and

(d) wood production, mainly consisting of development work in agroforestry, supplemented by training based at the agricultural school at Tchivinguiro.

The Project would be operated jointly by the MEP (Ministry of Energy and Petroleum) through the DNRFE (Department of New and Renewable Sources of Energy) and the Ministry of Agriculture, through the DNACO (National Directorate for the Conservation of Nature).

The project is closely interrelated with and could obtain significant support from other proposed projects, particularly those on Improved Cooking Stoves (ICS) and Improved Woodfuel Supply Systems (WSS). This is true for both project preparation and implementation. The preparation of the pilot project for Huila-Namibe should follow that for the ICS and WSS projects. In that way, project leaders can benefit from the experience gained in preparing these specialized projects.

Project Components

A team of specialists should prepare an integrated pilot project in the field of biomass energy for the provinces of Huila and Namibe. The team should base its work on a reading of the available literature (especially that on the regional project prepared under UNDP financing) and on the work done to prepare the ICS and WSS projects. The team should formulate a coherent pilot project that could be replicated in other areas wherever the security situation is favorable. In preparing the pilot project, the team should consider at least the following technical components:

(a) inventory of accessible forest resources, particularly forest plantations;

(b) mapping of the present system for supply of woodfuels to the main urban centers (Lubango, Namibe, and Tombwa);

(c) analysis of the workings of existing charcoal production co-operatives and investigation of the possibilities of organizing other producers now operating outside the cooperative;

(d) development and implementation of a revised supply system for Lubango, Namibe, and Tombwa;

(e) development, introduction and dissemination of improved cooking stoves;

(f) establishment of tree nurseries for the creation of windbreaks and other forms of tree planting outside forests;

(g) introduction of an elementary course in agroforestry at the agricultural school at Tchivinguiro, near Lubango; and

(h) strengthening of DNACO's provincial representation for Huila and Namibe using, if possible, highly qualified manpower available at the Lubango branch of the Agostinho Neto University.

The fuel substitution component listed under "Background" above is not included in the specific Terms of Reference for the project preparation team as the issue of increasing the use of LPG in coastal cities falls somewhat outside the professional competence of a forestry team.

The Project Team

Areas of specialization of team members should include the following;

(a) forest operations for fuel production;
(b) Charcoal production;
(c) agroforestry;
(d) stove improvement;
(e) training; and
(f) project economics.

Two or three persons would need to work about five man-months, including three man-months in Angola. Estimated costs for the pilot project are approximately US$100,000 for the study and about US$500,000 for conducting the proposed operations on a pilot scale.

2. Improved Cooking Stoves

Development and distribution of improved cooking stoves has been suggested for several areas in Chapter V. The best strategy is to develop a national project for improved cooking stoves. Initial activities could well be concentrated in Luanda, where the largest single concentration of people using traditional stoves is found. The high prices for woodfuels in Luanda provide an incentive for economizing on the use of fuelwood and charcoal.

The Project would be carried out by the DNRFE within the MEP. The DNRFE has already initiated activities in this field as part of its preparations for the first national seminar on firewood and charcoal, which took place in Luanda in Jun 1987.

Terms of Reference for preparation of a project to improve the efficiency of cooking stoves are attached.

DRAFT TERMS OF REFERENCE:
PREPARATION OF A PROJECT FOR IMPROVED COOKING STOVES

During early 1987, partially in preparation for the first national seminar on firewood and charcoal, the DNRFE (Department of New and Renewable Sources of Energy) of the MEP (Ministry of Energy and Petroleum) studied the stoves used in the seven provinces where it had undertaken a survey of the consumption of woodfuels. Although some local variations and innovations were found, the picture that emerged from the study was rather uniform: firewood was burned in ordinary three-stone stoves placed in unsheltered positions, and charcoal was burned in simple square metal stoves. There were also cases where charcoal was burned in three-stone stoves.

Three arguments are generally given to support the introduction of improved cooking stoves. They are: (a) use of improved stoves can help reduce the national consumption of fuelwood, thus reducing the pressure on available forest resources and safeguarding the environment (however, it is well-known that the effect of a stove program on national wood consumption is marginal); (b) use of improved stoves reduces a household's need for wood and thus also reduces both the cash cost of procuring woodfuels and the cost in time needed for woodfuel collection; (c) use of improved stoves could contribute to an improvement of the environment in the kitchen.

While the forest administration of a country often stresses the first argument, the ultimate success or failure of a stove improvement program depends on the degree of acceptance of the stoves on the part of the population. This means that the stove improvement program must be designed so that it primarily meets the needs and aspirations of the population concerned.

A large number of stove projects are being implemented in various countries in Africa. Being a latecomer in this field, Angola can learn from successes and failures elsewhere. For this purpose, it is proposed that one or several study tours be organized for the concerned staff at DNRFE to observe other stove projects. One stove project acknowledged to be successful is the national program in Burkina Faso for the development and introduction of improved stoves for firewood and charcoal.

As regards the availability of woodfuels, the capital of Burkina Faso, Ouagadougou, shares many of the characteristics of Luanda. There are also clear differences. Thus, while charcoal is the principal woodfuel used in Luanda, in Ouagadougou firewood is the principal fuel. Further, the urban and peri-urban population in Ouagadougou is thoroughly organized, which makes the task of introducing improved stoves easier. Also, the stove models used in Ouagadougou are adapted to the particular social and dietary conditions prevailing in that city and are made to fit a number of standard cooking pot sizes. However, in spite of the differences between the two cities in this regard, information useful to Angola could certainly be obtained from the program in Burkina Faso.

DNRFE's 1987 survey of biomass cooking stoves in seven provinces of Angola can be viewed as an appropriate, if modest, beginning of a national program for the design, production and dissemination of improved cooking stoves in Angola. Such activities have been proposed as a matter of priority in both Luanda, Benguela/Lobito, and Huambo. It seems appropriate that much of the development work should be carried out at the national level or at least with strong technical support at that level. It is, further, believed that field activities in such a program for improved stoves should initially be concentrated in Luanda, where a large number of people use inefficient stoves to burn woodfuels that are bought at quite high prices. Benguela/Lobito would get second priority in the program and Huambo third. Stove development should also be included in the pilot project in Huila-Namibe, principally in the city of Lubango.

Project Components

The preparation of an enlarged project for improved cooking stoves should probably start with a study visit to an ongoing successful stove project elsewhere in Africa. As mentioned above, Ouagadougou seems to be a suitable location. However, other locations should also be considered. The study tour should be organized for both the Angolans potentially concerned by the project, mainly in DNRFE, and the expatriate specialists expected to take part in project preparation.

The second step in project preparation would be a search for suitable stove models and competent stove producers (existing or potential) in Angola. As a third step, the project preparation team would design an expanded project for development and introduction of improved cooking stoves in Angola, to be centered initially in Luanda.

The Project Team

The expatriate member or members of the project preparation team would mainly investigate the general field of stove projects, particularly in Africa. Knowledge of wood and charcoal combustion and of the technical design of stoves for these fuels is also needed. One or two expatriates would probably be needed. The expatriates would need to spend about three man-months in project preparation, including arrangements for and participation in the study tour mentioned above.

Costs

Expatriate experts (3 man-months)	$ 35,000
Expenses	10,000
Study tour (3 Angolans, 2 expatriates)	25,000
Materials and other	15,000
	85,000
Importation of 1,000 stove kits	15,000
	$100,000

3. Improved Woodfuel Supply System

In Chapter 5, the need for an improved system for the supply of woodfuels to the major cities both on the coast and in the inland areas of Angola was discussed. A project should be undertaken to analyse the present woodfuel supply system for Luanda, Benguela-Lobito, and Huambo and to develop ways to improve the system.

The Project would be organized by the DNACO within the Ministry of Agriculture. Terms of Reference for preparations for the project are attached.

DRAFT TERMS OF REFERENCE: PREPARATION OF A PROJECT FOR IMPROVED WOODFUEL SUPPLY SYSTEMS

Background

Improved woodfuel supply systems are needed in Angola, particularly for Luanda, Benguela-Lobito, and Huambo. An improvement of the presently fairly well-functioning system for Lubango and Namibe would also be included in the pilot project proposed for Huila-Namibe. Initially, however, efforts should probably be concentrated on Luanda.

The present system for supply of woodfuels to Luanda is not well known, or at least not well documented. There are uncertainties as to the geographical origin of the firewood and charcoal being used in Luanda, the organization of production, and the distribution network. Many of the present operations are carried out by individuals operating outside the formal, legal framework. Better knowledge of the present system is a necessary condition for any action aimed at improving the system.

While no inventory of Angola's forests exists, the general extent of the forest resources in Bengo and Kwanza Norte is known. Efforts should be devoted to finding an area of natural forest able to supply a significant part of the fuel needed in Luanda. The area should then be allocated to firewood and charcoal producers, who would be obliged to follow certain management principles, primarily to ensure a successful natural regrowth of the forest cover following cutting of the wood. The main threats to such regrowth are probably grass and bush fires. Therefore, the need for fire protection must be considered.

Particular attention should be devoted to finding suitable organizational forms for the production and marketing of firewood and charcoal. At present, owners of the means of transport occupy a key position in exploitation of the wood, its conversion to firewood and charcoal, and transportation of these fuels to the urban areas. Licenses to cut wood are often issued to truck owners, who have to show them in order to pass road check points with a load of firewood or charcoal. The truck owners then engage laborers to cut the wood and produce the charcoal. DNACO (National Directorate for the Conservation of Nature) is responsible for issuing the licenses. Given DNACO's acute shortage of qualified field staff, it is difficult to ascertain whether a given load of woodfuels has been produced in accordance with a given license.

In certain areas of the country, for example in the province of Namibe, local laborers have formed cooperatives, which apply for cutting licenses, produce the firewood and charcoal, and transport the fuels to the centers of consumption. Such a cooperative forms a very different management unit than that of a truck owner using hired laborers. As the cooperative is formed on a geographical basis, its members are likely to value the sustained production of wood, as this will secure them continuous employment in the area they can cover. They could thus be expected to respect certain restrictions regarding exploitation, such as minimum diameters for cutting, prohibitions against cultivating exploited areas, obligations to carry out reforestation, etc. The truck owner hiring local laborers would seem to have much less to gain from following such rules. A limited number of cooperatives, each working within a set geographical area, are also fairly easy to supervise. If this reasoning is valid, it would be advisable to study whether woodfuel supply cooperatives could also be successfully established around Luanda.

In designing the woodfuel supply system for Luanda, similar systems operating in other countries in Africa can serve as useful examples. One such case is the system for supply of charcoal to Mogadishu in Somalia. The wood used is an Acacia species. It grows quite slowly (less than half a cubic meter per hectare per year) but presently covers a large area, about a million hectares. The wood is transported to Mogadishu from an average distance of about 300 km, mainly over a rather poor asphalt road. The charcoal is produced by "cooperatives" (in reality teams of workers employed by an entrepreneur), which have licenses covering 25 square kilometers. This area lasts three to seven years for the team. As the forest stands are not cut too heavily cut at thy time of exploitation, they are able to recover in about 20 years, when they can be exploited again.

The Mogadishu system is well integrated into the country's legal and fiscal framework. Fees are paid for licenses and further fees are paid by the truck owners, based on the weight of the charcoal entering Mogadishu. Although some charcoal does enter Mogadishu outside this organized system, the amounts are generally believed to be small.

While there are a few key similarities between the supply system of Mogadishu and Luanda, such as the shortage of woodfuels close to the city, the arid conditions, the long distances from forested areas, and the existence of large natural forest stands, there are also obvious differences. For example, in Angola the institutional framework for a supply system of the Mogadishu type is lacking. Further, the present security situation both in the areas potentially suitable for exploitation and along the roads leading to Luanda makes organization of a functioning, unified supply system unfeasible. Nevertheless, it is quite possible that a study of the Mogadishu system (or another system showing key similarities to Luanda) could provide inspiration for the design of an improved system for Luanda.

<u>Project Components</u>

Project preparation would proceed as follows:

Phase I: Study of present system, probably including:
- mapping of the present supply routes
- survey of present raw material areas

- study of the generation process in cut-cover areas
- mapping of the present organizational set-up.

Phase II: Study of a functioning woodfuel supply system for another major city in Africa.

Phase III: Development of an improved system for Luanda.

Most of the work in the first phase of project preparation would probably have to be done by the Angolan organizations concerned, primarily by DNACO. During Phases II and III, however, expatriates acquainted with well-functioning systems for supply of woodfuels to major cities elsewhere in Africa might provide valuable additional knowledge. Specification of the expatriate knowledge required would probably have to await the completion of Phase I outlined above. About four man-months of expatriate inputs could, however, be put forward as the minimum for project preparation as outlined above. The cost of the above expatriate manpower, together with travel, subsistence and support would be about US$75,000.

4. Domestic Fuel Substitution

This Project would aim at the gradual susbtitution of LPG for firewood and charcoal for use as a domestic cooking fuel. It would be directed mainly at the major urban concentrations on the coast, namely Luanda, Benguela, and Lobito. Needed for the project is mainly increased production and distribution of LPG and gas containers. In order to make it possible for poor families to use LPG, which is a much cheaper fuel than either firewood or charcoal, a simple short-term credit scheme may prove to be essential.

This Project would be carried out by the appropriate units within the MEP and SONANGOL as it falls outside the competence of organizations primarily engaged in biomass energy.

JOINT UNDP/WORLD BANK ESMAP PROGRAM

ANGOLA: POWER SUBSECTOR INVESTMENT REVIEW AND UPDATING OF THE LEAST COST EXPANSION PLAN FOR THE NORTHERN SYSTEM

1. The Energy Assessment recently concluded for Angola by the Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) identifies investment planning in the electric power subsector as a major unresolved issue in the development of the energy sector as a whole. Angola needs assistance in designing an investment strategy including rehabilitation, resumption of deferred maintenance, and new facilities in the context of a country with three separate grids facing great uncertainties in the pace of power demand growth in both space and time.

Electricity Supply

2. Electricity supply in Angola is the responsibility of two companies: ENE and SONEFE (Sociedade Nacional de Estudo e Financiamento de Empreendimentos Ultramarinos). ENE is a State enterprise, created in 1980 and intended to become the sole national power utility in charge of generation, transmission, and medium voltage distribution all over the country. The company is currently operating the "Central" and "Southern" Systems and several isolated systems. SONEFE is in charge of generation and transmission in the "Northern" System, the largest system in the country, and supplies about 300 clients directly at high voltage (60 kV) and medium voltage. Distribution in the area of Luanda is the responsibility of EDEL (Empresa de Electricidade de Luanda). Low voltage distribution in the rest of the country is sometimes the responsibility of ENE but is often handled by local municipal bodies (Comissariados) who may also own small captive diesel sets.

Overall Generating Conditions

3. Total installed capacity in ENE and SONEFE plants is approximately 463 MW. Of the total capacity, 287 MW is in hydro units, 102 MW in gas turbines, and 74 MW in diesel sets. In 1987 available capacity reached 275 MW (59% of total) but there were severe constraints on thermal units due to difficulties in fuel supply. The two gas turbines in Luanda (56.8 MW) burn Jet B fuel while the gas turbine in Cabinda (12.3 MW) runs on natural gas. The two remaining gas turbines, in Biopio (22.8 MW) and Huambo (10 MW), run on diesel oil. Annual

electricity generation in Angola peaked at 1,029 GWh in 1974, with 858 GWh (83.4%) from hydro origin. After a sharp decline in the years following independence, generation resumed growth but experienced a second decline over the period 1983-85 and is still below the values of 1974. In 1986, total generation was 754 GWh with 691 (91.7%) from hydro plants.

4. Electricity supply in Angola consists of three separate grids and numerous isolated systems. The three main systems are associated with the basins of three important rivers: the Kwanza for the Northern System; the Catumbela for the Central System; and the Cunene for the Southern System. These systems supply the main load centers in Angola: Luanda (in the Northern System); Benguela, Lobito, and Huambo (in the Central System); and Lubango and Namibe (in the Southern System). The main isolated systems are those of Cabinda, Uige, and Bie. Another important system in the province of Lunda Norte belongs to the mining company ENDIAMA (Empresa Nacional de Diamantes de Angola) and was mainly used for diamond mining activities.

5. Hydro has always been the main supply source. Its share has remained within 80-85% of total supply, increasing to 91% in 1986 in spite of the total unavailability of Lomaum and a partial unavailability of the Biopio plants. No new hydro plant has been built since 1974. From 1980 onwards, SONEFE and ENE tried to overcome the difficulties caused by sabotage and disruption of the hydro supply by installing new gas turbines in Luanda and Huambo and diesel units in Lobito and other major centers. Because of inadequate maintenance and lack of technical assistance and spare parts, the new facilities have not resolved supply problems. Therefore, current available capacity in the Central System is limited to 47 MW out of the 111 MW installed. The table below summarizes the installed and available capacities in the various systems and compares them with peak demand.

ANGOLA: INSTALLED AND AVAILABLE GENERATING CAPACITY, 1987
(MW)

	Hydro		Thermal		Total		Peak
System	Instl.	Avail.	Instl.	Avail.	Instl.	Avail.	Demand a/
Northern	197.6	135.0	56.8	56.8	254.6	191.8	90-100
Central	49.4	7.2	61.8	39.5	111.2	46.7	30
Southern	27.2	13.6	25.3	15.1	52.5	28.7	9-10
Isolated	12.9	2.4	31.7	5.0	44.6	7.4	n.a.

a/ Estimated at generation; reflects varying amounts of suppressed demand.

Source: SONEFE and ENE.

Background

6. Tentative conclusions of the Energy Assessment are to emphasize maintenance and rehabilitation and to give lower priority to additional (new) generation capacity. Furthermore, a rehabilitation program for the entire subsector was identified. It would take 5 or 6 years to complete and require about US$200 million at 1987 prices. The Assessment further made a critical analysis of some of the new investments being considered by Angola, notably the dam and power plant at Capanda.

The Review

7. The present review would be built on existing subsectoral knowledge. Its objectives would be to:

(i) Identify better and in greater detail the power sector rehabilitation program; analyze its needs for qualified manpower, management and materials; to identify the main constraints to the execution of this program and to find ways to resolve them; to conduct a critical review of its feasibility;

(ii) Critically review the investment program of the subsector and the various utilities (ENE, EDEL, SONEFE, CELB, GAMEK); verify the justification of the investment program and its compatibility with utility and government finances and its adequation to the needs of the grids. Conduct this analysis in the context of realistic assumptions about the growth of the economy and of power demand. Review existing feasibility and prefeasibility studies for hydropower plants in the Northern, Central and Southern Systems and suggest a priority list of which ones should be updated first, especially their technical and economic characteristics.

(iii) Review the technical and economic feasibility of major investments or, if needed, perform such analysis;

(iv) Update the Least Cost Expansion Plan of the Northern System. Analyse the earlier expansion plans developed by SONEFE and more recent consultant studies and compare their hypotheses and conclusions. Analyze their relevance to the present and foreseeable situation of Angola. Analyze the expansion of the Northern System both with and without an interconnection to the other two systems.

(v) Study what alternative uses could be found for equipment and materials already procured for projects which, for various reasons, cannot or should not be pursued.

Evaluate the condition of this equipment and make recommendations regarding its utilization, including the possibility of trade among the various utilities/enterprises.

(vi) Prepare an investment program with an estimate of financial costs (including the costs of safeguarding existing works which are not now needed until they will be) and a time phasing which takes into account Angolan staff constraints and a feasible level of external technical assistance. This investment program should be presented in such detail as to permit a rapid appraisal by international financial institutions and/or other bilateral or multilateral donors/financiers; and

(vii) Identify the most urgent technical assistance needs to strengthen management and accounting of the utilities. Evaluate ongoing activities under multilateral or bilateral auspices and propose a global technical assistance program, of three to five years' duration, closely tied to the availability of Angolan counterparts.

8. This investment review would consider the demand growth scenarios prepared for the Energy Assessment Report (corrected by any new information) as a basis from which to determine the need for rehabilitation and new investment and the updating of the Least Cost Expansion Plan (LCEP) for the Northern System. A sensitivity analysis of demand growth in Luanda should be carried out by taking into account a gradual meeting of repressed demand (through improvements in the distribution grid), the effect of substantially higher tariffs and the pace of industrial sector rehabilitation (major consumers or potential consumers should be treated individually, separate from small or residential consumers).

9. The following considerations should be kept in mind as guidelines to the carrying out of the investment review:

(i) Assign highest priority to rehabilitation of existing facilities;

(ii) Strive for improved reliability of supply to the main cities which are also the main industrial areas;

(iii) Improve supply to Luanda by addressing the main problems in generation, transmission, transformation and distribution in the Northern Grid;

(iv) Postpone most small projects in isolated systems mainly for lack of managerial/technical staff, even if equipment or materials have been purchased;

(v) Postpone rural/village electrification and urban household connections until hydro supply conditions have been improved, tariffs readjusted and billing and collection procedures have been strengthened; and

(vi) Estimate the need for external technical assistance to support power subsector staff (NE and other utilities) in charge of the major rehabilitation projects (Lumaum, the Southern System, transmission and distribution grids).

Capanda

10. With respect to the Capanda dam and power plant, this study will include a detailed analysis of the feasibility of continuing the project or of interrupting it, for an eventual resumption of work at a future time to be determined. The main objective of this part of the Study is to provide an exhaustive analysis of the costs and benefits of interrupting the project in comparison with other alternatives available to Angola. More specifically, the study will:

(i) Identify the best moment for (and the implications of) stopping work on the Capanda project, taking into account: (i) technical aspects (size and stage of the civil works already carried out and to be carried out); ii) economic aspects (possibility of selling the energy produced, feasibility of expanding the Northern Grid and repercussions on the costs of energy in the Northern System); iii) financial aspects (status of the financing plan and probability of obtaining the additional funds needed to complete the project); and iv) organizational aspects (structure of GAMEK and its institutional and management capability).

(ii) Identify alternatives to be developed in the event that work is interrupted on the Capanda Project, tying them in with the rehabilitation of the three systems, which is proposed and is being prepared through another part of this study). Identify specific investments to be made, until such time as the Capanda project can be resumed, to meet rising demand reliably. Identify the human and material resources needed and possible constraints to carrying out several projects simultaneously.

(iii) Analyze the consequences of stopping work on the Capanda project under two assumptions: i) a North-Center interconnection assumed around the year 2000; ii) such an interconnection to be constructed as soon as possible (say, early 1990s). The joint analysis of stopping work at Capanda and interconnecting the system should be carried out while fully keeping in mind the actual conditions in Angola pertaining to security, qualified manpower, financing, managerial capabilities and the status of power (rehabilitation/expansion) projects already decided upon in the Central and Southern Systems.

(iv) Analyze the financial and technical feasibility of safeguarding--over the next several years--the infrastructure and civil works already executed (excavation, tunnel).

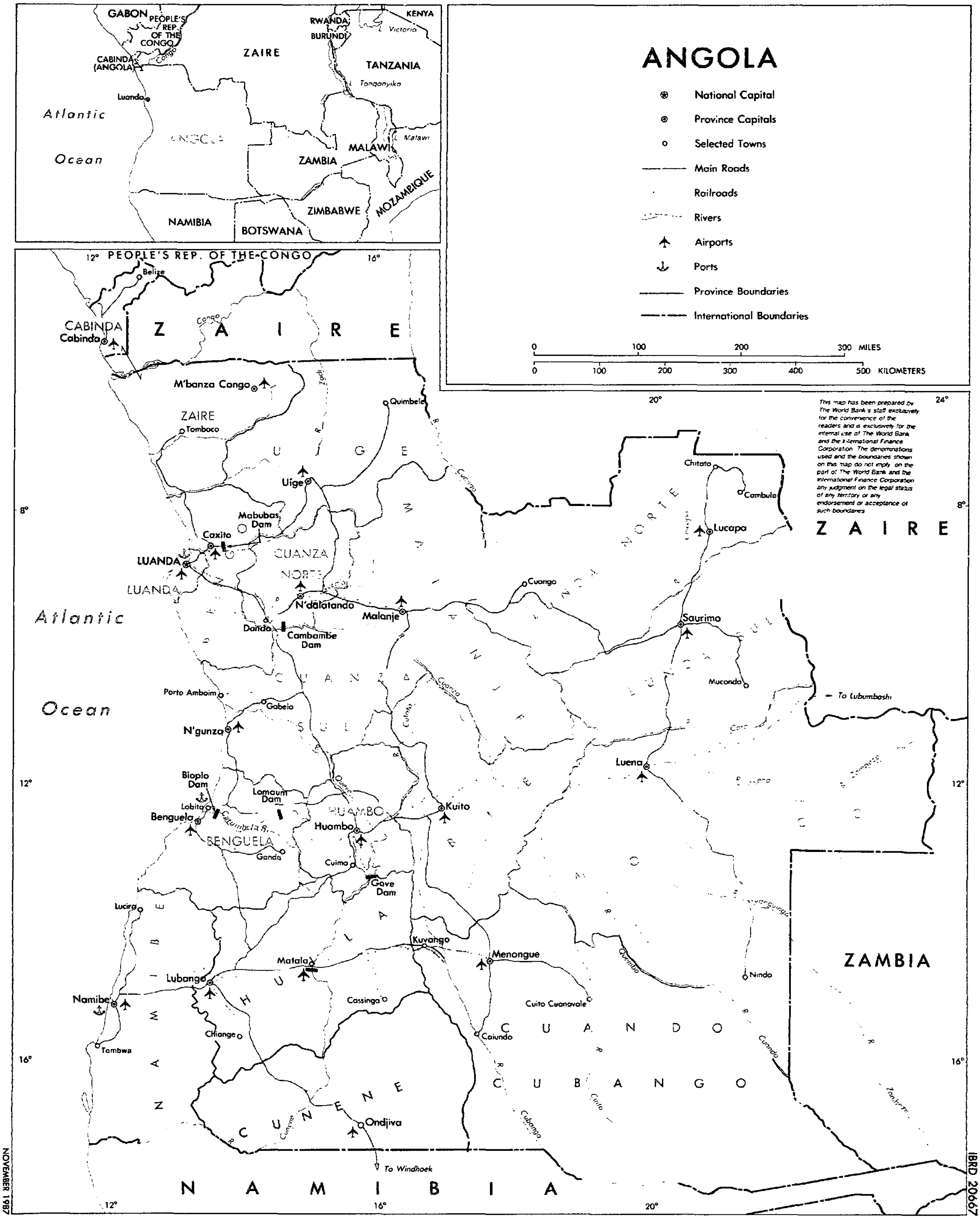
(v) Evaluate the feasibility and costs of using such equipment and materials (already acquired) for other justifiable projects including other power projects (identified in this review) or projects in other sectors (roads, ports, construction, agriculture, other infrastructure, etc.). Identify ways of preserving this equipment (or of using it) to minimize the deterioration and the costs of preservation.

(vi) Review legal and contractual questions which would need to be addressed should Angola decide to stop work on the project.

(vii) Identify the needs of GAMEK as an institution responsible for planning the development of the Kwanza River.

11. This Review would be carried out under the supervision of the Joint UNDP/World Bank ESMAP Program which would assume overall responsibility for the Review but parts of the work could be contracted out to a utility or to an engineering firm.

12. The overall Review would require approximately 25 manmonths of consultant time (including 10 man-months for the updating of the LCEP) and would cost between US$555,000 and US$600,000.



ANGOLA
National Capital
Province Capitals
Selected Towns
Main Roads
Railroads
Rivers
Airports
Ports
Province Boundaries
International Boundaries
0 100 200 300 MILES
0 100 200 300 400 500 KILOMETERS
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GABON
PEOPLE'S REP. OF THE CONGO
CABINDA (ANGOLA)
ZAIRE
RWANDA
BURUNDI
KENYA
L. Victoria
TANZANIA
L. Tanganyika
Luanda
Atlantic Ocean
ANGOLA
L. Malawi
MALAWI
ZAMBIA
MOZAMBIQUE
ZIMBABWE
NAMIBIA
BOTSWANA
PEOPLE'S REP. OF THE CONGO
Belize
CABINDA
Cabinda
Z A I R E
M'banza Congo
ZAIRE
Tomboco
Quimbele
U I G E
Uige
Mabubas Dam
Caxito
LUANDA
LUANDA
CUANZA NORTE
N'dalatando
Malanje
Cuango
Chitato
Cambulo
Lucapa
LUNDA NORTE
Saurimo
LUNDA SUL
Mucondo
To Lubumbashi
Z A I R E
Atlantic Ocean
Dondo
Cambambe Dam
CUANZA SUL
Porto Amboim
Gabela
N'gunza
MALANJE
Luena
MOXICO
Biopio Dam
Lobito
Benguela
Lomaum Dam
HUAMBO
Huambo
BENGUELA
Ganda
Kuito
BIE
Cuima
Gove Dam
Lucira
HUILA
Kuvango
Matala
Menongue
Lubango
Namibe
Cassinga
Cuito Cuanavale
Nindo
ZAMBIA
Chiange
Tombwa
NAMIBE
Caiundo
CUANDO CUBANGO
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