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Jordan
Energy Sector Study

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CURRENCY EQUIVALENTS

Currency Unit	=	Jordan Dinars (JD)
JD 1	=	1,000 fils
JD 0.33	=	US$1.00
JD 1.00	=	US$3.00

WEIGHTS AND MEASURES

1 meter (m)	=	3.281 feet (ft)
1 kilometer	=	0.621 mile
1 square kilometer (km^2)	=	0.386 square mile (mi^2)
1 cubic meter (m^3)	=	35.315 cubic feet (ft^3)
1 kilogram (kg)	=	2.205 pounds (lb)
1 ton (1,000 kg)	=	1.102 short ton (sh ton)
		0.984 long ton (lg ton)
1 barrel (bbl; 0.159 m^3)	=	42 US gallons (gal)
1 kilowatt (kW)	=	1,000 Watts
1 Megawatt (MW)	=	1,000 kW
1 kilowatt hour (kWh)	=	1,000 Watthours (Wh)
1 Gigawatt hour (GWh)	=	1,000,000 kWh = 1,000 MWh (=10^6kWh)
1 kilovolt (kV)	=	1,000 volts (V)
1 kilovolt ampere (kVA)	=	1,000 volt amperes (1 kVA)
1 Megavolt ampere (MVA)	=	1,000 kVA
1 quad	=	10^{15} Btu

GLOSSARY OF ABBREVIATIONS

BGR	-	German Federal Institute for Geological Research
CM	-	Council of Ministers
IDECO	-	Irbid District Electricity Company
JEA	-	Jordan Electricity Authority
JEPCO	-	Jordanian Electric Power Company
JPRC	-	Jordanian Petroleum Refinery Company
LPG	-	Liquified Petroleum Gas
LRAIC	-	Long Run Average Incremental Cost
MIT	-	Ministry of Industry and Trade
NEC	-	National Energy Committee
NPC	-	National Planning Council
NRA	-	Natural Resources Authority
RSS	-	Royal Scientific Society
toe	-	tons of oil equivalent
Tapline	-	Trans-Arabian pipeline

Financial Year = Calendar Year

JORDAN

ENERGY SECTOR STUDY

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IBRD 16299

SUMMARY

1. Jordan's energy resources are limited to oil shale and solar energy, both which are unlikely to contribute significantly to the future supply of energy given present technologies. There is encouraging geological evidence that small oil and gas reserves could be discovered; however, until then, the country will remain totally dependent on imported energy, mainly in the form of oil and petroleum products.

2. Jordan's oil imports have been rising steadily as a percentage of total imports from about 10% in 1975 to 20% in 1981. Simultaneously, their share of exports of goods and non-factor services increased from 19% in 1975 to 27% in 1981 as summarized in Table i below.

Table i

Oil imports and foreign trade
(JD million)

Year	Oil Imports	Total Imports	Oil imports/ Imports (%)	Exports of Goods & Non-Factor Services	Oil imports/ Exports (%)
1975	23	234	10	121	19
1976	34	340	10	183	19
1977	37	453	8	228	16
1978	43	459	9	266	16
1979	69	590	12	341	20
1980	114	716	16	470	24
1981	176	864	20	642	27

This underscores the priority that should be given by the Government to reducing the future imports of oil.

3. The success of Jordan's future energy policy hinges on the Government's ability to reduce the overall consumption of energy without adversely affecting the growth of the economy. Reduction of energy consumption can be best achieved by undertaking a comprehensive program for conservation, particularly in the industrial and transportation sectors, aimed at improving the energy efficiency of the economy. Moreover, the elimination of subsidies for energy would facilitate this process, guarantee that domestic prices reflect the economic cost of supply, and enhance the efficiency of investment decisions. In addition, the higher prices would help mobilize public investment resources which could provide financing for conservation and other sectorial needs.

4. Therefore, high priority should be given by the Government to the following main sectoral issues:

(a) development of domestic energy resources
(b) energy conservation
(c) energy pricing
(d) energy planning

Development of domestic energy resources: The Government is currently assessing the potential for constructing an oil shale power plant, despite the technical risks involved and relatively high costs associated with the development of oil shale mining facilities, without assurance that the shale power plant would be financially viable. Moreover, it may be wise to refrain from undertaking studies for the extraction of oil from the shale before the potential for the discovery of oil and gas is fully assessed and a conclusive decision is reached whether exploration should be terminated. Petroleum exploration has moved to the drilling stage before the geology of the promising areas is fully evaluated and a detailed program for exploration drilling is formulated. Finally, the program for the exploitation of solar energy has been progressing in a piecemeal fashion without guideline designed to ensure that its contribution to the overall domestic supply of energy is maximized. Therefore, it is recommended that the Government formulate a consistent program for the development of domestic energy resources, focus on completing the geological work needed prior to any exploration drilling, and slow down its program for the exploitation of oil shale.

Energy conservation: Energy consumption has increased at an average annual rate of about 16.5% between 1975 and 1981. This high rate of growth is primarily attributed to the accelerated development of the manufacturing and transport sector whose growth over the same period averaged 17% and 4% respectively. The growth of demand for energy is expected to average about 15% for 1982-1990, mainly because of the manufacturing and transport sectors which are expected to continue their growth at or slightly above historical levels. Despite the significant increases in the prices, the consumption of petroleum products continues unabated because the demand for these products is primarily affected by the income generated in the consuming sectors and the relatively high level of workers' remittances from the Gulf states and Saudi Arabia. As a result, energy consumption is likely to continue increasing rapidly unless the efficiency of energy utilization is significantly improved. This could be achieved not only through changes in the technologies used by energy-intensive industries, but also by improving the efficiency by which energy is supplied to the various sectors of the economy. Therefore, it is recommended that the Government initiate a program for energy conservation at all levels of energy use.

Energy pricing: In January 1982, the average domestic price for petroleum products was at about 95% of the average border price. The prices of gas oil/diesel, aviation fuel, 1/ kerosene, and to a much lesser extent, fuel oil are subsidized. In 1981, the net subsidy for petroleum products was about JD 20 million, representing about 54% of its level in 1979. The decrease has been the result of the Government decision in 1979 to gradually phase out the subsidies for petroleum products. Since then, domestic prices were raised five times resulting in an overall increase in the domestic price of petroleum products of about 153% although no specific date has been set by the Government to achieve parity with border prices. Based on the estimated price elasticities for Jordan, the increase in price is not expected to restrain demand significantly because of the strong income effect on the consumption by the industrial and transportation sectors. However, from a resource allocation point of view, setting domestic prices at parity with border prices would ensure the efficient consumption of energy, and would allow the Government to mobilize resources which could be used more economically for other purposes (e.g. energy conservation, development of domestic energy resources, etc.). It is therefore recommended that the Government continue its past effort to phase out the subsidies and set the end of 1985 as the target date for achieving parity between domestic and border prices for gas oil/diesel, fuel oil, and aviation fuel.

Energy planning: The energy sector is characterized by the existence of several entities which are in most cases technically and administratively well run. The main weakness of the sectoral organization is in the area of planning. Energy planning is divided among several institutions which are understaffed, and without a clear mandate entrusting one of them with the responsibility for integrating and coordinating energy plans. As a result, to this date, Jordan does not have a long-term development plan for the sector which would set national objectives and provide a framework for achieving them. The Government has recently become aware of the shortcomings of the institutional structure of the sector, and as a result, its five-year plan for 1981-1985 proposed the creation of a Public Energy Corporation to undertake planning for the energy sector, identify general strategies and carry out studies and research work. However, before creating such an agency, the Government should undertake a sectoral organization study to determine whether a new energy planning agency needs to be created, or whether all that is required is the strengthening of an existing institution. In the immediate future, however, it is recommended that the Government assign the responsibility for energy planning to the National Planning Council and strengthen its staffing by consolidating all the available expertise in the sector in a new

1/ Sold to the national airline, Alia.

section specifically designated for energy planning. This section would serve as the nucleus of what could ultimately evolve into an energy planning agency, if needed.

5. These recommendations are discussed in greater detail in the following chapters and in the annexes. Table ii below summarizes the main issues pertaining to the energy sector, along with the proposed strategy for its development. Table iii presents a list of studies to be undertaken in the energy sector, and their respective degree of priority.

(0573P, Pages 51-54))

Table ii

Proposed Strategy for the Development of the Energy Sector

Issues	Objectives	Recommendations	Studies
I. ENERGY RESOURCES			
A. Oil Shale			
a) Technologies for the utilization of oil shale are still at a very early stage of development worldwide (para. 2.08); b) NRA's program for the development of oil shale resources is proceeding too rapidly, threatening to overburden the country's financial and human resources (para. 2.06).	a) Prepare groundwork for future exploitation of oil shale deposits, pending advancement in technological research abroad; b) minimize use of domestic financial resources and rely more extensively on bilateral aid.	a) Postpone, for at least 10 years, plans to build commmercial size plants for either retorting or power generation; b) scale down the exploratory work planned for Al-Qatranah and Al-Husseineyyah and concentrate efforts for the next five years at El-Lajjun.	a) Reassess the economic viability of retorting and direct combustion based on economic prices and wages to determine which technology is more appropriate for Jordan, and prepare systematic and detailed prefeasibility and feasibility studies of mine and plants; b) undertake an evaluation of the extent of underground water which would be needed for the operation of an oil shale plant.
B. Oil and gas			
1) a) The present exploration program is very widespread, attempting to evaluate all the prospective areas in a very short time; b) a large amount of seismic data have been acquired much of which needs special processing methods; c) drilling operations are undertaken without sufficient high quality seismic data.	1) Maximize probability of discovering commercial oil and/or gas accumulations by carrying out geological and geophysical studies of a high technical level.	1) a) Continue acquisition of high quality seismic data; b) process and interpret seismic data in accordance with industry standards to make sure that adequate subsurface data is available to justify the drilling effort (para. 2.18); (c) in case NRA undertake exploration drilling itself, contract additional geophysical and engineering services and prepare massive training program for the staff (para. 2.19).	
2) International oil companies have demonstrated a lack of interest in exploring in Jordan (para. 2.15).	2) Attract foreign oil companies to undertake exploration drilling.	2) a) Offer updated packages of geological assessment for review to foreign companies (Annex 2, para. 35); b) review contract agreements to offer incentives for foreign firms to undertake exploration in drilling in Jordan (Annex 2, para. 36).	

Table ii (Continued)

Issues	Objectives	Recommendations	Studies
C. Geothermal Energy			
Uncertainty as to the extent of viability of the resource as a source of renewable energy (para. 2.21).	Build a viable system for the extraction and utilization of geothermal energy from the springs at Al-Zarah and Zarqa Ma'in.	Complete geological work before exploiting the resource.	a) Assess the size and quality of the geothermal energy resource from Al-Zarah and Zarqa Ma'in. b) Assess the possible applicaions of geothermal energy and determine the optimal mix of potential uses. c) Assess environmental impact of use of geothermal energy resources. d) Prepare detailed engineering design and cost specifications for the application identified above (Annex 3).
D. Renewable Energy			
1) On-going activies in renewable energy are progressing in a piecemeal fashion and lack coherence (para. 2.23).	1) Maximize the potential for developing renewable energy resources.	1) Implement immediately demonstration and research projects focussing on applications of solar energy to water and space heating, wind/solar thermal electricity conversion systems, and passive greenhouses.	1) a) Assess Jordan's renewable energy resources in detail with particular focus on solar and wind energy. b) Undertake a planning study to establish priorities among various renewable energy technologies and to formulate a strategy for their application.
2) a) Private production of solar collectors is unregulated and quality of production is not standardized. b) The operation of several producers of solar collectors hampers economies of scale. c) Imported equipment for the manufacture of solar collectors is taxed while electricity and diesel oil used for the same purposes are subsidized (para. 2.24).	2) Increase the competitiveness of the local solar collector manufacturing industry.	2) a) Encourage manufacturers of solar collectors to improve quality, reliability and cost of output (para. 2.24). b) Install facilities for the testing and standardization of solar collectors and provide overall technical assistance to local manufacturers. c) Eliminate import duties on equipment used in the manufacturing of solar collectors.	2) Assess potential for export of solar collectors to the Gulf countries (Annex 4, para. 10).

Table ii (Continued)

Issues	Objectives	Recommendations	Studies
II. SUPPLY OF ENERGY			
A. Petroleum Products			
1) Jordan would need to expand and rationalize its oil refining capacity before 1986 although it is not included in the investment program for 1981-1985 (para. 5.09).	Ensure that the future demand for energy is met at least cost to the economy.		1) a) Undertake a detailed assessment of the pattern of the future consumption of petroleum products, the use and location of demand (para. 5.09). b) Assess potential for substitution of coal and/or gas for petroleum products to meet the future demand of energy (para. 5.10). c) Review various alternatives for the expansion of the refining capacities to determine the optimal configuration for oil refining para. 5.10).
2) The transportation, storage, and distribution of petroleum products is highly inefficient (para. 8.19).			2) a) After completion of the above assessments, undertake a study for determining the optimal configuration for the infrastructure for the transportation, storage and distribution of petroleum products (Annex 7, para. 16). b) Undertake a study to determine the feasibility of building a pipeline to import gas from Saudi Arabia.
3) The energy consumption of the existing refinery is relatively high (para. 8.18).			3) Undertake a detailed study for assessing the potential for energy saving in refining through retrofitting and changes in the equipment used (Annex 10, Attachment 2).

Table ii (Continued)

Issues	Objectives	Recommendations	Studies
B. Electricity			
1) Fuel consumption in power plants is relatively inefficient (para. 8.25).	Improve the overall management of the power sector.		1) Undertake a load research and management study to set a framework for managing the demand of electricity consumption and the facilities in the sector to supply electricity at least cost to the economy and to improve the efficiency of power plants (Annex 10, Attachment 3).
2) Transmission and distribution losses are high (para 4.12).			2) Undertake a study for identifying the sources of the high losses at the distribution level and propose a system for standardizing the equipment and material used in the system (Annex 10, Attachment 4).
III. ENERGY PLANNING			
A. Institutions			
a) There is an overabundance of agencies in the energy sector with an inevitable dispersion of human, financial and administrative resources among them. b) No single entity has the full responsibility for the formulation, coordination and implementation of energy plans (para. 3.08).	Strengthen the local capabilities for energy planning.	a) In the immmediate future, assign the responsibility for energy planning to the National Planning Council (para. 3.09). b) Strengthen NPC's staffing by consolidating all the available expertise in the sector in a new section specifically designated for energy planning (para. 8.12).	Undertake a sector organization study to determine whether the new agency proposed by the Government is needed, to propose a structure for the sector, to identify responsibilities of the institutions, and to recommend the staffing and financial resources needed for each (para. 3.12).
B. Energy Data			
Data on energy consumption in the various sectors of the economy is dispersed and inadequate (para. 8.08).	Establish the technical information system necessary for planning the future development of the energy sector.		a) Undertake a study to identify the essential energy and economic data needed for planning and to design a system for the collection, organization, storage and retrieval of this data (Annex 10, Attachment 1). b) Following the start of the energy data base study, undertake a study to disaggregate the input/output model and extend the macroeconomic model of the Bank to include an energy sector submodel

Table ii (Continued)

Issues	Objectives	Recommendations	Studies
IV. DEMAND MANAGEMENT			
A. Conservation			
Consumption of energy has been growing very rapidly in the last ten years (para. 8.26).	Improve the management of energy demand through conservation.	After completion of the energy audit studies, establish designs for retrofitting equipment and procure adequate material (para. 8.28).	Undertake energy audits of the major energy consumers in the industrial sector (cement and building materials fertilizers, phosphate, oil refining, etc.) and of power plants (Annex 10, Attachment 2).
B. Energy Pricing			
1) Domestic prices for gasoil/diesel, fuel oil, kerosene, and jet fuel are below their border prices (para. 6.03).	Price energy products at their economic cost to ensure optimal utilization of resources in the economy.	1) Set the end of 1985 as the target date for achieving parity between domestic and border prices for gasoil/diesel, fuel oil, and aviation fuel (para. 6.07).	1) Assess the impact of raising the prices for petroleum products to eliminate the subsidies (para. 6.10).
2) Electricity tariffs are substantially below the economic cost of supply (para. 6.13).		2) Introduce increasing block rates into the low-voltage electricity tariffs (paras. 6.15-6.17).	2) Undertake a study to assess the impact on the resources mobilized by the subsector and the consumers of introducing increasing block rates for sales at the low-voltage level (para. 6.17).

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(0573P, Pages 55-59))

I. INTRODUCTION

1.01 This report is not intended as a comprehensive review of Jordan's energy sector. Its purpose is to identify the main issues in the sector and propose a course of action for addressing each. In this respect, the report concentrates on five areas of high priority. These are:

a) development of domestic energy resources;
b) organization of the sector;
c) projected trends in the consumption and supply of energy;
d) energy pricing;
e) investment program for the development of the sector; and
f) energy planning and strategy for the development of the sector.

1.02 Chapter II reviews Jordan's energy resources and focuses on the strategies for petroleum exploration and oil shale development. Chapter III presents the setting of the energy sector, and recommends the streamlining of the institutional structure and the strengthening of energy planning capabilities.

1.03 Chapter IV examines the factors responsible for the fast growth in energy consumption over the past ten years. Chapter V forecasts the demand for petroleum products and electricity, and assesses the existing and planned infrastructure to determine whether the projected demand would be met at least cost.

1.04 Chapter VI presents the current structure of prices for energy products in comparison with economic costs of supply. The Government policy of subsidizing energy prices is discussed in detail and a proposed strategy for the correction of existing distortions in pricing is outlined. Chapter VII reviews the Government investment program for the development of the sector for the 1981-1985 period and the proposed sources of financing. It concludes with an alternative investment plan based on the findings of the report. Finally, Chapter VIII discusses energy planning and the strategy for the development and management of energy.

1.05 The report is organized in two parts: the first covers the main issues and recommendations; the second consists of a set of annexes which deal with the issues in more detail. Therefore, the first part is intended for the policy makers and managers, while the second part would interest those who seek greater exposure to the issues and a more detailed justification for the recommendations set out in the report.

II. ENERGY RESOURCES

2.01 Jordan's presently known indigenous energy resources consist of relatively large deposits of oil shale, some tar sands, a small hydropower potential, and few geothermal sources of low surface temperatures. No commercially exploitable coal, lignite, uranium, oil, or gas reserves are known to exist. Moreover, with the exception of solar energy, Jordan's endowment of noncommercial and renewable energy is modest.

A. Oil Shale

Reserves

2.02 Oil shale deposits are presently known to exist at El-Lajjun south of Amman, Al-Qatranah in the Yarmouk valley, and Al-Husseineyyah in the southern part of the country (IBRD Map No. 16299). So far, only the deposits at El-Lajjun have been geologically investigated in some detail. As for the two other deposits, very little is known at present about their size and geological characteristics. The Government intends to initiate the preliminary stages for the geological assessment of these deposits during the implementation of the 1981-1985 plan (Annex 9, para. 19).

2.03 The deposits at El-Lajjun are located about 110 km south of Amman, between Qatrana to the east and Karak to the west. The deposits are shallow and thus suitable for low-cost open pit mining. The oil shale reserves at El-Lajjun are estimated at about 1.1 billion tons with an average oil content of about 10%. These estimates are based on 75 exploratory boreholes. Additional exploratory work is needed before the plan for the exploitation of the reserves is finalized (Annex 1, para. 15).

2.04 In 1979, the Natural Resources Authority (NRA) commissioned a study by the German Federal Institute for Geological Research (BGR) for the evaluation of the reserves at El-Lajjun. The study, which was completed in 1980, concluded that the shale was of a sufficiently good quality to justify further work in assessing the potential for its exploitation for power generation by direct combustion and the production of shale oil by retorting. Consequently, in 1980, the Government commissioned a prefeasibility study by Technopromexport (USSR) to assess the potential for directly burning the shale in a 300 MW power plant (conventional combustion). In addition, two other prefeasibility studies were awarded in 1980 to Kloeckner/Lurgi (West Germany). The first was for determining the possibility of using the shale in the generation of electricity by adopting Lurgi's newly developed technology of fluidized bed combustion; and the second was for assessing the viability of constructing a retorting plant for the production of shale oil.

2.05 The work by Kloeckner/Lurgi was concluded in 1982. Although the two options for the exploitation of oil shale were found to be viable, the study

recommended that NRA concentrate its efforts on retorting in view of the projected increases in the real price of oil and the financial cost of generating electricity in Jordan. This recommendation has two main shortcomings: (a) actual electricity tariffs were taken as an estimate of the economic cost of electricity instead of the long-run marginal cost; (b) the resource cost of unskilled labor, to be hired for mining the oil shale, was not used to evaluate the different options. It is therefore recommended that the Government request Kloeckner/Lurgi to reassess the economic viability of the two options based on economic prices and wages. Once the recommended reassessment is completed, the Government would have three possible options for proceeding to the next step in its long-term program for the exploitation of oil shale: (a) to build, for trial operation, a commercial size power plant (300 MW) based on the conventional combustion technology; (b) to construct a pilot power plant (about 20 MW) based on fluidized bed technology to allow for the collection of data on its operation; or (c) to erect, for trial operation, a single commercial size oil shale retorting unit yielding about 1,250 barrels/day.

Recommended Strategy for the Exploitation of Shale

2.06 In view of the increasing burden being imposed by the oil import bill on the foreign exchange resources of Jordan, and given the superior quality of its oil shale, NRA is justified in assessing the potential for exploiting the shale to meet part of the future demand for energy. However, at the outset, the Government should be aware that the implementation of a pilot program for determining the potential for commercially exploiting the shale involves substantial risks, both technical and financial. The risks would prevail irrespective of the strategy adopted and technology selected. Therefore, in formulating a plan for the development of the shale, the objective should be to select the path which would minimize the financial risk and reduce the burden on the technical and human resources of the country. This would immediately suggest a plan that entails thorough assessment of the resources and available technologies, and a gradual movement towards possible commercialization of the technology selected by starting with small demonstration units, then larger pilot scale plants, and finally reaching commercial size schemes.

2.07 The Government is in the process of formulating a long-term plan for fully assessing the optimal strategy for ultimately exploiting the oil shale. The formulation of such a plan would involve the following three elements which should be addressed in sequence:

a) an assessment of the options for the exploitation of shale under the presently known technological know-how;

b) an evaluation of the technology to be employed under each of the options considered economic; and

c) the determination of the time horizon for reaching the commercialization phase of the technology selected.

2.08 Options for the Exploitation of the Oil Shale: The retorting of shale for the extraction of oil involves complex technology which is presently at the embryonic stage of development. Few test models have been constructed

in the industrialized countries (mainly the USA and Brazil). However, despite the experience gained in these pilot schemes, the viability of commercial size retorting plants is still questionable. Plans to construct commercial size plants in the industrialized countries have either been slowed down or abandoned. Therefore, in order to reduce the risk associated with the construction of a pilot retorting scheme in Jordan, NRA should proceed slowly and cautiously to capitalize on the experience and results obtained from operating similar plants currently under construction. By contrast, the generation of electricity by burning shale in a plant based on direct conventional or fluidized bed combustion involves a relatively simpler technology for which relevant industrial experience is more readily available. The technology involving the generation of electricity from lignite of low calorific values has provided extensive experience, some of which is applicable to the shale; however, so far all experimentations concerned with the generation of electricity by direct combustion have provided, at best, marginal results when compared to the cost of generating electricity by burning fuel oil or coal. Therefore, from a purely risk-aversion point of view, and given the unproven nature of the presently-known technology, it is recommended that the Government consider postponing, for at least ten years, its plans to build commercial size plants for either retorting or power generation; and that it concentrate its resources in the interim period in undertaking systematic and detailed prefeasibility and feasibility studies, and the construction of prototype models before moving to the full scale pilot stages.

2.09 Selection of Technology: The proposed Lurgi retorting process has a relatively high energy efficiency by treating all raw shale (including the fine shale), making utilization of the residual energy in the retorted shale and by avoiding dilution of the product-gas with off-gas. However, this process has been running on oil shale only at the small scale of about 20 barrels per day, whereas the less energy efficient processes in Brazil and USA have been tested at pilot plants of up to 1,000 barrels per day. If Jordan decided now, to go ahead with a 1,250 barrels per day plant of the selected technology, it would be the first country to do so and consequently would have to take the full risks associated with such a step. The direct combustion option involves two technologies: conventional and fluidized bed combustion. However, both technologies have not been sufficiently tested in commercial size plants to provide conclusive basis for choosing between them. Only the large power plant in Estonia is presently known to operate by using the conventional combustion technology. However, the experience gained there cannot be directly applied in Jordan because of differences in the quality and properties of the shale. Furthermore, the conventional combustion technology involves substantial environmental difficulties (fly ash and sulfur) which would add to the risk associated with the construction of commercial size plants. On the other hand, the fluidized bed combustion technology has the advantage of being environmentally safer and operationally more efficient; but commercial size plants have not yet been built and fully tested. Therefore, it is recommended that a stepwise strategy be adopted involving the detailed assessment of technologies worldwide, then the construction of a pilot plant based on whichever technology is judged more appropriate for Jordan. However, in order to reduce the risk and cost involved in testing the technology selected, the Government should attempt to finance a large proportion of the cost of the pilot plant through bilateral aid and avoid, to the extent possible, allocating its resources to proving technologies whose economic viability should have been established and tested in the industrialized countries.

2.10 Time Horizon for the Development of Oil Shale: Before embarking on the construction of a 1,250 barrels/day retorting module, results of oil shale developments abroad should be awaited. The first commercial plant in western countries (Union Oil's 10,000 barrels/day project in Colorado) is expected to come on stream by end-1983. Because of the substantially different technology, it is further advisable to also wait for the start-up of a larger oil shale retorting unit of the selected technology. In the meantime, the advantages and disadvantages compared with the direct combustion option should be carefully evaluated and, if the retorting option is found to merit further investigation, then detailed studies for a smaller pilot plant should be prepared. This is expected to take about 3-4 years. A decision on whether to proceed with a small scale pilot retorting unit could be made by 1987. In view of the existing and the planned extension of the power generating capacities in Jordan (Aqaba 2 X 130 MW) which are expected to meet the projected demand until 1990, there is no urgency for accelerating the program for the development of power generation from shale. Prior to such development, the Government should initiate detailed studies that would provide the input required for designing a critical path for the commercialization of oil shale based generation, if this option proves viable. However, until the advantages and disadvantages of retorting and direct combustion have been fully evaluated and a subsequent study for either a retorting or direct combustion small pilot plant is completed, the Government's current schedule should be modified so as to plan for the construction of a pilot plant in the late 1980's, and the commissioning of the first commercial size oil shale plant, if any, for not earlier than the mid-1990's.

2.11 Moreover in view of the size and quality of the reserves at El-Lajjun it is recommended that the Government scale down the exploratory work planned for the other deposits (Al-Qatranah and Al-Husseineyyah); and that it concentrate on completing and reviewing detailed studies aimed at providing the basis for determining the optimal strategy for the exploitation of the shale. A possible work program is presented in Annex 1.

B. Oil and Gas Exploration

Geology

2.12 Jordan spans an area of approximately 97 thousand km^2 of which 75 thousand km^2 is covered by sedimentary basins, where petroleum reserves could be found. Past exploration work, by international oil companies and NRA, has identified several areas where oil and gas could have been generated. Four of these areas (IBRD Map No. 16106) are particularly attractive for petroleum exploration in the immediate future:

a) The Central Plateau: The Central Plateau area, located south and southeast of Amman, is characterized by a thick sedimentary section, containing rich oil source and reservoir rocks. Several of these geological structures mapped in the past provide strong indications of the existence of oil and gas accumulations.

b) The Northern Highlands Area: The Northern Highlands area, located north of Amman, contains both oil source and reservoir rocks, and therefore, chances are good that oil and gas accumulations are present.

c) The Northeastern Plateau (Risha): The panhandle area, located in the easternmost area of Jordan (Risha), has not been systematically explored until recently. Seismic surveys indicate the existence of a very thick sedimentary section, similar to those found in the neighboring countries. Therefore, the probability is fairly high that the geological elements needed for the formation of oil and gas are present.

d) Aqaba-Jordan Valley Rift: A geologically very complicated zone, some 300 km long and up to 30 km wide. It contains thick sedimentary sequences and could contain oil and gas accumulations. However, search for these fields would be much more expensive than in the areas mentioned above because of geological complexities.

Past Exploration

2.13 Several foreign oil companies explored in Jordan between 1946 and 1978. Geological and geophysical programs were undertaken, and 14 exploration wells were drilled. In several wells, oil and gas shows were encountered. In fact, one of these wells (Wadi Rajil) is believed to have penetrated an oil-bearing section; however, this was not recognized by the operator at the time.

2.14 As a result of their exploration work, the oil companies concluded that "Middle East-sized oil fields" were unlikely to be present in Jordan. As a result, by the mid-70s, all international companies abandoned exploration work in Jordan.

2.15 The Government, while concerned about the lack of interest shown by the oil companies, remained convinced that the oil and gas potential of the country had not been fully evaluated. In 1976, NRA embarked on an exploration program funded from the national budget. Two foreign consulting firms were appointed, BEICIP (France) and Welldrill (UK), to review past exploration data and formulate an exploration program. The firms recommended additional seismic work which was subsequently executed and interpreted by CGG (France). Also geological and geochemical studies were undertaken. In 1980, the new data was presented to the oil industry; however, despite some initial interest, not a single oil company acquired exploration rights. The lack of interest by the internationally reputable firms stems from the fact that the geology of Jordan is complex, and that the chances of discovering large reserves are small. Consequently, these firms saw better opportunities elsewhere for risking exploration funds and deploying their scarce technical manpower.

2.16 Past exploration work has been insufficient to provide conclusive evidence on Jordan's petroleum prospects. In addition to the complexity of the geological conditions, the geophysical methods used have been insufficient for properly mapping the geological structures. These problems have been

by now largely overcome due to rapid progress in the geophysical field. It is recommended that NRA continue a sustained effort using the most up-to-date exploration tools.

The Government Program for 1981-1985

2.17 The most recent disappointing response by the foreign companies to the geological packages offered by NRA prompted it to continue its own seismic work in addition to embarking on an exploration drilling program. At the end of 1981 three seismic parties were under contract; in November 1982 one party, CGG (France) was operative. In 1981/1982, about 8,000 km of seismic lines have been profiled, and a definite improvement of the seismic data quality has been noted. Concurrently, NRA has contracted a drilling rig from Naftagas (Yugoslavia). Two wells have been drilled near Wadi Rajil while drilling of a third one is under way. Several possible oil bearing horizons have been found in these wells; testing is under way with a workover rig which was provided by INOC (Iraq National Oil Company).

2.18 NRA is determined to continue with its aggressive exploration program; sufficient funds are available to support a high level operation at least through 1983. Seismic surveys will continue through 1983 with one, or possibly two, crews. The present program foresees acquisition of over 6,000 km of near seismic lines. Intensive seismic processing is indeed required for all areas, and new seismic acquisition methods need to be employed in the geologically complex areas like the Northern Highlands and the Dead Sea Graben. Therefore, it is recommended that processing and interpretation of seismic data be carried out in accordance with industry standards to ensure that adequate subsurface data is available to justify the drilling effort. However, because the interpretation of seismic data is a lengthy process, it might not sustain a continuous drilling program as presently planned by NRA.

2.19 After the results of the seismic work are known, it is recommended that NRA make a new attempt to attract the interest of oil companies. In the unlikely event that no foreign company would be interested in the results, NRA could undertake the drilling itself. This, however, would require high level technical personnel, not only for actual drilling operations but also for the attendant pre-drilling work. Therefore, in addition to the technical services agreements that NRA has concluded with Welldrill (a UK consultant for oil exploration and production matters) and with INOC (which has seconded engineers to NRA), it is recommended that NRA contract geophysical and engineering services and prepare a massive training program for its staff to gain access to and have a working knowledge of latest technical developments.

C. Hydropower

2.20 Jordan's hydropower potential is limited to about 24 MW (87 GWh per annum) of which 4 MW (14 GWh per annum) is at the King Talal Dam on the River Zarqa, and 20 MW (70 GWh per annum) could be tapped if the multipurpose Maqarin Dam, near the Syrian border, is built. However, construction of the Maqarin Dam , on the Yarmuk River, would be subject to the conclusion of an agreement on riparian rights between Jordan and Syria. The potential at King Talal will be exploited when the current plan to raise the height of the dam an additional 15 meters is completed by 1984. A feasibility study, including detailed engineering designs, for the power house is currently under way.

D. Geothermal Energy

2.21 Geothermal resources exist in the form of hot springs at Al-Zarah and Zarqa Ma'in, about 10 km from the northern end of the Dead Sea. The surface temperature is about 45°C at Al-Zarah and 63°C at Zarqa Ma'in. The combined hourly discharge of these springs into the Dead Sea is estimated to be about 2,000 m^3. At present, the geophysical and geochemical characteristics of the springs are not available. The Government has budgeted about JD 400 thousand (US$1.2 million) in its 1981-1985 plan for the exploitation of geothermal resources. However, before starting the development of the resources, it is recommended that the Government undertake a detailed study to geologically assess the resource, determine an optimal strategy for its exploitation, and eventually prepare engineering design and specification for constructing the required energy extraction and utilization system. Draft terms of reference for this study are provided in Annex 3.

E. Renewable Energy

Resources

2.22 Solar energy constitutes the main renewable energy resource in Jordan. Its intensity (in the horizontal plane) is substantial and is estimated at about 1700 Btu/ft^2/day. Jordan's wind resource is limited and suitable mainly for water pumping.

On-going Activities in Renewable Energy

2.23 Current activities in renewable energy consist of a set of separate projects, the bulk of which is carried out by the Royal Scientific Society (RSS) which acts as the focal point for most of the renewable energy effort in the country (Annex 4, paras. 4-7). The major demonstration project is a German-built solar-assisted desalination system at Aqaba. As a field application, 88 photovoltaic-powered units are used to operate radio telephone systems in rural and remote desert locations. Another application involves the concentration of brine from the Dead Sea in 3 ponds with a combined area of about 76 km^2, and the precipitation by solar energy to produce annually over 1 million tons of potash and other by-products.

2.24 The only commercial application of solar energy in Jordan pertains to the production of solar water heaters, used mostly for providing domestic hot water. This industry employs about 100 technicians, has a capital outlay of some US$2 million and an annual production capacity of about 1 million ft^2 of collectors (equivalent to about 28,000 household units). However, the industry needs to improve the quality and reliability of its output. In addition, its market is limited to the local residential consumers, while the larger markets in the commercial and industrial sectors at home and abroad (especially in the Gulf countries) have not yet been tapped. The major constraint to the development of this industry is the lack of a firm commitment on the part of the Government to regulating and promoting the use of solar energy.

2.25 On-going activities in renewable energy lack coherence because most of the projects have been undertaken separately without being closely coordinated with one another. Furthermore, although RSS has access to very good manpower and technical facilities, it has not been able to utilize them fully because it is largely underfunded. In order to ensure that the potential for developing Jordan's renewable energy resources be fully utilized, the Government should discourage the ad hoc implementation of renewable energy projects as it dissipates resources, and should rather focus on planning a coherent plan of action. Therefore, it is recommended that a study be undertaken to assess the potential of various renewable energy applications, to establish priorities among them, and develop a program for their implementation. However, pending the completion of the study, a number of projects which have already been identified and which would certainly be endorsed by the planning study should be considered for immediate implementation. (Annex 4, para. 10)

III. INSTITUTIONAL SETTING OF THE SECTOR

3.01 Several entities are concerned with the operation and development of Jordan's energy sector (Annex 5). The planning, coordination, and policy formulation involves three bodies: the National Planning Council (NPC), the Ministry of Industry and Trade (MIT), and the Jordanian National Energy Committee (NEC). The development of domestic sources of primary energy is entrusted to the Natural Resources Authority (NRA). The production and delivery of secondary energy is the responsibility of the Jordan Petroleum Refinery Company (JPRC), the Jordan Electricity Authority (JEA), the Jordanian Electric Power Company (JEPCO), and the Irbid District Electricity Company (IDECO). Energy research involves the Royal Scientific Society (RSS), and the Universities of Jordan and Yarmouk.

3.02 NPC is an autonomous Government agency responsible for the formulation of long-term economic plans. NEC was formed in 1977 to review and advise the Government on policies relating to the supply and development of energy in Jordan. MIT is responsible for regulating the operations of the private and public enterprises in the energy sector. It also plays a major role in formulating the policies for the pricing of energy, and the negotiation of concessional agreement with the private firms (JEPCO, IDECO and JPRC). In 1977, an energy department was established in MIT to function as a secretariat for NEC in preparing studies relating to energy conservation, planning, production and distribution.

3.03 NRA is a Government agency responsible for all activities relating to the exploration for and development of minerals, hydrocarbons and underground water. The Petroleum Department at NRA oversees all oil-related activities in Jordan, which, among other things, covers geological surveys, negotiations with foreign firms of contracts for exploration, and more recently, the implementation of a program for exploration drilling. The Department of Geology at NRA supervises the studies dealing with the development of oil shale.

3.04 JPRC is a privately-owned firm in which the public sector holds 12% of the total share. It operates the only oil refinery in the country located 35 km northeast of Amman. JPRC is responsible for refining the crude oil purchased by the Government, and distributing and marketing all petroleum products in Jordan. JPRC's operations are regulated by MIT in accordance with a concession agreement which ensures the company a fair return on investment.

3.05 JEA is a financially and administratively autonomous publicly owned utility. It is responsible for the formulation of plans for the overall development of the power subsector; the construction of generation and transmission facilities; the generation and transmission of virtually all the publicly supplied electricity, and the distribution of electricity in the areas under its jurisdiction. In addition, JEA regulates the distribution utilities in charge of low voltage electricity sales. JEPCO is a private company owned by the public (77%), JEA (13%), and the municipalities (10%). It distributes electricity in an area of about 2,000 km^2 covering the city

of Amman and its environs. In 1980, JEPCO accounted for about 81% of total electricity sold in Jordan (Annex 6). IDECO is a semiprivate company owned by JEA (46.5%), the Municipalities of Irbid Governorate (42.5%), and by private investors (11%). Its service covers a concessionary area encompassing the Governorate of Irbid. IDECO's sales in 1980 constituted about 10% of the electricity sold in Jordan (Annex 6).

3.06 Solar energy research is entrusted to the RSS and the universities of Jordan and Yarmouk. RSS is well organized and its staff is of the high caliber. However, the Society's activities in the energy field need to be more closely integrated with the national objectives for the sector.

3.07 The Department of Petroleum at NRA lacks the expertise needed to undertake the ambitious plan for geological and oil exploration drilling. Moreover, the Authority has been unsuccessful in the past in recruiting experienced staff mainly because of the relatively low compensation packages offered compared with those offered in the oil-exporting countries in the area; and the lack of a work program of the size that would attract Jordanian professionals qualified in petroleum exploration. As a result, NRA plans to initiate an expensive training program for its staff in the departments of Petroleum and Geology to undertake extensive work in oil exploration and oil shale development. The training program for petroleum exploration would cover highly technical work ranging from evaluation of geological work to drilling for oil, while the training for the exploitation of oil shale would only be concerned with mining. The training of Jordanians by the Authority is viewed as a means of reducing its needs for expatriates whose recruitment has been difficult, and of providing the expertise needed for the implementation of its planned five-year programs for petroleum exploration and oil shale development. This is an ambitious objective which is unlikely to be achieved soon in view of the time required to acquire the level of expertise that would reduce the need for dependence on few internationally experienced experts, particularly in the areas of oil exploration and drilling, and oil shale mining and development. Moreover, if the Authority is unable to fully implement its planned programs and provide professionally challenging opportunities for its staff, it would stand to lose a large proportion of that staff to the oil companies in the Gulf states and Saudi Arabia. It is therefore recommended that NRA consider strengthening the staff in the petroleum department by concentrating its training program on the execution and supervision of detailed geological work and seismic interpretation, etc. Later, as the scope of the exploration program widens, commensurate training could be initiated. Furthermore, the Government should consider lifting the ceiling on the compensation package offered by NRA in order to attract at least a few internationally experienced professionals that would provide guidance and field training for the newly-trained Jordanians.

3.08 Several entities and agencies are involved in the operation and management of Jordan's energy sector. The unique feature of this setting is the lack of coordination and the large difference in the technical and administrative capabilities of the entities. All the enterprises responsible for the production, transportation and distribution of energy (JEA, JEPCO, JPRC, and to a lesser extent, IDECO) are fairly well staffed and capable of executing their responsibilities at standards that are

substantially higher than those found in the area and in most cases comparable to those found in the industrialized countries. By contrast, the agencies responsible for the overall management of the sector, and the formulation and coordination of plans, lack a clear direction, and are either overextended (NPC) or understaffed (NEC). Moreover, none of these agencies has responsibility for systematic energy planning. As a result, to this date, Jordan does not have a national plan for energy that would outline a set of consistent macroeconomic objectives ranging from pricing policies, conservation and demand management, investment priorities, financing, to the increased use of renewable energy, etc.

3.09 At present, NEC is, in essence, responsible for the formulation of overall policies in the energy sector. However, since the membership of the committee is made up of high ranking officials with other administrative responsibilities (ministers, directors of departments and corporate managers), its effectiveness as an energy planning body is constrained because of the limited input provided by the Energy Department at MIT. Since its creation, the Energy Department has been unable to adequately execute its responsibilities because of lack of precise objectives, shortage of funds, and above all, inexperience. The Department continues to encounter difficulties in attracting and retaining staff of the quality needed to ensure effective support for NEC and adequate input in the formulation of energy policies. So far the Energy Department has been able to recruit only one professional with experience in energy who was seconded from JEA; however, he is unable to provide the input needed because of the inadequate technical support provided by his staff consisting of 6 recent university graduates.

3.10 According to its mandate, NPC is responsible for the coordination of sectoral plans, the selection of projects for the national development plans and the mobilization of foreign and domestic financing for these plans. However, its coordinating function is basically an aggregation of plans for each energy subsector drawn independently by the enterprise or agency responsible without assurance that the plans are part of an overall least cost strategy for the overall development of the sector. In sensing the need for a more systematic analysis of the interrelationship between energy and economic growth, NPC has moved to fill the existing gap in the institutional structure of the sector by commissioning several energy planning related studies. However, its staff is currently over-burdened because of the wide responsibilities covering all sectors of the economy; and as a result, the time devoted by the Council to energy planning is fairly limited.

3.11 The main constraint to the Government's ability to formulate comprehensive national energy plans is the abundance of agencies in the sector among which the country's human, financial and administrative resources are dispersed. Consequently, the sector suffers the absence of a nucleus of human and financial resources needed for undertaking energy planning. <u>There is a clear need for the Government to consolidate the expertise in a single agency with the responsibilities for formulating overall energy plans covering infrastructure, policies for pricing and demand management, conservation and taxation strategy for inducement of retrofitting and improved efficiency by industry</u>.

The Government has recently become aware of the shortcomings of the institutional structure of the sector, and as a result, its five-year plan for 1981-1985 proposed the creation of a Public Energy Corporation to undertake planning for the energy sector, identify general strategies and carry out studies and research work. The proposed corporation would also be responsible for oil and natural gas exploration, development of oil shale and renewable energy. Before creating such an agency, the Government should undertake a detailed study to determine whether a new energy planning agency needs to be created, or whether all that is required is the strengthening of an existing institution. Furthermore, the study should propose a structure for the energy sector, identify responsibilities of the institutions and recommend the staffing and financial resources needed for each. The Government has already agreed in conjunction with a Bank loan for the fourth power project to undertake a comprehensive organization study to commence by not later than December 31, 1982 and complete, by June 30, 1983.

3.12 There is still an urgent need for Jordan to immediately start formulating a long-term comprehensive plan for the development of the energy sector, and integrate it with the development plan for the country. However, the prevailing fragmentation of responsibility for energy planning and the shortage of experienced staff in planning throughout the sector are expected to be major constraints for the formulation of an energy plan. In view of the fact that the completion and review of the sector organization study is likely to take about two years, an interim measure should be considered by the Government. Since NPC has a team responsible for the overall planning and given that it has already started several studies whose aim is to improve the use and development of energy, it is recommended that the Government consider as an interim measure, the assignment of the responsibility for energy planning to the Council and strengthen its staffing by consolidating all the available expertise in the sector in a new section specifically designated for energy planning. This section would serve as the nucleus of what could ultimately evolve into an energy planning agency, if needed.

IV. HISTORICAL TRENDS IN THE CONSUMPTION AND SUPPLY OF ENERGY

A. Consumption of Energy

Overall Consumption of Energy

4.01. Jordan's per capita consumption of energy increased at an average annual rate of about 12% for the period 1975-1981; from 471 kgoe in 1975 to 930 kgoe in 1981. The growth of energy consumption during this period averaged about 16.5% a year, compared to an average annual rate of growth for the GDP of 12.3%; resulting in an energy coefficient of 1.3. 1/ Over the same period, the intensity by which energy was consumed increased at an average annual rate of about 4%; from 2.5 toe/1000 JD in 1975 to 3.1 toe/1000 JD in 1981.

4.02 The high rate of growth of energy consumption during the past six years was primarily due to: the increased access of the households, commerce and small industries to publicly supplied electricity; the initiation or expansion of relatively large energy intensive industries such as cement, phosphate, etc.; the increased remittances of the Jordanian workers which stimulated a higher demand for energy than would have otherwise prevailed; and the growth of the transportation sector particularly the road and air transport.

Petroleum Products

4.03 Consumption of petroleum products increased at an average annual rate of about 14.6% over the period 1970-1981. As shown in Table 4.1 below, aviation fuel had the highest rate of growth (22.6%), followed by gas oil/diesel (17.1%), LPG (15.7%), fuel oil (15.4%), gasoline (10.5%), and kerosene (6.8%).

Table 4.1

Growth of Consumption of Petroleum Products, 1970-1981

	1970-1981	1970-1975	1975-1981
Aviation Fuel	22.6%	20.6%	24.7%
Gas Oil/Diesel	17.1%	15.6%	18.3%
LPG	15.7%	13.2%	17.8%
Kerosene	6.8%	9.8%	4.5%
Fuel Oil	15.4%	9.2%	20.8%
Gasoline	10.5%	10.9%	10.3%
Overall	14.6%	11.7%	17.0%

4.04 In 1980, the transportation sector accounted for about 48% of all the petroleum products consumed, the power subsector 17%, industry 13%, domestic consumers an additional 15%, and the remaining 7% was divided among all other consumers. Table 4.2 summarizes the sectoral distribution of the products consumed in 1980.

1/ The energy coefficient is defined as the ratio of the growth rate of energy consumption to that of GDP.

Table 4.2

Sectoral Distribution of Petroleum Products Consumed in 1980

Sector	Percentage of Total Products Consumed	Percentage of Total Gas Oil Consumed	Percentage of Total Fuel Oil Consumed
Transport	48	73	4
Electricity	17	13	50
Industry	13	7	42
Domestic	15	5	-
Other	7	2	4

Electricity

4.05 The consumption of electricity increased at an average annual rate of about 19% between 1975 and 1981; resulting in a coefficient of electricity consumption to GDP of about 1.6. Moreover, electricity consumption per unit of GDP increased from 1,038 kWh/1000 JD in 1975 to 1,496 kWh/1000 JD in 1981.

4.06 The rate of growth of electricity consumption over the past six years has been high principally because of the commissioning of several large energy consuming industries such as ceramics, steel pipes, etc; the expansion of some of the existing energy-intensive industries such as cement, phosphate and the refinery; and the increase in the proportion of the population with access to publicly supplied electricity, from 39% in 1975 to 67% in 1980, as a result of the Government's intensified program for rural electrification.

4.07 The sectoral distribution of electricity consumption changed significantly between 1975 and 1981. The domestic consumers' share of total sales increased from 26% in 1975 to 35% in 1980, while the share of industry decreased from 46% to 36%. In 1981, the household sector accounted for 37% of total electricity sales, the industrial 34%, commercial 14%, water pumping 8%, and the remaining 7% was shared among public institutions, street-lighting, broadcasting and TV. The growth of sales by customer classes is summarized in Table 4.3 below.

Table 4.3

Growth of Electricity Sales by Customer Class between 1975-1980 (%)

	JEA	JEPCO	IDECO
JEA	21	-	-
IDECO	27	-	-
Industry	285 /1	18	27
Domestic	42	27	28
Commercial	-	18	38
Others /2	-	15	20

/1 Covers only 1979 to 1980 because prior to 1979, all of JEA's bulk sales were purchased by JEPCO and IDECO.

/2 Includes streetlighting, hospitals and public institutions.

B. Supply of Energy

Petroleum Products

4.08 Jordan continues to be totally dependent on imported crude oil and petroleum products for meeting its energy needs. Its supply of crude oil is taken from the Trans-Arabian pipeline (Tapline) which was constructed to transport Saudi Arabian crude across Jordan into Lebanon. Virtually all the petroleum products consumed are produced domestically at the refinery operated by JPRC, and located at Zarqa, 35 km northeast of Amman and 43 km from the Tapline. At present, the refinery has a capacity of about 12,000 t/day (Annex 6, para. 16); however, this capacity would have to be expanded to meet the projected demand after 1987 (para. 5.09).

4.09 The refinery's output of gasoline, kerosene, gas oil and aviation fuel is transported and distributed throughout Jordan by tanker trucks owned and operated by JPRC. Fuel oil is transported by the consumers, and LPG is transported and marketed by independent retail distributors.

Electricity

4.10 In 1976, JEA started, as a part of the 1976-1980 five-year plan, to gradually acquire and upgrade the generating capacities in the major load centers. By 1980 autogeneration was only confined to 40 MW retained by the large industries and principally used as back-up systems. In 1981, the peak demand in the interconnected system was 200 MW compared to an installed capacity of about 388 MW (Annex 6, Attachment 4), leaving a reserve margin of about 116 MW or about 30% of the installed capacity.

4.11 At present, Amman, Irbid, Balqa, the Jordan Valley and Karak are interconnected by about 1,000 km transmission lines (132 kV and 33 kV). In addition, the Jordanian national grid was interconnected with the national transmission grid of Syria in 1977.

4.12 Since 1975, all three utilities JEA, JEPCO and IDECO have expanded their medium and low voltage distribution network to keep up with the increased demand in both the urban and rural areas. In addition, 170 villages have been electrified which increased the access of the rural population to electricity from 26% in 1975 to 48% in 1981. Another 140 villages would gain access to public electricity service between now and 1986 (Annex 7, para. 20). Losses at the rural and urban distribution levels continue to be high, particularly in the case of IDECO (Annex 6, para. 20). A study should therefore be undertaken to determine the sources of the relatively high losses in Jordan's distribution networks, and outline a strategy by which these losses could be reduced (para. 8.25).

C. Energy Balance

4.13 The refinery has been able to provide the mix of petroleum products demanded in Jordan's domestic market. Small quantities of light petroleum products (LPG, aviation fuel, and gas oil) have been traded in some of the

past years to supplement domestic production or dispose of surplus products. An energy balance for 1981 is presented in Table 4.4 below: imports of crude oil amounted to about 2,130 thousand tons and were processed by the refinery whose own consumption and losses amounted to about 157,000 toe. Part of the refinery production of fuel oil (269,000 toe) and gas oil/diesel (79,000 toe) were used for electricity generation with total losses in the electricity sector of about 60 thousand toe, including transmission and distribution losses. About 1,913 thousand toe were left for final use, of which 18% were consumed by industry, 53% by the transportation sector, 18% by households, and 11% by commerce and others.

Table 4.4

Energy Balance, 1981 /1
('000 toe)

	Crude Oil	LPG	Gasoline	Jet Fuel	Kerosene	Gas Oil/ Diesel	Fuel Oil	Fuel Gas	Asphalt	Electri-city /2	Total
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	2,130	-	-	-	-	-	-	-	-	-	2,130
Exports	-	-	-	-	-	-	-	-	-	-	-
Total Supplies	2,130	-	-	-	-	-	-	-	-	-	2,130
Oil refineries	(2,120)	58	278	273	153	619	573	9	107	-	(50)
Electricity gen.	-	-	-	-	-	(79)	(269)	-	-	288	(60)
Energy industries' own use & losses	-	-	-	-	-	-	(98)	(9)	-	-	(107)
Total Final Use	10	58	278	273	153	540	206	0	107	288	1,913
Industry	10 /3	-	-	-	-	62	183	-	-	98	353
Transport			278	273	-	434	23	-	-	-	1,008
Households	-	58	-	-	153	31	-	-	-	107	349
Commerce & others	-	-	-	-	-	13	-	-	107	83	203

/1 Brackets snow transfer or input to other sectors.
/2 Electrical quantities were converted into their oil equivalent using the following factor: 1 kWh = 0.25 kgoe.
/3 Used in cement plants.

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V. FORECAST OF DEMAND AND SUPPLY OF ENERGY

A. Growth of the Economy

5.01 Jordan's economy experienced a relatively high rate of economic development over the period 1975-1980 during which the GDP increased in real terms at an average annual rate of about 9.4%. According to Bank staff projections, the real growth of GDP is expected to increase slightly to about 10% for 1980-1985, then drop to about 7.6% for 1985-1990. These high rates of growth are primarily attributed to the historic and forecast growth of the industrial sector whose share of the GDP has increased from about 10% in 1975 to 19% in 1980, and is expected to reach 29% by 1985. The real rate of growth of the industrial sector averaged about 17% for 1975-1980; and it is expected to rise to 20% for 1980-1985, then drop to 11% for 1985-1990. The real growth of the other sectors of the economy are also expected to rise slightly, with the exception of the transportation sector, whose growth would increase from 4% for 1975-1980 to 11% for 1980-1985, then drop to 7% for 1985-1990. The peaking of the growth rate during the period 1980-1985 is largely attributed to the continued dependence of the neighboring countries on the port of Aqaba and on Amman airport for the supply of imported goods and materials which are delivered to their ultimate destination by Jordan's trucking industry. This dependence is caused by the limited capacities of the ports in the neighboring countries; and was exacerbated more recently by the border war between Iraq and Iran. The reliance of the area on Jordan is expected to continue over the next five years as Iraq goes through a period of intensive postwar reconstruction; and as the port facilities in the other oil-exporting neighboring countries are expanded to accommodate a more stable inflow of imports. Thereafter, the demand for imports through Jordan is expected to subside, and as a result, the projected growth rate for 1985-1990 is expected to decrease to about 7%. The historical and projected growth rates of the main sectors of Jordan's economy are presented in Table 5.1 below.

Table 5.1

Historical and Projected Real Growth Rates for the Main Sectors of Jordan's Economy /1
(%)

	1975-1980	1980-1985	1985-1990
Industry/2	17.0	20.0	11.0
Agriculture	3.0	5.0	5.0
Transport	4.0	11.0	7.0
GDP	9.4	10.3	7.6

/1 World Bank projections.
/2 Industrial sector includes mining and manufacturing.

5.02 The overall consumption of energy for 1975-1980 increased at an average annual rate of about 16.5% mainly because of the growth of the industrial and transportation sectors. The rate of increase in the consumption of energy for 1980-1985 is expected to decline because of the Government's plans to increase domestic energy prices to eliminate the subsidies for petroleum products, and the emphasis it would place on conservation and demand management for restraining the future demand for energy. Consequently, the future growth of energy consumption over the next 8 years depends, to a large extent, on the time horizon assumed for the elimination of the subsidies; the projected increase in the real price of crude oil; and the timing and effect on the industrial energy consumption of a program for conservation. These are discussed in detail in the section below which concludes with the most probable scenario for the growth of energy consumption between 1982-1990.

B. Demand for Energy

Forecast of Demand for Petroleum Products

5.03 The forecast of the demand for petroleum products, except for aviation fuel, was derived using income and price elasticities for each product estimated from historical observations. 1/ Elasticities for aviation fuel were borrowed from a study of the demand for fuel by international airlines. The projections for 1982-1990 of the real income generated in each of the major sectors of Jordan's economy were estimated by the Bank mission. Table 5.2 below presents the estimated income and price elasticities for each product.

Table 5.2

Estimated Income and Price Elasticities /1

Product	Income Elasticity		Price Elasticity		Coefficient of Determination
	Short-Term	Long-Term	Short-Term	Long-Term	
LPG	-	1.6	-	-0.7	.92
Gasoline	0.3	1.5	-0.3	-1.4	.994
Aviation fuel /2	-	1.5	-	-0.2	n.a.
Kerosene	0.2	0.5	-0.1	-0.3	.973
Gas oil/diesel	0.8	1.9	-0.03	-0.06	.984
Fuel oil	0.7	1.3	-0.03	-0.06	.979

/1 All elasticities are significant at 95% confidence.
/2 Bohi, Douglas, Analyzing Demand Behavior: A Study of Energy Elasticity, Resources for the Future, Inc. Johns Hopkins University Press, Baltimore, 1981, p. 127.

The elasticities obtained in the case of Jordan are in line with what is observed in most other developing countries. It is expected, however,

1/ The elasticities were derived by relating the consumption of each product to the growth of the value added in the major consuming sector; e.g. transportation and electricity for diesel/gas oil; industry, mining and electricity for fuel oil, etc.

that the long-term price elasticities of demand for petroleum products would rise in the future as the economy shifts away from large and energy-intensive projects based on the extractive industries to relatively smaller privately owned export oriented industries; and the elimination of the prevailing practice of setting prices on a cost-plus basis which was partly responsible for the modest decrease in energy consumption observed in the past as energy prices were increased.

5.04 Four scenarios were considered for the growth of the future demand for energy. These are all based on identical rates of growth for the income generated in the major sectors of the economy. However, as stated above, the difference between the four scenarios depends on the assumptions made about: a) the time horizon for eliminating the subsidies for energy; b) the future increase in the real price of crude oil; and c) the timing and impact of conservation (Annex 7, para. 4). The scenario, adopted for this report, is based on the following assumptions:

(a) World prices for petroleum products would remain stable (in real terms) until 1985, and rise in real terms thereafter at an annual average rate of about 1% 1/;

(b) The Government would pursue its current effort in eliminating subsidies for petroleum products and would raise domestic prices for energy to reach parity with border prices by 1985;

(c) A conservation program would be undertaken between 1982 and 1985; its overall impact would start taking effect in 1986 and gradually reach 20% of the projected energy consumption for 1990 The 20% overall reduction in energy consumption attributed to the implementation by the Government of an industrial conservation program was based on: (i) detailed energy audits of similar industries elsewhere (cement, fertilizers, etc.); (ii) preliminary assessment by the mission of the potential saving in the major energy consuming industries of Jordan. However, this reduction should be considered as a minimum because the potential for greater energy efficiency brought about by economic pricing of petroleum products and electricity, and an intensified program of investment in energy-efficient equipment for retrofitting and conservation has been known to bring about a greater reduction in overall consumption than assumed in this report (Sweden, France, etc.)..

5.05 According to the conservation scenario, the annual growth of demand for energy would increase at a rate of about 15% until 1985 and then slow down to about 10% between 1985 and 1990. Table 5.3 below presents the forecast supply and demand for petroleum products for 1985 and 1990. An energy balance for 1985 and 1990 is provided in Annex 7 (Attachments 12 and 13).

1/ This is consistent with the macroeconomic projections of the review of the five-year economic plan for 1981-1985.

Table 5.3

Forecast Supply and Demand for Petroleum Products, 1981-1990
('000 toe)

	1981	1985	1990
Supply			
Imports			
Crude oil	2,130	3,700	4,300
LPG/Gasoline	-	-	55
Middle distillates	-	-	920
Fuel oil/naphtha	-	-	565
Total supply	2,130	3,700	5,840
Demand			
Petroleum products			
LPG	58	91	147
Gasoline	278	396	637
Jet fuel	273	474	665
Kerosene	153	168	202
Gasoil/Diesel	619	1,157	1,883
Fuel oil	573	1,157	1,893
Asphalt	107	148	238
Total Products	2,061	3,591	5,665
Crude oil	10	-	-
Refinery losses and own consumption /1	59	109	175
Total Demand	2,130	3,700	5,840

/1 Including consumption of fuel gas.

5.06 The three other scenarios which were considered in this study excluded any program for conservation (Annex 7, paras. 5-7). However, the difference between scenarios in the projected demand is small because of the strong role income plays in determining the demand for energy by the industry and transportation sectors which together account for 78% of total consumption. This underscores the fact that, in the case of Jordan, as indicated by the price elasticities, the setting of prices at parity to border prices would ensure the efficient allocation of energy resources, and also mobilize resources for the Government; however, its impact in determining future demand would be limited compared to the impact of income growth. The restraint of the future demand for energy would depend on direct intervention in the patterns and intensities of energy consumption in various sectors. Therefore, in addition to raising the price of energy to fully reflect its cost to the economy to ensure the efficient allocation of petroleum products and electricity between competing ends, it is recommended that, in order to slow down the growth of demand for energy, the Government formulate a comprehensive plan for managing the demand for energy. This would be achieved

by undertaking energy audits of the major energy consuming industries such as the refinery, the potash, steel, cement, fertilizer and glass industries encouraging changes in the technologies currently being used; and substituting between fuels to ensure a more efficient production, delivery and consumption of energy.

Forecast of Demand for Electricity

5.07 The forecast of demand for electricity sales at the high voltage level is also based on the long-run income and price elasticities. In addition, the expected demand by the major new industries or the expansion of some of the existing ones have been added after ascertaining whether these new blocks of demand would materialize as projected. The forecast of sales by JEA to JEPCO (80% of sales) has been derived for each of JEPCO's consumers based on the estimated price and income elasticities, then aggregated to constitute the sales of JEA to JEPCO in which losses in distribution have also been included . The forecast of sales to IDECO has been derived using the same elasticities derived for JEPCO and then also aggregated. Table 5.4 below presents a summary of the forecast demand for electricity for 1981-1990.

Table 5.4

Forecast Demand for Electricity, 1981-1990
(Interconnected system)

	1981	1985	1990
Bulk Sales		GWh	
JEPCO	680	1,070	1,887
IDECO	78	183	333
Other JEA direct consumers	214	439	630
Total Northern Region	972	1,692	2,850
Central Region	5	319	450
Southern Region	-	107	175
Total Interconnected System	977	2,118	3,475
Transmission losses and station use	82	205	337
Total Generation Interconnected System	1,059	2,323	3,812
Maximum Demand		MW	
Interconnected system	200	461	736

5.08 Total electricity generation would increase from 1,059 GWh in 1981 to 2,323 GWh in 1985 and 3,812 GWh in 1990, representing an annual growth rate of 15.37%. Maximum demand would increase from 200 MW in 1981 to 461 MW in 1985 and 736 MW in 1990. The high rate of load growth is mainly due to a rapid increase expected in JEA's direct sales to large industries and other consumers (Annex 7, paras. 9-11).

C. Supply of Energy

Future Supply of Petroleum

5.09 Unless a major discovery of oil and gas is made between 1981 and 1990, Jordan is expected to continue its total dependence on imported oil for meeting its demand for commercial energy. At present, the installed capacity at the refinery is about 4.3 million tons per year as a result of expansion that started in 1976. Since the demand for refined products is expected to reach 5.8 million tons by 1990 (para. 5.05), the capacity of the refinery would significantly fall short of providing Jordan's needs for petroleum products unless it is expanded. Imports of products would be necessary to supplement refinery production as early as 1987, and would gradually increase to reach 1.5 million tons by 1990. Of this total, nearly 975 thousand tons would consist of premium-value products. The last expansion (1979) of the refinery at Zarqa allowed in the design for the addition of facilities that would increase the refining capacity by another 1.3 million tons per year. This would increase the overall refining capacity to 5.6 million tons which would be capable of meeting the projected demand for petroleum products until 1990. However, there is no assurance that such an expansion would represent the least cost alternative, particularly since the Government plans to locate the new large industries near the city of Aqaba which is about 360 km from the refinery. Therefore, it is recommended that before expanding the refinery, a detailed assessment of the pattern of the future consumption of petroleum products and its location be undertaken. This would provide the inputs needed for the design of the most economic option for supplying, transporting, and distributing petroleum products.

5.10 The import of large quantities of mid-distillates as outlined above might not represent the optimal strategy to correct the projected imbalance. Moreover, the expansion of the refinery at Zarqa might result in the failure of the refinery to capture the economies of scale in terms of fuel efficiency and product mix. Several alternatives should be considered: a) the expansion of the existing refinery to increase its crude unit capacity; b) the construction of a second refinery at Aqaba; or c) the installation of secondary conversion facilities, such as a hydrocracking unit, to convert fuel oil to required distillates and the import of deficit fuel oil. However, there is a potential for importing coal for power generation at Aqaba. The potential for using the coal at a later stage has been allowed for in the design of the plant. If coal is imported for power generation, then its use by the new cement plants and other industrial users for steam would reduce the cost of handling it and lower the overall cost of energy of these industries. Moreover, there is the possibility of importing gas, via a pipeline, from Saudi Arabia for use as an alternative for petroleum products and coal. The import of coal or gas would have a significant impact on the required refining capacity and its configuration. Nevertheless, irrespective of the alternative selected, investment in expanding Jordan's refining capacity would be needed

during the period 1982-1986 in order to ensure that by 1987, when large quantities of middle distillates would be required, adequate facilities would have to come on stream to meet the future demand for energy at least cost to the economy.

5.11 The transport and the distribution of petroleum products would also play a major role in determining the future investment in the energy sector. Under current plans the fuel oil produced by the refinery at Zarqa would be needed to operate the power plant at Aqaba (360 km). This would come in addition to the demand by large industries such as the new cement plant at El-Rashadia, the phosphate mining industry at El-Hassa and Shadiah, etc., which are between Zarqa and Aqaba. In order to meet the demand of these major consumers in the most economic way, a pipeline would be needed to transport and distribute the fuel oil.

5.12 The 1981-1985 plan for the refining of oil and transportation and distribution of petroleum products involves: a) the expansion of the storage facilities at Zarqa and in Aqaba; b) the construction of a third connection (18"-20" pipeline) to the Tapline to increase the capacity of the existing system for the supply of crude to the refinery, and the construction of a pipeline between the refinery and the new international airport (Queen Alia) to transport aviation fuel for the national and foreign airlines; c) the expansion of the capacity of the existing lubrication oil plant by another 15,000 tons a year; and d) the construction of a new plant for the recycling and upgrading of used lubrication oils with an initial capacity of also 15,000 tons. All of these projects are expected to be commissioned during the plan period (para. 7.02).

5.13 In addition, the NPC has initiated a study by Williams Brothers (UK firm) to determine the feasibility of constructing a multiproduct underground pipeline between Zarqa and Aqaba to supply the power plant and the major industries in between. Initially, the pipeline is intended to transport products (mainly fuel oil) to the south and crude oil from Aqaba to Zarqa. If a second refinery is constructed at Aqaba later on, the Government would like to use the pipeline to transport products to the north. However, such plans should be reassessed in light of a national strategy for the development and use of energy resources in Jordan (para. 5.10). This strategy would be based on: a) the assessment of the impact of importing coal or gas for industry and power generation at Aqaba on the future mix of petroleum products demanded and the location of the demand; and b) the design of optimal energy supply systems. Therefore, it is recommended that the Government consider undertaking a detailed study in the near future to determine the future patterns of energy consumption in Jordan and the location of the major consumers and outline a development strategy for the supply of energy which would ensure that the future demand for energy is met at least cost to the economy. Draft terms of reference for this study are presented in Annex 7, Attachment 11.

Future Supply of Electricity

5.14 The 1981-1985 plan for the development of generation includes the expansion of the capacity at the Hussein steam power plant and the commissioning of the first phase of the steam power plant at Aqaba; both would be operated by burning fuel oil. The expansion of the Hussein plant would involve the addition of 4 generating units of 66 MW each of which three would be in commercial operation by 1982, and the fourth would be commissioned in 1984. The full development of the Aqaba power calls for the installation of a 900 MW steam plant at Aqaba on the Red Sea. The development is divided into three phases which would be staggered to coincide with the growth of demand for electricity.

5.15 About 643 km of transmission lines and 747 MVA in substation capacity are planned for 1982-1986. The 132-kV transmission line from Ma'an to Aqaba will complete the transmission link between the northern central and southern regions to allow for the integrated operation of the power system in Jordan. JEA's distribution network expansion to be implemented in the period 1981-1987, includes about 1,497 km of overhead lines and 165 MVA in substation transformer capacity. In the same period, JEPCO plans to construct 24 transformer substations with an installed capacity of 121 MVA and to install 74 km of cables and 36 km of overhead lines as well as to reinforce the existing 33-kV network by adding 130 MVA in power transformer capacity, 25.5 km of 33-kV cables and 9 km of 33-kV overhead lines. JEPCO will also build about 350 new distributrion substations in its concession area.

5.16 JEA has prepared a national plan for the extension between 1981-1993 of publicly supplied electricity to the rural areas covering about 500 villages and isolated settlements. At present, 284 villages with a total population of 290,000 are being electrified, and when the work is completed, 422 villages would be electrified or about 43% of the total number of villages having 91% of the total population in Jordan. The remaining villages would be electrified in three stages:

Stage	No. of Villages & Housing Schemes	Period
1	170	1984-1986
2	100	1987-1990
3	120	1991-1993

With the completion of the third stage, almost all the rural population in Jordan would have access to the public power supply.

VI. ENERGY PRICING

A. Petroleum Products

Historical Overview

6.01 Prior to the oil embargo of 1973, the petroleum subsector was a net contributor to the national budget through the taxes levied on gasoline and gas oil/diesel. This contribution started eroding, and eventually turned into a net subsidy by 1975, as the price of imported crude continued to increase and domestic prices of petroleum products were held at their 1972 level. By the end of 1978, the net subsidy for petroleum products reached JD 22 million (US$66 million) which represented about 14% of the Government's domestic revenues for that year 1/2/. Following the second round of significant increases in the price of oil at the end of 1978 and early 1979, the Government projected that if domestic prices remain unchanged, the subsidy for petroleum products would reach levels unsustainable by the national budget. Consequently, it decided to gradually phase out the subsidy, starting 1979, by raising the prices of petroleum products to ultimately close the gap between domestic and border prices. Domestic prices of petroleum products were since increased five times: in March and July of 1979, February of 1980 and February and November of 1981.

6.02 Domestic prices of petroleum products increased during the period 1973-1982 at an average annual rate of 19% in nominal terms and 7% in real terms. However, if only the post-1978 period is taken into consideration, the increase in prices is significantly higher; averaging 31% in nominal terms and 13% in real terms. As a result of the increase in domestic prices of petroleum products since 1979, which exceeded the real increase in the price of imported oil, the net subsidy decreased in real terms from JD 24 million (US$72 million) to JD 10 million (US$30 million) in 1981 (Annex 8, para. 4).

Level and Structure of Petroleum Prices

6.03 Under the prevailing policy, the prices of all products are subsidized, with the exception of motor gasoline, LPG and the aviation fuel sold to foreign airlines, which are taxed. The subsidy for kerosene stems from the Government's desire to ensure that low-income consumers have access to the fuel which is primarily used for household purposes such as cooking and lighting. The subsidies for gas oil/diesel, jet fuel and fuel oil, which are used by the agriculture, transportation and industrial sectors as well as the power subsector, are maintained by the Government for two main reasons: a) to dampen the full effects of the rising prices paid for crude oil from being reflected in the general price level; and b) to ensure that Jordan's exports remain competitive in the region. However, these subsidies are not justified on social and economic grounds (para. 6.07).

1/ The Government total domestic revenue, which includes tax revenues, fees, licenses, etc., amounted to JD 156.5 million.

2/ Detailed records of the total subsidy extended to the consumers of petroleum products were not kept by the Government; as a result, the estimates given here are based on reconstructed figures based on the little information that was available.

6.04 In January 1982, the weighted average domestic price for petroleum products was at about 95% of the average border price; US$272/ton compared with US$285/ton. However, the relationship of domestic and border prices varied considerably from gasoline which continues to be highly taxed at about 190% of its border price, to gas oil at about 67% of its border price. Table 6.1 below compares domestic and border prices for petroleum products.

Table 6.1

Relationship of Domestic and Border Prices for Petroleum Products (January 1982) (US$/ton)

Product	Border Price	Domestic Price	Tax or (Subsidy)	Domestic Price as % of Border Price
LPG	390	394	4	101
Gasoline /1	360	683	323	190
Jet fuel /2	338	201	(137)	59
Jet fuel /3	338	449	111	133
Kerosene	320	221	(99)	69
Gas Oil/Diesel	318	213	(105)	67
Fuel Oil	169	150	(19)	89

/1 Weighted average of premium and regular gasoline
/2 For national airline
/3 For foreign airlines

Source: Petroleum products average spot prices, Petroleum Economist, The International Energy Journal. Volume XLIX, No. 1, January 1982, p. 36.

6.05 The Government buys the crude oil from Saudi Arabia which is delivered to the refinery at Zarqa by special pipelines connected to the Tapline (Annex 6, para 16). JPRC refines the crude oil, and markets the petroleum products in exchange for commissions that vary with the product. These commissions are reviewed and adjusted periodically to ensure a fair return to the owners of the refinery.

6.06 In 1981, the reconstituted barrel cost the Government US$37.7/barrel (US$271.6/ton) compared to a revenue of about US$33.6/barrel (US$242.2/ton), leaving a net deficit of about US$4.1/barrel (US$29.4/ton). This amounted to about US$60 million (JD 20.0 million). The distribution of the net subsidy among the sectors and products is summarized in Table 6.2 below.

Table 6.2

Distribution of Net Subsidy by Sector and Product in 1981
(US$ Million)

Product	Transport	Industry	Power	Domestic	Other	Total
Jet Fuel	14.9	-	-	-	-	14.9
Kerosene	-	-	-	7.5	-	7.5
Gas Oil	23.5	2.1	4.4	1.7	0.5	32.2
Fuel Oil	0.3	2.2	2.7	0.2	-	5.4
Asphalt	-	-	-	-	-	-
	38.7	4.3	7.1	9.4	0.5	60.0

Strategy for the Future Pricing of Petroleum Products

6.07 The subsidy for gas oil/diesel accrues mainly to the transportation sector, the power subsector, industry and households (Annex 6). The subsidy for jet fuel benefits the national airline, while the subsidy for fuel oil accrues to industry (cement , oil refining, etc.,) and the power subsector. These subsidies are maintained by the Government in the hopes that: a) they would be indirectly passed on to the consumers through relatively lower prices for goods and services produced by the transport, industrial and agricultural sectors; and b) the price competitiveness of Jordanian exports would be ensured. The subsidy for kerosene is passed on directly to the household consumers through the reduced price paid for the product in the market. Given the fact that the bulk of the subsidies accrue to consumers who generally can absorb the higher prices for petroleum products without significantly increasing the prices of their output (trucking, air transport, power generation); and that, for consumers who could be adversely affected by the higher prices (industry), there are other direct means of cushioning the adverse impact of higher prices (retrofitting, conservation), the subsidies are not justified on social and economic grounds. However, the subsidy for kerosene is socially justified and could be maintained, if desired by the Government. Therefore, it is recommended that the Government continue its past effort to phase out the subsidies, and that it set the end of 1985 as the target date for achieving parity between domestic and border prices for gas oil/diesel, fuel oil, and aviation fuel, to ensure that these fuels are consumed in an economically efficient mix, and to mobilize some of the surplus currently accruing to the consumers of energy.

6.08 Increases in domestic prices needed to achieve parity with border prices by 1985 would have a relatively small impact on restraining the future growth of the demand for petroleum products, because the long-run price and income elasticities of demand have shown that the consumption of petroleum products in Jordan is more responsive to changes in income than to increases in prices (Annex 7, Table 7.2). Therefore, in the case of Jordan, the elimination of the subsidy would result in a greater resource mobilization for the Government, and to a much lesser extent, it would restrain the growth of future demand for energy. However, from a resource allocation point of view, parity with border prices is essential in inducing consumers to use petroleum products and electricity efficiently. The elimination of the subsidies for petroleum products by 1985 would mobilize about US$170 million as shown in Table 6.3 below.

Table 6.3

Resources to be Mobilized by the Elimination of the Subsidies for Petroleum Products by 1985
(US$ Million)

Aviation fuel	47.0
Fuel Oil	18.0
Gas Oil/Diesel	105.0
Total Resources	170.0

6.09 The potential for interfuel substitution which higher prices for petroleum products could bring about, is rather small. In the transportation sector, the import of diesel-operated passenger cars for private or commercial use is not allowed. This rule also covers buses for mass transit. Therefore, the potential of the trucking industry moving from diesel to other fuels is virtually zero. In industry, almost all autogeneration has been converted to operate by burning fuel oil (para. 8.22). In addition, JEA has been shifting away from gas oil/diesel to fuel oil by converting its diesel units (Annex 6, para. 23). This is demonstrated by the fact that consumption of diesel oil by JEA has dropped from 56% of total fuel in 1976 to 23% in 1981 and would reach only 10% by 1990. Therefore, the potential for substitution in the power subsector is also negligible. Substitution could possibly take place in the household demand for diesel or gas oil for heating where, if the price increases, there could be a shift to electricity. However, given the high level of electricity tariffs and the recommendations that it be increased to reach parity with marginal cost (para. 6.16), it is unlikely that consumers would switch to electricity and away from diesel oil despite its higher prices. Only if Jordan imports coal or gas would there be substantial potential for interfuel substitution in industry and power generation.

6.10 The higher prices for petroleum products would raise the prices of the goods and services produced in Jordan. The extent of that rise depends largely on the share of energy in the total inputs used to produce each good. Detailed information on the pattern of energy consumption is needed in order to assess the impact of closing the gap between domestic and border prices. Otherwise only generalized assessments could be made which would be meaningless for policy formulation. The Government should give high priority to the compilation of energy data which would serve as a basis for expanding the recently constructed input/output model (35x35). The data base would also provide the necessary input for monitoring energy consumption and relating it to norms established in the industrialized countries (paras. 8.08 and 8.11). The compilation of energy data and its organization into a data base would take about two years to complete. In the interim, however, the Government could follow a strategy whereby prices for energy are raised for some selected consumers, on which the impact of higher prices would be easily ascertainable. For that purpose, the Government should concentrate on the major consumers of petroleum products and electricity, and collect detailed information on the energy consumption of each plant or consumer and the contribution of energy to the overall cost of their products. This would enable the Government to assess, within a relatively short period of time (6 months), the impact of the proposed strategy for the elimination of the

subsidies for petroleum products on the major consumers and make possible the setting of the framework for moving the prices of petroleum products on a selected basis.

6.11 A proposed strategy for an interim policy for pricing petroleum products would entail the following:

Aviation fuel: The impact of raising its price is most easily ascertainable. The entire subsidy for aviation fuel accrues to the national airline (Alia). A detailed analysis of Alia's energy consumption and an estimate of its contribution to the overall cost of operations can be undertaken within a relatively short period of time. An agreement on a timetable for reaching parity with border prices possibly coupled with the institution of an improved system for fuel management would provide Alia the time needed to absorb the higher prices while improving its energy efficiency. However, should the Government decide to continue subsidizing the airline, it would be preferable to do so through direct budgetary allocation rather than indirectly via the price paid for fuel. The indirect nature for transmitting the subsidy to Alia does not provide the incentives for the airline to improve the scale or efficiency of its operations. Therefore, it is recommended that the Government consider undertaking a detailed assessment of the patterns of Alia's consumption of energy and ascertaining the impact of eliminating the subsidy for aviation fuel over the next 3 years on the cost and competitiveness of the airline.

Fuel Oil: The assessment of the impact of higher prices for fuel oil on the economy is relatively simple to undertake because the product is consumed by few large consumers who can be easily identified. JEA accounts for almost 50% of all the fuel oil consumed in Jordan. Consumption by industry is divided among the cement plant, the refinery, the potash complex and the fertilizer plant. The impact on JEA's tariffs of higher prices for fuel oil is readily available; that is, for each 10% increase in the price of fuel oil, the average tariff would have to be increased by about 4%. This would provide the means of assessing the primary and secondary (electricity tariffs) impact on industry of increasing the price of fuel oil. Since the consumers of fuel oil are few, the compilation of information on their financial and operational settings, and the analysis of the impact of higher prices for energy on the prices of their output could be completed in less than 6 months. Therefore, in view of the concentration of the consumption of fuel oil among few large consumers, the Government should consider undertaking a detailed review of the operations and cost structure of each to ascertain the likely impact of higher prices for energy on the prices of the products produced by each.

Gas Oil/Diesel: This fuel is mainly consumed by the transportation sector (73%). The rest is shared among the power subsector (13%), industry (7%) and household consumers (15%). Agriculture accounts for less than 1%. The subsidy extended to the power subsector could be eliminated without significantly affecting the tariffs because JEA's consumption of gas oil as a percentage of total fuel used is expected to decrease from 20% in 1982 to less than 10% by 1985 when the subsidy is projected to be eliminated. Similarly, as in the case of fuel oil an assessment can be

easily undertaken of the impact of phasing out the subsidy over a 3 year period on the prices of the affected industries. Moreover, since the gas oil is not used as a feedstock but as a source of energy for power generation at the industrial sites, there is a scope for the Government to cushion the impact of rising prices for diesel by providing incentives to industry to adapt the isolated generating facilities to burn fuel oil and reduce their dependence on JEA for power supply during peak hours (paras. 8.22-8.23). This underscores the importance of the power subsector's demand management study and the industrial conservation study proposed in this report (para. 8.27). As for the transportation sector, it is difficult to ascertain the impact of higher prices for fuels on the transportation cost of goods and services, and, in turn the price of the goods and services transported. However, if experience gained elsewhere is applied to Jordan, the higher prices for energy would raise the transportation cost, but since transportation constitutes a small percentage of the total cost of the goods and services delivered to the market (usually between 3%-5%), the impact of higher costs for transportation is unlikely to significantly raise the general price level in the economy. The only risk of raising the prices for gas oil to the transportation sector is the round of unjustified increases in the general price levels which could be triggered by attributing the increase to the higher cost of energy. Therefore, it is prudent for the Government to examine in detail the impact of eliminating the subsidy on the cost of transportation within Jordan and the likely effects of higher transportation costs on the general price level. A preliminary assessment of the impact of higher energy prices on the transportation sector is expected to be available by March/April 1983, when the results of a national transportation study undertaken by a team of consultants, are submitted for review to the Government. As for gas oil consumed by households, the fact that it is used for home heating by a small proportion of the population with a relatively high income would limit, to a great extent, the social impact of higher price brought about by the elimination of the subsidy.

Kerosene: Kerosene is almost exclusively consumed by the low-income urban and rural consumers for cooking and lighting. The long-run demand for kerosene is fairly inelastic to changes in price and income estimated at -0.1 and 0.2 respectively, which reflects its use as a necessity by the low-income consumers. Socially, therefore, there is justification for subsidizing kerosene. However, it is recommended that the Government consider maintaining the overall burden of the subsidy constant in real terms until 1985 by transmitting all future increases in the cost of production to the consumers, and then gradually phasing out the subsidy over the period 1985-1990.

B. Electricity Tariffs

Historical Overview

6.12 In nominal terms, the average revenue from the sale of electricity has increased at an average annual rate of about 12.7% between 1975 and 1981; from 16.7 fils/kWh (US5.0c/kWh) in 1975 to 34.2 fils/kWh (US10.2c/kWh) in 1981. In real terms, however, the average annual rate of increase was less than 1%; from 16.7 fils/kWh in 1975 to 17.6 fils/kWh in 1981. The real price

of electricity has been oscillating since 1975 because of Government delays in allowing JEA to reflect in its tariffs changes in its operating costs stemming from increases in the general price level and fuel bill. It is noteworthy to mention that although JEA's fuel bill increased, in real terms, at an average annual rate of about 10% between 1975 and 1981, which would have required an annual increase in the average revenue of about 5%, the average revenue had increased by less than 1%. JEA has been able to absorb the significant increase in its fuel bill because of its gradual shift, since 1978 towards more intensive use of fuel oil to replace the more expensive gas oil. However, more recently, delays in adjusting the tariffs have lowered JEA's self-financing capabilities (para. 6.13).

Tariff Level and Economic Cost of Supply

6.13 JEA is expected to cover about 25% of the annual cost of its investment program through revenues generated from the sale of electricity. This financial target was to a large extent achieved during the period 1975-1980 through periodic increases in tariffs. In keeping with its 1979 decision to gradually phase out the subsidy for petroleum products (para 6.01), the Government raised, in 1981, the prices of fuel oil by 66% and gas oil/diesel by 73%, but JEA was not allowed to pass on these increases to its consumers through the fuel adjustment clause. As a result, JEA's internal cash generation for 1981 dropped to about 11%. Early 1982, the Government extended a grant to the corporation of about US$3 million to bring the internal cash generation to 25%. Although budgetary allocations from the Government would maintain JEA's internal cash generation at 25%, these would have two negative impacts on the power subsector: a) it would hinder the development of JEA into an autonomous self-financing public enterprise; and b) it would lower the prevailing tariff levels relative to the economic cost of supply which would ultimately result in the uneconomic use of electricity. Therefore, it is recommended that the Government consider allowing JEA to reflect in its tariffs all future changes in its fuel bill through the fuel adjustment clause without requiring the intervention of the authorities.

6.14 The decision taken by the Government in 1981 not to allow JEA to cover the higher cost of fuel from its consumers stemmed from its belief that such an increase would have been socially unacceptable, and would not have allowed the electricity-intensive industries sufficient time to fully adjust to the earlier increase of 1980. This has had the effect of lowering the tariffs relative to the economic cost of supply (LRAIC). Table 6.4 summarizes the relationship between the average tariff at each voltage level and the average economic cost of supply.

Table 6.4

Relationship of Prevailing Tariffs and the Economic Cost of Supply - January 1982
(fils/kWh)

	Prevailing Tariff	Economic Cost
Bulk Supply		
Direct, JEPCO, IDECO	23.4	26.2
Retail Supply		
Pumping MV	28.0	27.7
Large Industries MV	28.5	26.8
Urban Households	37.0	48.9
Rural Households	37.0	71.6
Small Industries LV	30.6	35.7
Commerce LV	45.0	41.2
Institutions LV	34.3	41.2

6.15 In January 1982, the average economic cost of electricity, based on LRAIC, for sales to the bulk consumers was about 26.2 fils/kWh compared to an average revenue for sales to JEPCO, IDECO and the large industrial consumers of about 23.4 fils/kWh. The average revenue was about 34.2 fils/kWh representing about 91% of the average economic cost of supply of 37.6 fils/kWh, implying that, on the average, the prevailing tariffs fall slightly short of conveying to consumers the economic cost of the resources used in meeting their demand for electricity. As discussed above, this difference is largely attributed to the inability of JEA to pass on the increases in the domestic prices for fuel oil and gas oil/diesel to the consumers. If JEA was allowed to reflect in its tariffs the increases in its fuel bill during 1981, the average tariff would have been 39 fils/kWh, or on the average about 5 fils/kWh higher than the prevailing average tariff, and 2.6 fils/kWh above the average economic cost of supply.

Subsidy to Electricity Consumers

6.16 In 1981, the economic subsidy to the consumers of electricity amounted to about US$13.4 million, of which US$12.7 million accrued to some of the low-voltage consumers, namely the households (rural and urban), and the remaining US$0.7 million accrued to the large industrial consumers. Among all the consumer categories, the medium-voltage industrial consumers and the commercial consumers, were taxed while all other consumer categories were subsidized. Of the total economic subsidy of about US$17.0 million, 77% (US$13 million) accrued to the domestic consumers and 11% (US$1.9 million) to the low-voltage industrial consumers, 8.2% (US$1.4 million) to the institutions (Government and private), and the remaining 4% (US$0.7 million) to the large industrial consumers. However, about 21% (US$3.6 million) was covered by the medium-voltage industrial consumers and the commercial consumers, leaving a net subsidy of about US$13.4 million. This was accounted for by the fact that the utilities have been selling electricity to the

domestic rural and urban consumers at a tariff below economic cost of supply. The erosion of the tariffs paid by consumers at each voltage level relative to the cost to the economy of meeting their demand would induce the uneconomic use of electricity. Therefore, it is recommended that the Government consider the restructuring of electricity tariffs in Jordan to ensure that tariffs at each voltage level reflect the economic cost of supply during both the peak and offpeak periods; and that it assess the impact of time-of-day pricing on the pattern of consumption at each voltage and the effect of the changes in that pattern on the operation of the power system. A large proportion of these issues would be addressed in the load research and management study proposed in this report (para. 8.24).

6.17 At present, the tariff structure at the low-voltage level is based on a uniform block rate; that is, consumers pay the same rate irrespective of the kWhs consumed. The income elasticity of electricity consumption for the domestic consumers is estimated at about 1.5 compared with a price elasticity of about -0.4. This indicates that on the whole the increase of tariffs to domestic consumers would not reduce the consumption but would on the average mobilize more resources for the utilities (JEA, JEPCO and IDECO). The net effect of rising real income and rising real tariff would be increased consumption of electricity by domestic consumers, but at a lower rate of growth than if the real tariff was not increased. This has been demonstrated by the growth of consumption in 1980 where, after the 40% increase in the average tariff to the consumers of electricity, the growth of consumption slowed down for the first 3 months after the increase, then resumed its growth at a rate slightly below the rate observed before the increase. There are strong indications that the consumption of electricity by the domestic consumers in Jordan is affected by the relatively high remittances from Saudi Arabia and the Gulf States which accrue to the households. However, the impact of these remittances is not measurable. In 1981, 90% of the domestic consumers consumed 360 kWh or less per annum and accounted for 65% of the overall consumption, the remaining 10% of the consumers whose consumption was higher than 360 kWh per annum accounted for 35% of total consumption.

6.18 From a resource allocation point of view, tariffs for domestic consumers should be set at parity to the economic cost of supply. This would constitute an objective that the Government should plan to achieve, at the latest, by 1985. At present, the economic pricing of electricity sold to the household consumers, which account for 36% of total sales, would imply that the tariff should be raised from 37 fils/kWh to 48.9 fils/kWh for urban consumers, and to 71.6 fils/kWh for rural consumers. However, should the Government desire to cross-subsidize the low-income rural and urban consumers, the tariff could be restructured to ensure a minimum consumption at a tariff equal to the weighted marginal cost of supply 1/, and charge higher consumption at a tariff that is above marginal cost to recover all or part of the subsidy.

1/ Equal to the average of the marginal costs of supply to urban and rural consumers weighted by these consumers' respective share in total low-voltage sales.

6.19 In the interim, however, and since the Government is concerned that higher tariffs would be socially unacceptable, the increasing block rates structure could be achieved by: a) maintaining the tariff at its current level of 37 fils/kWh for the first 360 kWh per annum since all domestic consumers are presently willing to pay this price; and b) charging 52fils/kWh for consumption higher than 360 kWh per annum, which consumers have already demonstrated their willingness to pay in IDECO's concession area. In addition and in order to achieve parity between the same consumer class in all Governorates, the tariff for consumers in Irbid with less than 360 kWh per annum could be lowered to 37 fils/kWh. The adoption of the proposed increasing block rates would mobilize about JD 1.01 million (US$3.3 million). Therefore, it is recommended that the Government undertake a study to assess the impact on the resources mobilized by the subsector and the consumers of introducing increasing block rates for sales at the low-voltage level.

6.20 The tariff for water pumping is also based on a uniform block rate; as a result water pumping continues during the peak periods when JEA has to operate the combustion turbines by burning diesel oil, rather than during the off peak period when JEA meets the demand by operating power plants that burn fuel oil which has a much lower economic cost. Under the prevailing tariff, the Amman Water and Sewage Authority and Water Supply Corporation have no incentive to shift the pumping to the offpeak period. The introduction of peak/off peak rates for water pumping could result in higher savings to the economy. Therefore, it is recommended that the Government undertake a study to assess the costs and benefits to the economy of restructuring the tariffs, and the need for building larger storage facilities for water pumping. This would also be addressed in the proposed load research and management study (para. 8.24).

VII. INVESTMENT IN THE ENERGY SECTOR

A. Planned Investment in the Energy Sector, 1981-1985

7.01 The planned investment in the development of the energy sector for 1981-1985 would amount to about JD 225.9 million (US$677.7 million) of which JD 163.4 million (US$490 million) would be for power, JD 37.5 million for petroleum refining and marketing, JD 23 million (US$ 69 million) for petroleum exploration, JD 1.5 million (US$4.5 million) for oil shale exploration and development and JD 400 thousand (US$1.2 million) for geothermal exploitation. The investment program would amount to 7% of total projected investment for the five-year period. Table 7.1 below summarizes the investment by subsector.

Table 7.1

Investment by Subsector, 1981-1985

	Amount (JD million)	Percentage Share in Total
Power	163.4	72.3
Refining and marketing	37.5	16.6
Petroleum Exploration	23.0	10.2
Oil Shale Exploration	1.6	0.7
Geothermal Exploration	0.4	0.2
Total	225.9	100.0

The planned investment in the energy sector for 1981-1985 (expressed in current prices) would increase by about 47% relative to the investment for 1976-1980; that is, from JD 153.8 million to JD 225.9 million. Details on the investment for the period 1976-1980 are provided in Annex 9 (paras. 1-7).

7.02 The power subsector is expected to absorb the largest share (72%): half of the investment would go to generation, the other half being distributed between transmission (20%), urban distribution (24%), and rural electrification (4%). The planned investment in the oil refining and marketing subsector would cover mainly the expansion of storage capacities and the construction of two pipelines; it would account for about 17% of total investment in the energy sector. The remaining 11% would cover investments in exploration for petroleum, oil shale, and geothermal sources. In addition to this, a supplementary budget of about JD 100 million is being considered to cover part of the Government program for the development of oil shale. The total cost of the program, which would cover the construction of a retorting plant and a 200-MW oil shale based power plant, would amount to about JD 265 million.

B. Financing Plan for the 1981-1985 Program

7.03 Jordan's energy sector is expected to contribute about 26% of the cost of the investment program for energy from internal sources and customer contributions, 19% from the national budget, and the remaining 55% from local and foreign loans and grants as summarized in Table 7.2 below.

Table 7.2

Financing of the 1981-1985 Plan for Energy

Sources	Amount (JD million)	Percentage Share in Total
Internal cash	54.2	24
Customer contributions	4.8	2
Government	43.0	19
Loans	123.0	54
Grants	0.4	1
	225.9	100

7.04 The internal cash contribution would be provided by the revenue-earning entities in the sector (JEA, JEPCO, IDECO and JPRC). If the investment program of these entities is separated from the overall investment program for the sector, internal cash generation and customer contributions would provide about 29% of the cost of the investment program (JD 59 million out of JD 200.9 million). The Government contribution to the investment program of the revenue-earning entities would amount to JD 18.4 million, representing only 9% of the program. The Government contribution would cover the infrastructural or the socially-oriented parts of the investment program. The rest of the financing would come from local and foreign loans. In view of the fact that most of the projects included in the 1981-1985 investment plan of the revenue-earning entities have either started or are about to be initiated, and given the past success experienced by these entities in securing loans and supplier's credits, the likelihood of their success in securing all the financing for their investment plan is high and consequently significant slippage is not expected.

7.05 By contrast, the implementation of the investment plan of the non-revenue earning entities in the sector, namely NRA, would depend almost totally on the national budget. According to the current financing plan, the Government is expected to cover the entire sum of JD 23 million for petroleum exploration and JD 1.6 million of the JD 2 million for oil shale and geothermal exploration. As for the supplementary budget for oil shale development, it is to be financed by bilateral aid and supplier's credits although no details about the availability of funds have been provided yet.

C. Alternative Investment Plan for 1981-1985

7.06 The issue is not whether the Government would be able to provide the financing for petroleum exploration, but whether it should finance the purchase of a drilling rig and the drilling of exploratory oil wells without adequate geological and seismic interpretation as discussed in Chapter II (paras. 2.19). A more cautious exploration program is recommended in this report which would involve a more detailed seismic work and the postponement of the plans to purchase a drilling rig. The proposed plan would cost about JD 3.5 million. Therefore, in view of the risks involved in initiating an extensive petroleum exploration program before further geological work is undertaken after which foreign firms could be induced to resume exploration drilling in Jordan, it is recommended that the Government reduce its allocation for oil exploration from JD 23 million to not more than JD 5 million which would be more than adequate for financing the work program proposed in this report.

7.07 As for the exploratory work planned for oil shale, the Governmment should freeze disbursements for oil shale until the results of the ongoing studies are completed in order to provide the input needed for determining the next step to be taken in the development of the shale. Furthermore, in view of the recommendation that plans to build a retorting pilot plan and a commercial size power plant be postponed, the Government should delay disbursing anyfund from the supplementary budget until the late 1980's. The work program for exploration for geothermal energy should be completed before the Government starts disbursing its funds for the exploitation of the resource. Moreover, as with other countries, the Government should intensify its efforts in securing financing from bilateral aid agencies to cover a greater proportion of the cost of the strategy proposed in this report.

7.08 As for the refining subsector, the investments planned do not allow for the expansion of capacity. As the report points out, Jordan's refining capacity is expected to fall short of meeting the forecast demand for petroleum products starting 1987 (para. 5.09). Consequently, it was recommended that a study be undertaken to formulate a program for expanding the country's refinery facilities. Investments to be undertaken during the 1981-1985 five-year plan would depend on the configuration proposed by the study. The minimum that would be required would correspond to the addition of facilities which have already been allowed for in the design of the existing refinery and which would increase its capacity by another 1.3 million tons per year. Although financing for this additional investment would be covered partly by JPRC's internal cash generation, and partly by foreign loans and supplier's credits, the planned investments for 1981-1985 should include an additional JD 60 million to cover either the cost of expanding the refinery at Zarqa and part of the pipeline to Aqaba, or to cover the initial payment for the construction of a second refinery. Therefore, it is recommended that the Government's investment plan for the petroleum refining sector be increased from JD 37.5 million to JD 97 million.

7.09 Finally, in order to improve the management of energy demand and restrain the future growth of energy consumption, a program for conservation should be undertaken during the 1981-1985 plan (para. 8.28). The program would include the initiation of energy audit studies in power and in the major

energy-intensive industries. These studies would be followed by engineering designs for retrofitting and the procurement of equipment and material. Therefore, it is recommended that provisions be included in the 1981-1985 plan to cover the cost of this program. The cost of the program, expected to fall within a range of JD 25-40 million, is estimated on the basis of experience gained in similar retrofitting and conservation projects undertaken in other countries. The final cost would depend on the results of the energy audits and on the speed at which the recommended investments are undertaken. Financing for these investments, which typically have a short payback period, would come from supplier's credits for the imported equipment, and from the national budget, possibly through low-interest loans to the industrial consumers concerned.

7.10 The aforementioned recommendations would result in a revised investment program for the 1981-1985 five-year plan. Total investments in the energy sector 1/ would amount to JD 306.4 million, distributed among the various subsectors as indicated in Table 7.3 below:

Table 7.3

Proposed Investment Program for the Energy Sector, 1981-1985

	Amount (JD million)	Percentage Share in Total
Power	163.4	53.3
Refining and Marketing	97.0	31.7
Petroleum Exploration	5.0	1.7
Oil Shale Exploration	0.6	0.2
Geothermal Exploration	0.4	0.1
Conservation	40.0	13.0
Total	306.4	100.0

This would represent an increase of nearly 36% over the investment program proposed by the Government, from 7% of total investment to 10%. However, the share of the energy sector in total investments under the investment plan proposed in this report would still represent a lower percentage than 13% observed in the previous plan (1976-1980).

1/ Including the higher estimate for the cost of the investment program in conservation.

VIII. ENERGY PLANNING AND DEVELOPMENT STRATEGY

8.01 The main shortcoming of Jordan's energy sector is the absence of a comprehensive and consistent long-term plan for the development, production, marketing and pricing of energy. The programs for petroleum exploration and oil shale development are uncoordinated. There is no justification in undertaking studies for the extraction of oil from the shale (paras. 2.04 and 2.05) before the potential for the discovery of oil and gas is fully assessed and a conclusive decision is reached whether exploration should be terminated. Petroleum exploration by NRA has moved to the drilling stage before the geology of the promising areas is fully evaluated and a detailed program for exploration drilling is formulated. NRA intends to purchase a drilling rig despite the fact that such a purchase would be uneconomic in view of the shortage of Jordanians experienced in exploration drilling for petroleum.

8.02 JEA is in the process of constructing the Aqaba power plant; however, to this date, the decision has not been finalized whether fuel oil for the plant would be supplied by the refinery at Zarqa or imported. A study by Williams Brothers (a UK consulting firm) for the construction of a pipeline between Zarqa and Aqaba is currently being completed. A decision on the pipeline, its capacity, whether the pipeline should be installed from Zarqa to Aqaba or from across the border or both, and whether a network of pipelines would be needed will require a detailed feasibility study which will have to take into account: a) the economics of utilizing coal or natural gas or imported fuel oil; b) the future demand for petroleum products, particularly distillate fuels relative to fuel oil; c) the likely modification of the refinery by the installation of additional conversion facilities to convert fuel oil to premium value mid-distillates; and d) the construction of a new refinery at Aqaba.

8.03 Moreover, while the power subsector's least-cost development plan dictates the construction of the power plant at Aqaba which would enable JEA to meet the demand for electricity until 1990, NRA is assessing the potential of constructing a 200-MW oil shale power plant. The shale power plant would not represent the least-cost alternative in view of the technical risks involved and relatively high costs associated with the development of the shale mining facilities without assurance that the operation of the power plant would be financially viable. Furthermore, despite the fact that the reserve margin of the power system would be about 90 MW by 1985, JEA has not initiated a demand management study that would provide a strategy for operating all the generating facilities in the country (autoproducers, JEA, IDECO), and integrating them with possible power imports from Syria, in order to ensure that the future demand for electricity would be met at least cost to the economy.

8.04 The program for the exploitation of solar energy has been progressing in a piecemeal fashion without a guideline to ensure that its contribution to the overall domestic supply of energy is maximized. The private production and marketing of solar water heaters is unregulated and the quality of the equipment is not standardized resulting in frequent breakdowns which frustrate consumers and hamper the widespread use of the equipment. Added to these difficulties, is the fact that the existence of several small producers

contributes to the failure of each in capturing the economies of scale needed to lower the cost of production and in turn the price. Moreover, the Government taxes all imported equipment for solar water heaters while it subsidizes the price of electricity and diesel oil used by households for water and space heating. Finally, the building codes for new construction do not as yet provide direction or incentives for the use of energy efficient material and design.

8.05 As for the pricing policy, subsidies are maintained in the fear that their elimination would slow down the growth of the economy and trigger an increase in the general price level. There is no justification for the extension of subsidies for energy to all consumers. However, because of inadequate data on energy consumption, particularly by the industrial and transport sectors, the Government is reluctant to raise the prices to eliminate the subsidies. Consequently, the subsidies continue to accrue to consumers who deserve the assistance and those who can manage without it.

8.06 The actions taken so far by the Government are commendable. The Government has demonstrated its awareness of the major role energy plays in the future development of the economy by initiating several studies to assist the policy makers in formulating energy policies. The input/output model sponsored by NPC is an example of that awareness. Moreover, its decision to eliminate the subsidies for petroleum products, and the increases in domestic prices introduced since 1979, are major steps in rationalizing energy consumption in Jordan. The Government's commitment to improving energy pricing and planning is not at issue here, but the sequence by which the various actions were undertaken and the absence of an overall framework that relates these actions to a national objective. Primary attention should be given by the Government to energy planning and the formulation of a strategy for the development and management of energy, particularly in the area of conservation which should receive highest priority.

A. Energy Planning

8.07 There is a pressing need for Jordan to formulate a long-term plan for the development of the energy sector; outline consistent policies for energy pricing, conservation and demand management; and strengthen the coordination within the energy sector. However, the achievement of these objectives would require a) the construction of an energy data base; b) the extension of the macroeconomic models constructed under the auspices of NPC; c) the consolidation of the available expertise in the sector in a single agency; d) the assignment of the responsibilities for the formulation and implementation of plans to the agency entrusted with planning; and e) the initiation of an extensive program for the training and strengthening of the local capabilities for planning.

8.08 Energy Data Base: The data pertaining to the consumption of energy in Jordan is scattered between agencies in the sector and the national department of statistics. The data covering the production and import of petroleum products, and the consumption of the major consumers such as the power subsector, the cement plant; etc. are available at JPRC. Very little information is available on the pattern of energy use in the transportation and the agricultural sectors. Moreover, information on the consumption of petroleum products for household purposes such as lighting, cooking, and space and water heating is fairly limited. In addition, the breakdown of the Government's consumption of petroleum products is not available.

8.09 The data covering the generation of electricity is available at JEA; however, information on the use of the installed generating capacities by the large autoproducers is not known. The overall sales of electricity to the major high-voltage consumers is available at JEA, but the information covering the medium-and low-voltage electricity consumption is at JEPCO and IDECO.

8.10 Data covering the consumption of energy at the low-voltage levels is highly aggregated and the exact end-use of electricity is not known with certainty. For example, the use of electricity by households is not matched with the household equipment used, and as a result, to this date JEPCO has very little information on the number of space heating and cooling equipment in use in Amman. If the Government is to formulate realistic energy plans and policies, there is a clear need for a study aimed at identifying the essential energy and economic data needed for planning, and designing a system for the collection, organization, storage and retrieval of this data. Detailed terms of reference for this study are presented in Annex 10, Attachment 1.

8.11 Extension of the Macroeconomic Models: NPC initiated a study whereby a 35x35 input/output model of the Jordanian economy was constructed with the assistance of foreign consultants. Later on, NPC initiated another study under USAID financing for assessing the impact of higher energy prices on the economy. These studies represent a significant step towards the improvement of energy planning; however, a higher level of disaggregation of the model is required in order to extract more detailed results needed for the formulation of energy policies and the evaluation of the impact of these policies on the economy. Once the input/output model is expanded and disaggregated the relationship between the inputs and outputs should be also expressed in physical terms (input/output coefficients) in order to provide a means of monitoring the energy used per unit of output produced by each sector, and allow for their comparison to internationally established norms. Moreover, the NPC should make use of the World Bank's macroeconomic model which, if adjusted to include a detailed energy sector sub-model, would enable the Government to interlink its industrial development strategy with energy, and assess its impact on the balance of payments, in response to the need for Jordan to concentrate on less energy intensive type industries for exports and to balance the outflow of foreign exchange with the inflow on the one hand, and the creation of employment on the other.. Therefore, following the initiation of the energy data base study, the Government should initiate a second study to be undertaken concurrently to disaggregate the input/output model and extend the macroeconomic model of the Bank to include an energy sector sub-model.

8.12 Consolidation of Local Expertise in Energy Planning: The five-year plan for 1981-1986 provided for the creation of an energy corporation which, among other things, would be responsible for energy planning. However, it is recommended in this report that before such an agency is created a study be undertaken to determine whether a new agency is needed and to propose a structure for the sector which would result in improving its efficient operation and management. As an interim measure and until the sector organization study is completed, the report proposes the consolidation of the presently scattered local expertise at a new department for energy planning to be created at NPC. At present, NPC has only a single economist who could effectively deal with energy planning. At least 3 other staff members are needed with previous experience in energy who could be drawn from JEA, JPRC and the departments of statistics and the department of energy at MIT. In addition, a systems expert would also be needed. In addition, and as a minimum, 3 of the young engineers in the department of energy at MIT should be also assigned to NPC where they would receive on-the-job training. Therefore, the Government would consider the assignment of a least 7 professionals of which 3 should be experienced in energy. These would initiate and supervise the compilation of the energy data base, the disaggregation of the macroeconomic models and the formulation of policies for energy planning, pricing, and conservation.

8.13 Responsibilities for the Formulation and Implementation of Energy Plans: Until the sector organization study is complete and in view of the urgent need for the Government to initiate studies and formulate policies aimed at improving the planning and development of the energy sector, it is recommended that the Government assign to NPC the responsibilities for the formulation of energy plans and policies. In addition, the council should be entrusted with the mandate for the coordination and implementation of the energy plan (para. 3.12).

8.14 Training in Energy Planning: There is no shortage in Jordan of qualified engineers, economists, statisticians and systems analysts. A large number of highly trained young Jordanians is available; however, most of them lack experience in energy; particularly the planning aspects. As a result, the proposed consolidation of staff for energy planning at NPC would not bring about the projected impact, in terms of improved planning and coordinated implementation of the plan, unless a comprehensive program for training in energy planning, audits and conservation, data analysis and monitoring, and project evaluation is initiated. The training program should involve two elements: the training of Jordanians with the proper technical background at highly specialized institutions throughout the world for periods ranging between 3 to 12 months; and the recruitment of highly skilled expatriates to assist with staff of NPC in formulating plans for energy development, and the implementation of these plans and management. The expatriates would provide the in-the-field training which is needed in order to strengthen NPC's energy planning capabilities. It is therefore recommended that the Government consider the design of a comprehensive training program aimed at providing the staff at NPC with the necessary tools for formulating energy plans, initiating energy audits, identifying the priorities in the sector, and setting policies for pricing and conservation.

B. Strategy for the Development of Energy Resources

8.15 Unless oil and gas are discovered, Jordan's dependence on imported energy would continue. Although the prospects for the discovery of petroleum are good, the production from such discoveries would not affect the overall supply of energy before 1987 because of the time required for the completion of the geological work, exploration drilling, and if successful, the development of the new fields. Oil shale, if developed, is unlikely to contribute significantly to the overall demand for energy before the turn of the century at the earliest. Solar energy could at present substitute for some of the electricity and petroleum products used for water and space heating; however, unless the technology is changed radically, the increased use of solar energy would be confined to the household uses and the supply of low temperature hot water for institutional and industrial use. Therefore, in formulating an energy strategy and policies, the Government should take as given the continued total dependence on imported energy for at least the next five years, and, partial dependence thereafter, if the petroleum exploration program is successful.

8.16 In view of the expected dependence of Jordan on imported energy, the only options available for the Government in developing the energy sector is to concentrate on ensuring that the future demand for energy is met at least cost to the economy and that energy is consumed efficiently from both the technical and economic points of view. In addition, a comprehensive plan for petroleum exploration should be formulated and initiated shortly.

Supply of Energy

8.17 The efficient supply of energy in Jordan would require improvement in the efficiency of: a) crude oil refining; b) the system for the transportation, storage and distribution of petroleum products; and c) the operation of the power system. In addition, in the case of the refinery, the processing configuration should be improved so as to maximize the yield of desired premium value distillates products.

8.18 Efficiency of the Refinery: In 1981, the refinery is estimated to have consumed about 1.9 million Btu/toe of petroleum products compared with 1.4 Btu/toe for similar refineries of identical configuration in the industrial economies. The difference is attributed mainly to the fact that the indusrial market economies have invested heavily in conservation and retrofitting equipment since 1973. If the energy consumption of the refinery at Zarqa is brought down to the average level of consumption observed in the industrial economies, the total energy saving for 1983-1985 would amount to about 130 thousand tons or US$22 million in terms of the January 1982 prices. Therefore, it is recommended that the Government commission a detailed study for assessing the potential for energy saving in refining through retrofitting and changes in the equipment used. Sample terms of reference are presented in Annex 10, Attachment 2.

8.19 System of Handling and Marketing Petroleum Products: At present, all the petroleum products produced by the refinery at Zarqa are transported and distributed by road. Of particular importance is the transportation of fuel oil which accounted for about 29% of all the petroleum products produced in 1981 and is expected to increase to about 34% by 1987 and 36% by 1990 (Annex 7, Attachment 4). Currently, tanker trucks deliver the products to the major consumers (power plants, cement, phosphate, etc) using diesel oil, a higher value product. Most of these consumers are located either at the outskirts of Amman or between Amman and Aqaba. For example, the fuel oil consumption of the cement plant is forecast to increase from 90,000 tons in 1982 to 200,000 tons in 1986. Currently, the product is transported by trucks owned by the plant. If a 50 mile 5" pipeline is used to transport the product, the present worth of the pipeline would be about US$5 million compared to the present worth of the trucking option of about US$7.5 million. In terms of consumption of energy, the pipeline option would reduce the consumption of diesel oil for 1983-1990 by about 1,700 tons representing about 0.02% of all the gas oil/diesel forecast to be consumed during the period (Annex 7, Attachment 4). 1/

8.20 Moreover, LPG which is consumed mainly at and around Amman is marketed in an uneconomic way. The fuel bottles are transported by the distributors from the refinery to the distribution center at Amman, then the empty bottles are transported back to the refinery for refilling. Since the distributors pay for the cost of transportation which are covered by consumers, JPRC has no interest in improving the system for servicing the LPG consumers. LPG could be transported by tanker trucks to servicing outlets near the demand centers and the bottles filled and distributed through these centers. This system would avoid the use of diesel oil to transport the empty bottles on the average 60 km to be refilled at Zarqa.

8.21 The potential for savings to the economy by improving the existing system for handling petroleum products was demonstrated by the two examples discussed above (paras. 8.19 and 8.20). There are possibilities for Jordan to reduce its consumption of energy by constructing a pipeline network that would transport industrial fuels between the refinery and the main demand centers. The Government should undertake a study for determining the optimal configuration for the infrastructure for the transportation, storage and distribution of petroleum products. However, such a study should be undertaken only after another study is completed which would determine the location of the future demand for these products and the most efficient means for refining in order to meet the demand at least cost (Annex 7, paras. 12-16).

8.22 Management of the Power System: In 1981, there was about 40 MW of generating capacity operated by the large industrial consumers (refinery, cement, phosphates, etc) (Annex 6, para. 22). These represented about 20% of the peak demand in that year (Annex 6, para. 18) and 10% of JEA's installed capacity. However, in view of the expected decline of the reserve margin

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1/ Assuming that about 200,000 tons of fuel oil would be transported each year at a distance of about 30 miles by 25-ton diesel trucks with a fuel mileage of about 8 miles per gallon.

between 1982 and 1986, the 40 MW would represent about 9% of the maximum demand in 1985 (Annex 7, para. 9) and almost 8% of installed capacity. If these small systems are managed to operate during the daily peak periods and the potential for the import of electricity from Syria is integrated more closely in the operations of JEA system, the likelihood of outages would be greatly reduced between now and 1986 when Aqaba comes on stream. In addition, since all the isolated systems have been converted by the owners to operate by burning fuel oil, and since JEA uses gas oil to operate its peak plants, there is a scope for reducing the overall consumption of gas oil by having the autoproducers meet their own demand during the peak periods and using JEA's supply for backup.

8.23 To demonstrate this point, consider the refinery at Zarqa which requires about 6 MW capacity during peak periods. Assuming an additional 3 MW would be required as a reserve margin, the average incremental economic cost of supply would be about 17 fils/kWh during peak compared with JEA's marginal cost of supply of about 26 fils/kWh (Annex 8, para. 20). This would result in a net annual saving to the economy of about US$324,000 and would reduce the consumption of gas oil by about 3,000 tons annually, representing 0.2% of total consumption of the product for 1983-1990 (Annex 7, Attachment 4). 1/ If the refinery is to use a gas turbine and operate by burning the refinery gas, the savings would be substantially higher.

8.24 The refinery's consumption of electricity was used for illustrative purposes to demonstrate the need for a load research and management study whose purpose would be to propose the means by which the installed capacities in Jordan could be matched with the demand in the most efficient way possible. Such a study would also propose the shift of unessential demand for electricity from peak to off peak periods, e.g, water pumping load. Therefore, it is recommended that the Government and JEA undertake a load research and management study which would set a framework for managing the demand of consumers and the facilities in the sector to supply electricity at least cost to the economy. Sample terms of reference for the proposed study are provided in Annex 10, Attachment 3.

8.25 Two other areas where economy in the power sector's use of energy could be achieved are: a) the improvement in the efficiency by which the power stations use fuel oil and gas oil; and b) the reduction of losses in the transmission and distribution of electricity. Improvement in the energy efficiency of power plants could be achieved through retrofitting, better scheduling of maintenance and economic dispatching. These would be covered in the load research and management study (para. 24). Reduction of transmission and distribution losses could be achieved by improving the quality of equipment, using appropriately sized and matched equipment, and elimination of

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1/ Assuming 3x3 MW at a cost of US$1,000/kWh, an economic life of about 10 years, a discount rate of about 10%, fuel consumption of about 0.254 kg/kWh, generation for only 2,000 hours out of a total 8,760 hours per year and a border price for the fuel oil of about US$169/ton.

theft. Therefore, it is recommended that JEA, IDECO and JEPCO undertake a study for identifying the sources of the relatively high losses at the distribution level and propose a system for standardizing the equipment and material used in the sector. Sample terms of reference for the study are presented in Annex 10, Attachment 4.

Consumption of Energy

8.26 Jordan's energy intensity is high relative to both the developing and the industrial countries. In 1979, the energy intensity was 0.617/$1,000 GDP which is higher than that of Turkey, Italy, Greece and UK; all with per capita income higher than that of Jordan. Table 8.1, below summarizes the standing of Jordan relative to other middle-income and industrial economies.

Table. 8.1

Jordan's Energy Consumption and its Relationship to That of Some Middle-Income and Industrial Economies (toe)

Country	Energy Consumption (Per US$1,000 GNP)	Per Capita Energy Consumption	Per Capita Income in US$
Japan	0.323	2.840	8,810
Denmark	0.335	3.985	11,900
France	0.349	3.330	9,550
Germany	0.377	4.418	11,730
Switzerland	0.390	3.425	13,920
Austria	0.402	3.471	8,630
Turkey	0.404	0.538	1,330
Belgium	0.412	4.497	10,920
Spain	0.429	1.881	4,380
Italy	0.437	2.292	5,250
Portugal	0.455	0.997	2,180
Chile	0.470	0.795	1,690
Greece	0.478	1.894	3,960
U.K.	0.595	3.750	6,320
Jordan	0.617	0.753	1,180
Ireland	0.605	2.546	4,210
Argentina	0.609	2.359	2,230
Hungary	0.705	2.715	3,850
Bulgaria	0.975	3.602	3,690

Source: World Development Report, 1981.

The figures provided in Table 8.1 cannot be used for comparison by saying for example that Japan is almost twice more efficient in its consumption of energy than Jordan because the consumption of energy is a function of the contribution of the manufacturing sector to the GDP and the mix of industries within the sector. However, the table provides an indication of the range of energy intensities in some major countries and underscores the potential for improving energy efficiency by moving from the lower to the higher segment of the scale.

8.27 The transportation sector which presently accounts for nearly half of all petroleum products consumed in Jordan is expected to grow at an accelerated rate over the next ten years. As a result, demand by the transportation sector is likely to remain preponderant unless substantial improvements in the efficiency of energy use by the sector are achieved. Given the existing patterns of energy consumption in the transportation sector and the limited potential for interfuel substitution (para. 6.09), increased efficiency would depend, to a very large extent, on the rationalization of prices for petroleum products consumed in the sector. In addition, proposals for increased efficiency are expected to result from a national transport study initiated by the Government. The objective of the study is to determine means for optimally planning and organizing the transportation sector (freight transport, air and sea transport, highway and road network design, etc.). Among the tasks outlined in the terms of reference for this study are: a) the assessment of the impact of eliminating the subsidies for gasoil/diesel and jet fuel on the freight road transport subsector and the commercial aviation subsectors; and b) the formulation of recommendations on policies relating to fuel pricing and consumption aimed at reducing wasteful fuel consumption. An interim report for the study was submitted to the Government on October 22, 1982, and the final draft is expected to be available by March/April 1983.

8.28 The industrial sector and power subsector are expected to consume about 38% of all the petroleum products consumed in Jordan in 1985 and about 42% by 1990. Their consumption of petroleum products would be mainly in the form of fuel oil and gas oil/diesel. Since over the next five years, pricing is expected to continue playing a limited role in significantly restraining energy consumption, the only means for curbing the growth of future demand for energy by the major energy-intensive industries and the power subsector would be through the improvement of the prevailing practices for managing and using energy. However, as the economy gradually moves towards a more balanced growth, and the price elasticity of energy demand increases (para. 5.03), higher prices for petroleum products would then contribute more significantly to restraining the demand for energy. Conservation, changes in the technologies used, and improvement in the systems for meeting the energy demand would be addressed in the load management research study (para. 8.24) and the study for the design of an optimal system for the refining of crude oil and the storage, transportation and distribution of petroleum products (para. 8.21) which are proposed in this report. This leaves conservation and retrofitting in the industrial sector, and the potential for changes in the technologies being used to improve energy efficiency. As indicated in Table 8.2 below, energy consumption in the industrial sector is concentrated in three major industries: cement and building materials, phosphate mining, and petroleum refining.

Table 8.2

Energy Consumption in the Industrial Sector /1
('000 toe)

	Fuel Oil	Gas Oil/ Diesel	Electricity
Cement and building material	94	11	36
Phosphate mining	53	20	14
Refinery	90	-	14
Others	35	31	34
Total	272	62	98

/1 Estimates for 1981.

Based on a preliminary assessment by the mission, and on detailed energy audits of similar industries elsewhere, it is estimated that an energy saving of about 15-20% of current consumption could result from retrofitting and changes in the equipment used in these industries. 1/ Additional savings could also be achieved in the new major projects which are coming on stream starting 1983; namely potash, phosphate fertilizer, and white cement. However, a full assessment of the potential for energy saving in the industrial sector can only be derived from comprehensive energy audits of the major consumers. Therefore, it is recommended that the Government consider recruiting internationally reputable firms to audit the ten largest industrial consumers of energy and provide detailed engineering designs, specification of equipment and bidding documents which would be used in formulating an investment plan for energy conservation to be implemented between 1982 and 1985. Sample terms of reference are provided in Annex 10, Attachment 2.

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1/ Rough estimates indicate that energy saving in each subsector would be of the following magnitude: about 10% for cement, 15% for phosphates, and 30% for the refinery (para. 8.18).

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ENERGY SECTOR STUDY

Oil Shale and Tar Sands

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ENERGY SECTOR STUDY

Oil Shale and Tar Sands

A. Reserves

1. Oil shale deposits are presently known to exist at El-Lajjun south of Amman, Al-Qatranah in the Yarmouk valley, and Al-Husseineyyah in the southern part of the country (IBRD Map No. 16299). So far, only the deposits at El-Lajjun have been geologically investigated in some detail, and preliminary studies for their possible exploitation initiated. As for the two other deposits, very little is known at present of their size and geological characteristics. The Government intends to geologically assess these deposits during the implementation of the 1981-1985 plan for energy. Small deposits of tar sands have recently been discovered in Wadi Isal; however, no indication of their commercial value is available at present.

2. The deposits at El-Lajjun are located about 110 km south of Amman, between Qatrana to the east and Karak to the west. They are easily accessible by road, and are close to the new potash and phosphate industries in central part of Jordan. The deposits extend in a north-south direction over a distance of about 10 km and an east-west direction of about 2.5 km. The reserves are put at about 1.1 billion tons of oil shale with an average oil content of about 10%. 1/. These estimates are only based on 75 exploratory boreholes, 38 of which were drilled in 1968 by the Natural Resources Authority (NRA), and the remaining 22 were drilled in 1979 by the German Federal Institute for Geological Research (BGR) in collaboration with NRA. However, additional exploratory work is needed before the plan for the exploitation of the reserves is finalized (para. 13).

3. In addition to the oil, the following products were obtained in the analyses of the shale from El-Lajjun (Fisher test): gas and losses about 2%; water about 5%, and spent shale about 83%. The spent shale contains about 30% of the original organic carbon in the raw shale, and the remaining 70% are transformed into oil and gas. The total sulphur content of the raw shale is about 3.5%, mostly in the form of organic sulphur. Another feature of the shale is its high phosphorous content.

1/ Determined by Fisher Assay and estimated to be about 25 US gallons per short ton. The oil content was determined by Fisher Analysis of each meter of shale in 36 out of the 75 boreholes drilled.

4. The deposits are shallow, and thus suitable for low-cost open pit mining. On the average, the oil shale layer is about 25-30 m thick and overlain by about the same amount of overburden. There is no waste material in the shale, except for one or two limestone banks of about 0.5 meter thick. Horizontally, the shale sub-layers are quite uniform without major faults in the deposit.

B. Exploitation of Oil Shale

5. In 1979, the Natural Resources Authority (NRA) commissioned a study by BGR for the evaluation of the reserves at El-Lajjun. The study, which was completed in 1980, concluded that the shale was of a sufficiently good quality to justify further work in assessing the potential for its exploitation for power generation by direct combustion and the production of shale oil by retorting. In addition, BGR recommended the need for more extensive technical evaluation of each application before a final decision is made on a strategy for developing the shale. Consequently, in 1980, the Government commissioned a prefeasibility study by Technopromexport (USSR) to determine the feasibility of directly burning the shale in a 300 MW power plant (conventional combustion). In addition, two other prefeasibility studies were awarded in 1980 to Kloeckner/Lurgi (West Germany). The objective of the first study was to assess the possibility of using the shale in the generation of electricity by adopting Lurgi's newly developed technology of fluidized bed combustion; and the objective of the second study was to determine the viability of constructing a retorting plant for the production of shale oil.

6. The study by Technopromexport was divided into two phases. Phase I covered the evaluation of the suitability of the shale for direct combustion in power plants similar to those currently operating in Estonia; and Phase II involved the design of such power plants for construction in Jordan. The report summarizing the results of Phase I, submitted to the Government in August 1981, recommended the immediate construction of a large 200 MW unit for testing purposes. However, since the report was not conclusive as to the impact of some shale properties (e.g. phosphorous content) on the boiler equipment and operating efficiency of the proposed plant, NRA decided to defer the implementation of Phase II until a more extensive evaluation of the properties of the shale and the technology is undertaken.

7. The work by Kloeckner/Lurgi was concluded in 1982. The study found both options for the exploitation of oil shale to be viable. However, in view of the projected increases in the real price of oil in the world market and the financial cost of generating electricity in Jordan, the study recommended that NRA concentrate its efforts on retorting. The study has two main shortcomings: (a) actual electricity tariffs were taken as an estimate of the economic cost of electricity instead of the long-run marginal cost; (b) the resource cost of unskilled labor, to be hired for mining the oil shale, was not used to evaluate the different options. It is therefore recommended that the Government request Kloeckner/Lurgi to reassess the economic viability of the two options based on economic prices and wages.

8. Once the recommended reassessment is completed, the Government would have three possible options for proceeding to the next step in its long-term program for the exploitation of oil shale:

(i) Option I: build for trial operation, a commercial size power plant (300 MW) based on the conventional combustion technology;

(ii) Option II: construct a pilot power plant (about 20 MW) based on fluidized bed technology to allow for the collection of data on its operations; and

(iii) Option III: erect for trial operation, a single commercial size oil shale retorting unit yielding about 1,250 barrels/day.

C. Recommended Strategy for the Exploitation of Shale

9. In view of the increasing burden being imposed by the oil import bill on the foreign exchange resources of Jordan and given the superior quality of its oil shale, the Government is justified in exploring the potential for exploiting the shale to meet part of the future demand for energy. However, at the outset, the Government should be aware that the implementation of a pilot program for determining the potential for commercially exploiting the shale involves substantial risks, both technical and financial. The risks would prevail irrespective of the strategy adopted and technology selected. Therefore, in formulating a plan for the development of the shale, the objective should be to select the path which would minimize the financial risk and reduce the burden on the country's technical and human resources. This would immediately suggest a plan that entails extensive assessment of the resources and available technologies, and a gradual movement towards possible commercialization of the technology selected by starting with small demonstration units, then larger pilot scale plants, and finally reaching commercial size schemes.

10. The Government is in the process of formulating a long-term plan for fully assessing the optimal strategy for ultimately exploiting the oil shale. The formulation of such a plan would involve the following three elements that should be addressed in sequence:

a) an assessment of the options for the exploitation of Jordan's shale under the presently known technological know-how;

b) an evaluation of the technology to be employed under each of the options considered economic; and

c) the time horizon for reaching the commercialization phase of the technology selected.

11. Options for the Exploitation of the Oil Shale: The retorting of shale for the extraction of oil involves complex technology which is presently at the embryonic stage of development. Few test models have been constructed in the industrialized countries (mainly the USA and Brazil); however, despite the experience gained in these pilot schemes, the viability of commercial size retorting plants is still questionable. Plans to construct commercial size plants in the industrialized countries have either been slowed down or abandoned. Therefore, in order to reduce the risk associated with the construction of a pilot retorting scheme in Jordan, NRA should proceed slowly and cautiously to capitalize on the experience and results obtained from operating similar plants currently under construction. By contrast, the generation of electricity by burning shale in a plant based on the direct conventional or fluidized bed combustion involves a relatively simpler technology for which relevant industrial experience is more readily available. The technology involving the generation of electricity from lignite of low calorific values has provided extensive experience, some of which is applicable to the shale; however, so far all experimentations concerned with the generation of electricity by direct combustion have provided, at best, marginal results when compared to the cost of generating electricity by burning fuel oil or coal. Therefore, from a purely risk-aversion point of view and given the unproven nature of the presently-known technology, it is recommended that the Government consider postponing, for at least ten years, its plans to build commercial size plants for either retorting or power generation; and that it concentrate its resources in the interim period in undertaking systematic and detailed prefeasibility studies, and the construction of prototype models before moving to the full scale pilot stages.

12. Selection of Technology: The proposed Lurgi retorting process has a relatively high energy efficiency by locating all raw shale (including the fine shale), making utilization of the residual energy in the retorted shale and by avoiding dilution of the product-gas with off-gas. However, this process has been running on oil shale only at the small scale of about 20 barrels per day, whereas the less energy efficient processes in Brazil and USA have been tested at pilot plants of up to 1,000 barrels per day. If Jordan decided now, to go ahead with a 1,250 barrels per day plant of the selected technology, it would be the first country to do so and consequently would have to take the full risks associated with such a step. The direct combustion option involves two technologies: conventional and fluidized bed combustion. However, both technologies have not been sufficiently tested in commercial size plants to provide conclusive basis for choosing between them. Only the large power plant in Estonia is presently known to operate by using the conventional combustion technology. However, the experience gained there by burning low calorific value lignite cannot be directly applied in Jordan because of differences in the quality and properties of the shale. Furthermore, the conventional combustion technology involves substantial environmental difficulties (fly ash and sulfur) which would add to the risk associated with the construction of commercial size plants in the near future. On the other hand, the fluidized bed combustion technology has the advantage of being environmentally safer and operationally more efficient; however, commercial size plants have not yet been built and fully tested. Therefore, it is recommended that a stepwise strategy be adopted involving

detailed assessment of technologies worldwide, then the construction of a pilot plant based on whichever technology is judged more appropriate for Jordan. However, in order to reduce the risk and cost involved in testing the technology selected, the Government should attempt to finance a large proportion of the cost of the pilot plant through bilateral aid and avoid, to the extent possible, allocating its resources to proving technologies whose economic viability should have been established and tested in the industrialized countries.

13. Time Horizon for the Development of Oil Shale: Before embarking on the construction of a 1,250 barrels/day retorting module, results of oil shale developments aborad should be awaited. The first commercial plant in western countries (Union Oil's 10,000 barrels/day project in Colarodo) is expected to come on stream by end-1983. Because of the substantially different technology, it is further advisable to also wait for the start-up of a larger oil shale retorting unit of the selected technology. In the meantime, the advantages and disadvantages compared with the direct combustion option should be carefully evaluated and, if the retorting option is found to merit further investigation, then detailed studies for a smaller pilot plant should be prepared. This is expected to take about 3-4 years. A decision to go ahead or not to go ahead with a small scale pilot retorting unit could be made about 1986/87. In view of the existing and the planned extension of the power generating capacities in Jordan (Aqaba 3 X 130 MW) which are expected to meet the projected demand until 1990, there is no urgency for accelerating the program for the development of power generation from shale. Prior to such development, the Government should initiate detailed studies that would provide the input required for designing a critical path for the commercialization of oil shale based generation, if this option proves viable. However, until the advantages and disadvantages of retorting or direct combustion have been fully evaluated and a subsequent study for either a retorting or direct combustion small pilot plant is completed, the Government's current schedule should be modified so as to plan for the construction of a pilot plant in the late 1980's, and the commissioning of the first commercial size oil shale plant, if any, for not earlier than the mid-1990's.

D. Work Program for the Period 1982-1990

14. A possible work program for the next ten years would involve the following 6 tasks:

Geological Assessment of the Oil Shale: In view of the size of the deposit at El-Lajjun, it is recommended that the plan currently proposed by the Government to geologically assess the reserves at Al-Qatranah and Al-Husseineyyah be significantly scaled down. Instead, the Government should concentrate on fully assessing the

structure of the reserve in the areas suitable for mining in the near future at El-Lajjun, and its properties, particularly the heat value of the shale;

Evaluation of the water resources at El-Lajjun: In conjunction with the geological assessment of the shale, the Government should undertake an evaluation of the extent of underground water which would be needed for the operation of a power plant and/or a retorting plant. This would provide the input needed as to whether the power plant should be water or air cooled;

Review of existing technologies: This review would compare existing technologies for retorting and direct combustion in order to determine the most appropriate one;

Feasibility study of mine and plants: This would cover the detailed layout of the mine, infrastructure, and pilot plants. It would provide cost estimates for each component, and the economic viability of the intended pilot and commercial size plant and infrastructure. The task would follow the completion of the review of available technology;

Engineering design and bidding documents: If the proposed commercial size plant proves viable in the preceeding task, the next step would be to prepare detailed engineering design and bidding documents for the pilot plant and the first phase of the mine;

Construction of pilot plants and mine: This step would only be undertaken, if all above studies lead to positive results.

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ENERGY SECTOR STUDY

Petroleum Exploration

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ENERGY SECTOR STUDY

Petroleum Exploration

A. Geology

1. Jordan spans an area of approximately 97 thousand km^2, of which 75 thousand km^2 is covered by sedimentary basins. Although most of the Arabian peninsula is characterized by a uniform morphology, the northwestern part, where Jordan is located, shows considerable variations. It is characterized by the presence of six main geological regions with distinct physiographic properties. These are:

(i) The Central Plateau: bordered in the west by the ridges that follow the Dead Sea Graben and grading into flat lands in the east; (ii) The Northeastern Plateau (Risha): a monotonously flat area which extends into Syria, Iraq and Saudi Arabia; (iii) The Mountain Ridge along the Dead Sea Graben and the Northern Highlands: a topographically high region with several distinctly different geological parts. Some oil exploration prospects exist in the region particularly north of Amman; (iv) The Aqaba-Jordan Valley Rift: a narrow depression extending from Aqaba in the south to Lake Tiberias in the north (360 km). This is a highly disturbed region with some geological properties similar to those found in the oil rich Gulf of Suez; (v) The Southern Mountainous Desert: generally characterized by crystalline basement outcrops with no oil potential. However, to the north, sedimentary sequences of Palaeozoic and Mesozoic ages appear which are more favorable to oil occurrences; and (vi) The Northern Plateau Basalt Province: covered by thick basaltic flows where total thickness can reach 1,000 m. These flows are deeply weathered which makes the area inaccessible by vehicles, and consequently oil exploration is not feasible (IBRD Map No. 16106).

2. Only the first 4 of the 6 regions listed above are of immediate interest for petroleum exploration:

The Central Plateau: This region covers mainly the area south of Amman. The south and southwest is mostly underlain by Palaeozoic sedimentary rocks, capped by some rocks of Mesozoic age. Although these can reach considerable thicknesses (several thousand meters), they contain an abundance of clastics and only minor shale intervals. As a result, they are of little geological interest for oil exploration. In the eastern part, older sedimentary formations are overlain by very thick Upper Cretaceous and Tertiary that can attain a composite thickness of several thousand meters. Marls, limestones and dolomites predominate, but there are some thick sandstones which are potential reservoir rocks. Source rocks and cap rocks are well established. Surface geological and seismic work shows

that traps for oil accumulations are present but there are no large anticlinal structures which characterize the major oil producing areas in the Middle East. Therefore, the prospects for petroleum discoveries are confined to small but potentially commercial fields.

The Northeastern Plateau (Risha): According to seismic surveys, this region has a very thick sedimentary section of up to 5,000 meters. So far, however, deep wells have not been drilled in the area, and as a result, the composition of the sedimentary section is unknown. Traps for oil and gas are likely to be small and difficult to define. This would make oil exploration particularly risky.

The Mountain Ridge along the Dead Sea Graben and the Northern Highlands: This region belongs to a major geological trend which can be followed from Egypt into Northeast Syria. Sediments are of Mesozoic age, mostly of marine origin, and thus favorable for the formation of oil, and their thickness is several thousand meters. Reservoir rocks and source rocks are present. Furthermore, pronounced geological structures are evident on the surface. Unfortunately very little is known about the form of geological structures at depth, as seismic data obtained to date is of very poor quality, which renders oil exploration too uncertain.

The Aqaba-Jordan Valley Rift is a geologically disturbed zone, over 300 km long and 14-30 km wide, containing a very thick sedimentary sequence (possibly over 10,000 m). Most likely, Palaeozoic and Mesozoic sediments are present at the base, but the late Tertiary sedimentary section attains very great thicknesses and salt deposits are very common, indicating the presence at depth of mature oil source rocks. Strong subsidence, particularly during the late Tertiary age, together with intensive salt flow structures leave no doubt that a variety of structural traps for oil have been formed. Unfortunately, seismic data obtained to date do not permit mapping of deeper horizons because of the thick salt layers above them, so oil exploration has been unsuccessful and inconclusive.

3. The subsurface geology of Jordan is not yet well understood, and the area is underexplored despite many favorable indications because: a) much of the seismic data collected so far is of poor quality; b) several areas are yet to be covered by seismic; and c) only 14 exploratory wells for oil have so far been drilled. Nevertheless, there are several areas in Jordan, within the four geological regions discussed above, where the basic ingredients for the generation and accumulation of hydrocarbons are present (source rocks, reservoir rocks, traps). These are: the eastern part of the Jordanian platform near Azraq (central platform), the Northern Highlands, the Dead Sea Rift, and the thick sedimentary section of the Northeastern Plateau (Risha) which is yet to be tested.

B. Exploration Activities

Foreign Oil Companies

4. Petroleum exploration activities in Jordan began in 1947 when the Trans-Jordan Petroleum Company 1/ obtained exploration rights covering the entire country. The company's exploration work involved surface geological mapping, and some gravity and magnetic surveys; no wells were drilled. By 1954, the company lost interest and terminated its exploration agreement.

5. In 1955 E. Pauley (US) obtained exploration rights covering an area of about 31,250 km^2. At first Pauley contracted part, and subsequently all, of his acreage to Phillips Petroleum (US). Phillips conducted geological and geophysical surveys (gravity, refraction seismic and reflection seismic) and drilled six wells in the Northern Highlands and the Dead Sea Valley. None of these wells gave encouraging results and the group withdrew from Jordan in 1961.

6. John Mecom (US) signed an exploration agreement in 1954 covering the entire country. However, despite the size of the area covered by the agreement, only minor surveys and the drilling of 3 shallow wells were undertaken, and by 1967 the company terminated its work in Jordan.

7. In 1968 INA (Yugoslavia) was awarded a contract covering Azraq and Sirhan in the southeast of the country. Subsequently, Deminex (Germany) acquired a 30% interest in this area. The consortium carried out some seismic surveys and drilled four wells including Wadi Rajil-1, where good oil indications were recorded in the Upper Cretaceous section (Attachment 1). However, despite the favorable oil indications the consortium terminated its operations in 1971.

8. The last contract was awarded to Filon Oil Company (US) in 1975, for an area in the northern part of the country. Consequently, Total (France) and Fugo (Japan) participated in the venture with Total being the operator. After some very poor quality seismic surveys, and the drilling of a single well, operations were terminated in 1978.

Government

9. As a result of the lack of interest displayed by international oil companies in exploring Jordan's oil potential, the Government decided in 1976 to embark on an exploration program funded from its own resources, and implemented by NRA. The objective of the program was to: a) reassess past geological and geophysical exploration data; b) generate new geophysical data through the utilization of modern technology because much of the old data was recorded by obsolete equipment, and could not be reprocessed advantageously; and c) thereafter embark on a promotional program aimed at attracting the interest of reputable international oil companies.

1/ Subsidiary of Iraq Petroleum, consisting of Esso/Mobil (US), Total (France), Royal Dutch Shell Oil (UK/Dutch) and BP (UK).

10. As a first step, NRA appointed BEICIP (France) and Welldrill (UK) to review past exploration data and formulate a work program. These firms confirmed that the available seismic data, particularly those gathered in the past, were inadequate, and recommended the execution of a new seismic program based on an appropriate technology, supplemented by photogeological and gravimetric studies. Subsequently, CGG (France) was contracted in 1978, to carry out and interpret 2,150 line-km of new seismic data, and reprocess 820 line-km of old seismic, at an overall cost of about JD 870 thousand (US$2.2 million). In addition, CGG carried out gravimetric surveys, photogeological studies and detailed structural geological analyses at an additional cost of about JD 160 thousand (US$0.4 million).

11. In 1980, 20 foreign oil companies were invited to review the exploration data available, and purchase the newly compiled geological/ geophysical data acquired since 1976 which was sold in four different packages. Only 6 companies acquired the data packages (each costing between US$10 and US$100 thousand). NRA recovered only US$840 thousand from the sale of its data packages compared to the cost incurred in preparing them of about US$2.6 million. In addition and much to the disappointment of NRA and the Government, none of the 6 companies (all well-known multinationals) expressed any interest in taking exploration rights in Jordan. Subsequently, 2 small promoters expressed some interest, but were turned down in view of their lack of technical and financial capabilities.

C. Exploration Data Currently Available

Surface Geology

12. A set of good quality 1:250,000 geological maps is available as a result of the extensive work undertaken by NRA and its consultants in mapping the entire country. In addition, the data on geological subsurface have been incorporated in the regional geological frame which provides a good overall knowledge of the stratigraphical development. A summary of the oil geology of Jordan was made by BEICIP and a review by Welldrill of all studies made prior to 1979 is also available. These studies and reports show the presence of source rocks, reservoir rocks and caps rocks in most of the areas in Jordan.

Geophysical Data

13. Gravity and Magnetics: Gravity and magnetic surveys began in Jordan in 1947 and were carried out intermittently by various companies that were involved in exploring for oil between 1947 and 1978. As a result, the depth of the crystalline basement in the areas of interest for exploration is reasonably well established.

14. Seismic Data: Until recently seismic data have generally been of poor quality, primarily because of the inadequate practice used in acquiring the geological information, and the careless manner by which the information was interpreted and processed. Since in the case of Jordan, large anticlinal

uplifts are the exception and small subtle structures are the rule, wide seismic grids of mediocre data cannot provide reliable structural contour maps and consequently locations for exploratory wells cannot be chosen with confidence. NRA is fully aware of this, and during their 1981/1982 surveys close attention was paid to quality control of seismic acquisition. In one area of considerable interest, good to excellent results were obtained (Azraq), and in some cases, direct indications of hydrocarbon accumulations were apparent. However, this will have to be verified by careful data processing.

15. In the Sirhan area, southeast of Azraq, good quality data is now obtained. The seismic grid is still very wide, but there are indications of favorable geological structures.

16. Aeromagnetic surveys over Risha indicate a deep magnetic basement. Early seismic surveys showed poor penetration; however, a gradual improvement has been achieved. Present data are of good quality and several structural traps for petroleum could be mapped.

17. In the Northern Highlands seismic data remains very disappointing. To a large extent, this could be due to the adverse surface conditions (limestones on outcrops, rough topography). Early drilling was done on the basis of surface geology and some gravity surveys. There is no way to ascertain whether these wells are indeed reliable tests of the petroleum potential of the area.

18. Past seismic survey efforts in the Dead Sea did generally not penetrate below the thick younger Tertiary salt section. In view of tectonic complications, thick salt deposits, and intense faulting, seismic data acquisition will remain a major problem and the planning of exploratory wells will be difficult.

Drilling Data

19. Fourteen exploration wells were drilled in Jordan between 1956 and 1978, 10 of which were located in the eastern part of the Central Plateau (Attachment 1). However, none of these wells encountered hydrocarbon accumulations, although in several cases oil and gas indications were recorded (Attachment 2). 1/ These negative results should be viewed with caution. Most of the wells drilled were based on inadequate geological information or poor quality seismic surveys. Nevertheless, source rocks have been described from several stratigraphic levels in the Northern Highlands and in the Azraq area. Along the Dead Sea Rift, many oil and gas shows clearly indicate the presence of source rocks. Good reservoirs occur in rocks of Palaeozoic to Mesozoic age. The presence of cap rocks is also well documented. Geological

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1/ In one well, Wadi Rajil-1 (para. 7), some oil was recovered during a short test. A consultant, in fact, has concluded that the well was not properly tested and that producible hydrocarbons were present.

traps are widely present, ranging from anticlines in the Northern Highlands to fault closures, fault traps or stratigraphical traps in the Azraq Basin. Detailed seismic surveys will no doubt establish possible drilling locations in Sirhan (south of Azraq) and Risha. NRA has resumed exploration drilling in 1981. So far two wells have been completed in the Wadi Rajil area where an exploration well, drilled in 1970, recovered some oil. In both wells numerous possibly oil-bearing reservoir intervals are present.

20. In view of the existence of areas with a fairly good chance for oil discoveries, why has the exploration work undertaken by both the foreign and NRA proven unsuccessful for so long? The main reasons for the lack of success can be attributed to several factors: a) the inadequacy of the seismic work undertaken in the past in both quantity and quality; and b) the use of wide grids for the seismic work instead of narrower grids, which are needed for mapping rather complex and subtle geological structures such as occur in Jordan.

D. The Government Program for 1982-1985

21. Despite serious setbacks experienced in the past years, the Jordanian Government has decided to accelerate its oil exploration program by providing NRA with substantial resources for its implementation. Exploration expenditures for 1982 are expected to reach JD 6 million (US$20 million); a similar amount is budgeted for 1983.

22. At the end of 1981 three geophysical firms (2 from France and 1 from the USA) were conducting seismic surveys; one firm (CGG France) is operating at present. A second seismic party (from INOC) may commence operations in 1983. In 1981/1982, in excess of 8,000 km of seismic lines were acquired. Most of the data obtained is of good quality and should allow mapping of geological structures which could contain oil and gas. However, they are limited to the Azraq area and parts of Risha. In all other areas, much additional seismic is required to enable adequate mapping of geological structures. To this end, NRA plans to acquire some 6,000 km of seismic lines during 1983 and 1984. In addition, hydrodynamic microtectonic and geochemical studies are planned.

23. NRA has contracted a drilling rig from Naftagas (Yugoslavia) for a one-year period, with an extension clause of two years. In addition, it has acquired a workover rig from INOC to carry out the extensive testing programs. Two wells have been drilled in the vicinity of Wadi Rajil (para. 7). Oil was encountered in several layers; from one interval 200 barrels/day 27° API oil was tested. Encouraged by its success in the Wadi Rajil area, NRA plans to contract a second drilling unit, also on a rental basis.

E. Assessment of the Government Program

Reasons for the Neglect of Jordan by International Oil Companies

24. The only established Middle East oil producer to demonstrate interest in Jordan was Iraq Petroleum Company (para. 4). A quick reconnaissance must have demonstrated to them that the favorable stratigraphy and the very large structures so familiar to them in Iraq and the Gulf States were not present in Jordan. In their eyes rewards would be small and of no interest to them.

25. Oil companies operating thereafter employed various exploration techniques, but none was successful in obtaining reliable subsurface information. Consequently drilling results were very disappointing. This, together with some rigid geological concepts (which were widely published) must have further discouraged potential investors.

26. As outlined in previous paragraphs, the many favorable geological aspects justify continuation of oil exploration in Jordan. There is little doubt that oil and gas has been generated in areas other than Azraq. Potential geological traps will, in all likelihood, be small and difficult to locate. Apart from ample financial resources and highly specialized manpower, an exploring oil company must have access to sophisticated computer programs and be satisfied that accumulations of a size of 25-30 million barrels are likely. While prospects of that size may not be of interest to the very large international oil companies, some middle size companies might become interested, particularly if such prospects are supported by adequate seismic data.

Government Exploration Strategy

27. Jordan's current exploration strategy results from the lack of interest displayed by the 20 foreign oil companies contacted in 1980 and represents an ambitious effort carried out by the Government alone. The amount of resources and efforts being assigned to oil exploration constitutes a commendable effort. However, it also contains a significant amount of risk, particularly as the program attempts to do too much in a relatively short period of time. In particular, the identification of drilling locations is, if carried out in accordance with industry standards, a slow process which requires: a) adequate geological and seismic data to confirm that a structure indeed exists; and b) the consensus of a representative group of geologists and exploring companies that the underlying data justifies the drilling effort. Therefore, it is recommended that future seismic surveys be based on rather narrow grids in order to locate small structures and generate adequate subsurface data to justify drilling.

Seismic Work

28. The oil potential of the Azraq area is the least controversial. A thick section of Tertiary and Cretaceous sediments is proven, reservoirs and cap rocks are present, and live oil shows have been encountered by drilling. The latest seismic surveys show that good quality seismic data can be obtained. However, additional seismic surveys are required to map drillable structures adequately.

29. Definition of geological structures will be the main risk. Traps will be small and difficult to map (fault traps, small horsts, stratigraphic traps). A dense seismic grid will be required, i.e. 1 x 1 km or at least 1.5 x 1.5 km. During the surveys great care must be taken to ensure optimum quality of seismic data. In addition, continuous discussion between the geological interpreters and the seismic processing center will be essential. As part of the structural interpretation, a close study should be made of the fluid content of the reservoirs identified in wells drilled so far. This may shed some light on the hydrodynamic regime as there is evidence of local meteoric water encroachment which may have flushed oil out of former accumulations.

30. An attractive geological section with source rocks and reservoirs has been established in the Northern Highlands. Large surface structures have been mapped but reliable subsurface results are particularly difficult to obtain. It is believed that a strong hydrodynamic gradient is present and that meteoric water influx has flushed oil and gas accumulations. It may well be that there is water encroachment, but it is premature to discard the area on this basis, before reliable subsurface information is available. Again, a prerequisite to any further work is the availability of high quality seismic data.

31. As traps may turn out to be of a larger size than in Azraq, the seismic survey grid needed to define them could be somewhat wider (2x2 km to 2.5x2.5 km). The main risk lies in data acquisition. Previous surveys used the dynoseis and vibroseis methods; reflection quality was very poor and did not allow mapping of geological structures. NRA plans to introduce the dynamite seismic methods which should result in better quality data.

32. The sedimentary section in the Risha area is of considerable thickness and could be in excess of 5,000 m. Apart from the uppermost part, nothing is known as regards the nature of the section. NRA at present carries out seismic operations and obtains very good data down to 5,000 meters or more. It is encouraging to note that in the sedimentary section indications of gentle structural features are seen.

33. With regard to the Dead Sea area, while the basic ingredients for the generation of hydrocarbons are present, exploration work would be very difficult, expensive and manpower intensive. Geologically, the area is the

most complex in Jordan due to faulting and the presence of thick salt bodies. Hydrocarbon accumulations are likely to be very small. Therefore, priority for further exploration should be given to the other areas mentioned above.

34. Before undertaking new seismic activities, it is recommended that NRA hire a specialized geophysical consulting firm to supervise, on its behalf, both the acquisition and the processing of the seismic data. This additional expenditure has proved to be highly justified in other countries, resulting in a significant improvement in data quality.

Drilling

35. After the results of the seismic work above are known, it is recommended that NRA make a new attempt to attract the interest of oil companies. If the seismic survey data is of good quality and geological structures are well defined, it is likely that with active promotion of the prospects by NRA, some oil companies would show interest in taking exploration permits. This would not preclude the option of NRA drilling itself if no foreign company is interested in the results, and if the geology justifies it. However, a major problem remains as regards the amount and rate of exploration drilling. Sufficient time should be allowed to ensure that all predrilling work is of a technically high level.

36. As part of the preparation of a model contract various contractual provisions designed to attract foreign oil companies would be considered. Two possibilities immediately suggest themselves as worthy of detailed consideration:

a) The fiscal terms could be designed to keep the state share of profits low until a field has earned a specified minimum return on investment with the state share escalating progressively as profitability increases. This would provide an incentive to develop small fields (up to, say 1,500 barrels/day) while protecting the national interest in the event of an unexpected major discovery (and is an approach increasingly adopted elsewhere where small fields are expected).

b) The NRA could participate with the foreign contractor as a joint venture partner in exploration. This would have the significant advantage over the present system that an experienced operator would be responsible for implementation, NRA would be a full partner in the operating committee and, by sharing the exploration cost, would reduce the financial exposure of the foreign company.

F. Institutional and Contractual Aspects

The Natural Resources Authority (NRA)

37. Established in 1966 and currently under the Prime Minister's Office, NRA is in charge of the assessment of Jordan's mineral, hydrocarbon and water resources. It is only in 1976 (para. 9) that NRA began to focus on oil exploration, which remains a relatively minor part of its overall activities.

38. At present its Department of Petroleum and Energy Affairs has a staff of approximately 20 professionals, of whom not more than 5 have had direct experience with the oil industry, including one foreign adviser with a long relevant experience in his home country. NRA has, and continues to face, serious difficulties in hiring and keeping experienced staff, essentially because its salaries are Government-regulated, and significantly below the scales for technical specialists in the Persian Gulf area.

39. Nevertheless, NRA has ambitious plans to strengthen the Department of Petroleum and Energy Affairs through an accelerated training program, and the recruitment of experienced personnel. It is currently proposed to establish five divisions, as follows:

Group	Duties
1. Exploration	-4-Year Planning -Permanent Reevaluation of Exploration Data -Identification of Exploration Priorities
2. Seismic	-Programming of Seismic Work -Supervision, Execution and Interpretation of Seismic Data
3. Drilling	-Preparation of Drilling Plans -Supervision and/or Execution of Drilling Activities -Preparation of Well Reports
4. Logistics	-Support of 3 Units Above -Procurement Management
5. Energy Studies	-Maintaining Energy Data Base -Assessement and Elaboration of Alternative Energy Programs

40. As mentioned above, the proper establishment of the above units would require the recruitment of a large number of experienced personnel, which would only be possible realistically through a revision of Government salary scales. Consideration is also being given to creating a separate entity in charge of oil exploration and, in the event of a commercial discovery, production. However, until a commercial discovery is made and developed, this entity will also depend on budgetary appropriations so that the present constraints might not be automatically eliminated by following that course of action.

Legal/Contractual Framework

41. Petroleum exploration in Jordan falls under the Law of Natural Resources No. 12 (1968). That law is general in nature, and does not provide a specific framework for oil exploration. As a result, specific terms and conditions of foreign oil company participation have been contained in ad hoc petroleum contracts whose terms have been left largely to the discretion of the oil company.

42. Although Jordan's legislation does not seem to have been an impediment in attracting foreign oil companies, it is recommended that a standard model contract be introduced in which key variables (work and expenditure programs, sharing of benefits) would be left for negotiations. If prepared with appropriate expertise, such a model contract would provide for: (a) a safeguard for Jordan, designed to ensure that the country's interests are adequately protected; (b) an equitable treatment of all foreign oil companies, as they will operate under essentially similar agreements; and (c) a more efficient negotiations process where only key variables would be discussed (Attachments 3 and 4.) In view of the high probability that discoveries in Jordan will be small, the fiscal terms would be designed to act as an incentive to explore for small fields while ensuring that Jordan receives a fair share of profits in the event of a major discovery.

January 1983
(0579P)

JORDAN

ENERGY SECTOR STUDY

Summary of Exploration Wells Drilled

1. Safra-1
6.15.57-12.14.58

Total depth: 2,584 m.

Located on a large surface structure, checked by some seismic.

No shows.

2. Ramallah-1
1.5.58-6.14.58

Total depth: 3,168 m.

Drilled on basis of surface geology with some seismic.

Slight oil and gas shows.

3. Suweileh-1
1.28.59-5.7.59

Total depth: 2,329 m.

Drilled on basis of subsurface geology.
No seismic

Some weak oil and gas shows.

4. Halhul-1

Total depth: 1,833 m.

Large surface structure.

Later deepened to 3,850 m.

No shows.

5. Jordan-Valley-1
5.15.59-6.6.59

Total depth: 1,098 m.

Drilled on basis of surface geology. No seismic.

No shows.

6. El Lizan
5.6.70-7.4.60

Total depth: 3,672 m.

Drilled on basis of gravity and information from shallow boreholes. No seismic.

7. Mar-Saba-1
12.9.64-2.2.65

Total depth: 1,416 m.

Drilled on basis of surface geology. No seismic.

Very slight oil shows.

8. Jericho-1
5.9.65-7.15.65

Total depth: 1,649 m.

Drilled on basis of surface geology. No seismic.

No shows.

9. Wadi Ghadaf-1
9.13.69-4.21.70

Total depth: 3,081 m.

Drilled on basis of surface geology with some seismic.

No shows.

10. Wadi Rajil-1
5.13.70-4.18.71

Total depth: 3,076 m.

Drilled on basis of gravity, magnetics and seismic.

Recovered some oil.

11. Wadi Sirhan-1
5.7.71

Total depth: 1,800 m.

Drilled on basis of geology, magnetics, gravity and some seismic.

No shows.

12. Wadi Hasim-1
12.18.71-3.1.72

Total depth: 2,783 m.

Drilled on the basis of some (poor?) seismic.

No shows.

14. Ramtha-1
1.9.78-4.21.78

Total depth: 2,755 m.

No positive results.

Source: Natural Resources Authority (NRA)
September 1981

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JORDAN

ENERGY SECTOR STUDY

Summary of Hydrocarbon Indicators

A. In Exploration Wells (for location see Appendix 1)

Ramallah-1	Slight oil and gas shows below 450 m.
Suweileh-1	Slight oil shows at 685 m in Jurassic colomites.
Mar Saba-1	Slight oil shows at 610 m.
Wadi Rajil-1	2,448 m - 2,450 m: recovered 450 litres oil water emulsion. 14° API, 3.3% sulphur. 2,644 m - 2,652 m: 100 litres oil water emulsion, 25° API, 1.8% sulphur. Note: The consultant firm Welldrill (UK) carefully analysed the oil indications in Wadi Rajil-1. They reached the conclusion that tests werenot properly run and that a Turonian Limestone/marl sequence could be oil-bearing.

B. Surface Indications

Azraq area	Good source rocks in Lower Tertiary-Upper Cretaceous section.
Northern Highlands	Source rocks described from Lower Tertiary, Upper Cretaceous and Jurassic/Triassic.
Aqaba-Jordan Graben	Abundant live oil seeps, occurrence of tar sands.

Source: Natural Resources Authority (NRA)
September 1981

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JORDAN

ENERGY SECTOR STUDY

Content of Model Contract

The label of the contract is not so important: concession, joint venture, etc. All contracts can be made to equate on questions to control, operating provisions and financial provisions. Key considerations for Jordan in these areas:

(a) on control: provide for full and regular submission of information, due diligence, good oil field practice etc., so that Jordan with consulting help and eventual home-grown expertise has all the materials (information and contractual reference) for reviewing/policing contractor behavior. Active state involvement in operations would be premature; some small participation (post-exploration) may be useful as an effective education device. Contract language should not only protect Jordan against contractor misbehavior but vice-versa, i.e., state rights to intervene, request, etc. should not interfere with good oil field practice.

(b) on operating provisions: provide for phased exploration period with relinquishments; contract award based on part on firmly committed work; emphasis on minimizing time between drilling or promising discovery well and declaration of commercially; Government sole risk provisions for appraisal and/or development of discoveries not declared commercial by oil company. Address question of gas development.

(c) on financial provisions: provide for wide range of potentially viable projects--i.e., only "base" terms applicable to smaller, less profitable discoveries (modest royalty and corporate income tax), with higher rates of Government take applying only to most profitable projects. This "scaling" of Government take would be best if accomplished on the basis of actual profit experience of the contractor, rather than anticipated profitability. Fiscal scaling can alternatively be written into the tax law. Price should equal world market prices in third party transactions. Avoid discounted domestic sales etc. (use of price fiscal mechanism). Gas terms need to be addressed, but need not differ from oil if fiscal scaling carefully structured.

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JORDAN

ENERGY SECTOR STUDY

Petroleum Law

Content of the law: a seperate law for petroleum is desirable to clarify rules applicable to the sector where other laws exist which otherwise may variously apply to petroleum. To minimize delays in its promulgation, provide some room for flexibility in contract format and fit with existing contracts, law should be broad in scope and brief in content. Most of operational and economic details should be written into the contract. Possible provisions of the law:

(a) ownership vested in state;

(b) foreign companies can operate in Jordan under contract from state or in association with Jordanian company approved by the state;

(c) all contracts to be approved by _____;

(d) status of contract (force of law?);

(e) possible contract forms (include but not limited to joint ventures, production sharing agreements, and/or service contracts);

(f) all exploration risk under contracts be borne entirely by foreign or private company signing the contract;

(g) all operations to be carried out in accordance with good oil field practice with appropriate measures to conserve petroleum reserves;

(h) natural gas flaring prohibited without prior authorization of _____;

(i) agreements with foreign companies to include provisions for training of Jordanians; and

(j) application of other laws (in particular of tax laws, which should be so structured as to avoid double taxation of foreign oil companies).

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JORDAN

ENERGY SECTOR STUDY

Utilization of Geothermal Energy at Al-Zarah and Zarqa Ma'in

Draft Terms of Reference for Feasibility Study

JORDAN

ENERGY SECTOR STUDY

Utilization of Geothermal Energy at Al-Zarah and Zarqa Ma'in

Draft Terms of Reference for Feasibility Study

I. General Background

1. Geothermal energy is the internal heat of the earth, and much of this energy is recoverable under currently available technology. Although, geothermal resources can be in the form of hydrothermal, geopressured, or hot dry rock, at present, only the exploitation of hydrothermal resources are viable.

2. Several countries throughout the world are using geothermal energy for generating electricity, space heating, industrial process heat and agricultural and aquacultural applications. Commercial exploitation of liquid dominated hydrothermal resources for electricity generation did not begin until the late 1950's when the New Zealand Government undertook the construction of a large geothermal electric power complex. Currently, worldwide electric power generation from geothermal resources exceeds 2,500 MWe. Fourteen countries currently produce electricity from geothermal energy some of which are the United States (925 MWe), Italy (420 MWe), New Zealand (192 MWe), Japan (168 MWe), and Mexico (150 MWe).

3. In the early 1920's Japan began using geothermal energy for direct heating of greenhouses and currently produces many vegetables and fruits by tapping the heat provided by its geothermal resources. In the 1930's Iceland pioneered the use of geothermal fluids for residential and commercial district heating purposes. The U.S. has heated homes since the early 1900's with geothermal energy. France has 10 operational district heating systems in place and Denmark, Germany, Sweden, Holland, and Austria have similar district heating systems at the planning or construction stages.

II. Existing Geothermal Resources in Jordan

4. In Jordan, geothermal resources are known to exist in the form of hot springs at Al-Zarah and Zarqa Ma'in, about 10 km from the northern end of the Dead Sea. The surface temperature is about 45°C at Al-Zarah and 63°C at Zarqa Ma'in. The combined hourly discharge of these springs into the Dead Sea is estimated to be in the neighborhood of 2,000 m^3.

III. Need for a Study

5. A study is recommended to assess the potential and possible applications for the geothermal springs. The ultimate objective of this study is to prepare detailed engineering design and site plans, to build a viable system for extracting and utilizing geothermal energy from the springs at Al-Zarah and Zarqa Ma'in. In order to realize this objective, the study would be conducted in three phases. Part A would involve the assessment of the size and quality of the resource. If the results of this phase indicate that the commercial exploitation of the resources is feasible, approval would be given to commence Part B of the study. In Part B, energy supply and demand assessments will be made and several optimal and near-optimal energy utilization plans will be recommended. Once one particular plan has been approved by the client, authorization will be given to commence Part C of the study. Preparation of detailed engineering drawings and site plans and collection of other information needed to construct the energy extraction and utilization system will take place in Part C of this study. A more detailed description of the objectives of Parts A, B, and C is given below.

6. Part A - Resource Assessment/Verification. This activity will verify the size of the reservoir, the well flow rates, and the thermal and chemical characteristics of the fluid from the wells. These will be used to determine the quantity and quality of the energy that can be reliably supplied over an acceptable period of time (10 to 20 years). It will also recommend possible methods of reservoir output enhancement and their associated costs.

7. Part B: Optimal strategy for exploitation of energy:

(a) Demand Assessment: This activity will determine the projected energy demand which could potentially utilize geothermal energy. For each of the anticipated uses load curves will be developed; if the anticipated uses are linked to structures (e.g. space heating of buildings, heating of greenhouses), then provision would be made to appropriate passive solar techniques wherever applicable. In addition, for each case, capital costs, operating and maintenance costs, quality of energy required, total extent of each end-use application and its importance to the community, trends in each end-use application, and other relevant data will be determined;

(b) Optimal Mix of Potential Uses: Based on the facility load curves, and other relevant data, several practical geothermal energy utilization scenarios will be developed. Each scenario will be characterized by aggregate load curves, energy demand growth/reduction projections, total capital, and operating and maintenance costs and other data needed to adequately assess the technical and economic viability of the project;

(c) Assessment of Environmental Impacts: For the geothermal energy output levels identified in the Resource Assessment/Verification activity, an environmental impact assessment will be made. This activity will assess the potential for, and the magnitude of environmental problems such as subsidence, seismicity, aquifer contamination, and air pollution associated with geothermal energy use. It will outline procedures for, and costs of controlling these problems; and

(d) Selection of Resource Utilization Plans: This activity will select several optimal (and near-optimal) mixes of facilities and end-uses that can be served by the springs at Al-Zarah and Zarqa Ma'in. The plans should encompass the consideration of hybrid systems as well as any other system configuration (e.g., combination of electricity generation and direct heat application, cascading usage of geothermal energy, etc.). The resource utilization plans will be characterized by: rate of return on investment, payback period, social preferences, total capital and operating and maintenance costs, types of facilities served, extent and need for conventional sources of energy, environmental impact, schematic diagram of geothermal energy extraction and use facilities and other relevant data required to select the utilization plan that is to be implementated.

8. Part C - Preparation of Engineering Design and Specification. After the client has approved a resource utilization plan all the necessary drawings, site plans and specifications required for constructing the energy production and utilization system will be prepared.

9. The consultants will cooperate with a steering group to be established in Jordan, composed of representatives from relevant agencies. The steering group will also provide assistance to the consultants in areas such as identifying sources of information, securing data, travel planning, scheduling meetings, obtaining visas, etc.

IV. Statement of Work

10. As mentioned earlier, the proposed study will be conducted in three parts. Part A will be focused on the assessment/verification of the geothermal resource. In Part B, an assessment of the energy demand characteristics of potential geothermal energy users will be undertaken. Engineering/economic evaluation of a small number of attractive systems configurations will be conducted. The client will select one system configuration for which detailed engineering and construction plans will then be developed in Part C of this study. A description of the activities likely to be needed in each part is presented below.

11. Part A - Resource Assessment. In this task the consultants will carry out an assessment of the resource in terms of its thermal energy production capacity and the characteristics of the fluid. The output of this task will be in the form of definitive statements, concerning the reservoir size, fluid temperature, wellhead pressure, fluid flow rate, fluid chemistry, well depths, sustainability of fluid production at the existing wells, potential for decline of temperature and/or pressure, and any other resource characteristics having an impact on lifetime, capital investment, operating and maintenance costs, and cost of energy estimates for the associated energy utilization systems.

12. The resource assessment will be based on the available geological, geophysical, geochemical, and fluid flow rate data for the two existing geothermal springs. It is anticipated that no significant well flow testing and geochemical/geophysical measurements will be necessary during this phase of the study. The contractor will be expected to suggest actions, such as enlargement of spring bases, installation of surface or downwell pumps for increasing well flow rate, fluid reinjection practices, and other geothermal reservoir management practices which could potentially increase the economically useful energy yield of the resource statements concerning the total energy output, rate of energy output, and the thermal and chemical characteristics of the fluid extractable from different reservoirs should be provided by the contractor at the end of this phase. This phase of the study should yield data which can be utilized for developing a reservoir/resource management plan to be incorporated into the overall energy utilization system to be adopted for detailed design in the final phase of this study.

13. Parts B and C of this study will be undertaken when the client has approved the Part A results. Approval will be given if the resource is found to be adequate for supplying significant amounts of energy for a reasonably long life span (10 to 20 years).

14. Part B - Evaluation of the Options for the Utilization of Geothermal Energy. In this phase of the study the contractor will:

(a) Review various end uses (thermal and/or electrical) which can be supported by the geothermal energy resource. This review will yield data such as:

(i) Demand growth/reduction projections;

(ii) Peak demand for individual end uses; and

(iii) Diurnal, hourly, and seasonal load analysis and yearly demand profile for individual uses.

(b) Match the resource with the demand to determine the optimal resource utilization strategy. Wherever appropriate, possible energy conservation measures and passive solar techniques in existing and planned energy using facilities, processes and systems will be considered in developing an optimal end use mix. Addition of potential new uses of geothermal energy (e.g., food processing, soil warming, crop drying, etc.) to the list of existing potential uses will be one of the options for maximizing the beneficial utilization of geothermal energy from the existing springs. Reservoir management techniques, such as periodic capping of the wells and flow variations will be incorporated into the process of optimizing the utilization of the geothermal resource.

(c) Develop configurations (schematic diagrams) for geothermal energy use systems representing efficient and economic utilization of the resource.

(i) Assess the environmental impact of the project, with special emphasis on the disposal of the spent brine. Carry out a preliminary assessment of the alternatives for alleviating the adverse environmental impact (including cost estimates);

(ii) Conduct engineering/cost studies to confirm the cost competitiveness of the proposed end use-mixes. Develop cost estimates of the proposed energy utilization projects, and estimate the payback periods with a specified rate of return on the investment for various system configuration. Rank various end-use mixes on the basis of their potential economic and other benefits and costs to the investors in the associated projects; and

(iii) Assess the sociological impacts of different high ranking end-use mixes and the related projects. Estimates of employment opportunities during the construction phases of different projects, as well as the estimated socio-economic impact on potential users of geothermal energy (new facilities, industries, etc.) and on the population near or at Al-Zarah and Zarqa Ma'in.

15. The focus of Part B will be on the available resource and the potential uses described above, respectively.

16. The contractor will prepare a list of end-use mixes ranked on the basis of their net economic benefit. The contractor will ensure that the candidate projects (end-use mixes and associated systems configurations) do not have unacceptable environmental and socio-economic impacts on the local population. A report documenting the basis for recommending the high ranking projects will be submitted to the client at the end of this phase. The client will select one of the high ranking system configurations for the preparation of detailed engineering and cost specifications in Part C of this study.

17. Part C - Development of Detailed Engineering/Cost Specifications. In this phase, the contractor will undertake the following activities relevant to the geothermal energy use plan selected by the Government.

(a) Develop detailed engineering design for the geothermal energy extraction and utilization system selected for construction. This design activity will cover the geothermal energy resource extraction, any other energy resource extraction and conversion (in case the selected option involves hybrid energy systems), and wherever applicable, passive solar and energy conservation elements which may be integrated into the proposed systems. The engineering specifications developed by the contractor should be in a detail sufficient for a precise determination of the project costs and the preparation of tender documents for the project. These plans will also be used for actual project construction; and

(b) Specify system performance pasrameters which the selected system should match when put into operation.

V. Reports and documentation:

Part A:

18. A report providing data concerning the thermal, geological, geophysical, and geochemical characteristics of the hydrothermal energy resources located at Al-Zarah and Zarqa Ma'in would be required after the completion of Part A. Empirical data/estimates concerning the known hydrothermal reservoirs and existing wells should be included in this document. This report should contain enough information about reservoir size, spring flow rates, sustainability of fluid production, estimated temperature and spring flow rate decline and other resource parameters which determine the technical and economic feasibility of exploiting the geothermal resource for meeting some of the energy needs of the population and industry located in the vicinity of these resources. This report should contain specific recommendations concerning the levels of geothermal energy that can be reliably and economically extracted from the reservoir over a 10 to 20 year life span.

Part B

19. The report will detail several optimal (and near-optimal) resource utilization plans. Complete information on each plan should be provided to enable the client to select one of the high ranking system configurations for the preparation of detailed engineering specifications in Part C of the study.

Part C

20. A report which could be converted into project specification for the purpose of inviting tenders for the construction of the selected system. The contractor will prepare detailed engineering drawings and specifications for the system selected by the client.

VI. Consultant Staff Required for Study

21. It is estimated that about 2 man-months of technical consultant effort would be required for Part A of this study. The technical effort for Part B and Part C is estimated at about 10 and 9-12 man-months, respectively.

22. It is expected that the preparation of the feasibility report will require personnel with experience in the following specialties:

(a) Geology/Geophysics/Geochemistry with emphasis in:

(i) Geology and geophysics of geothermal formations, and geochemistry of hydrothermal brines;

(ii) Interpretation of geophysical, geochemical and geological data concerning hydrothermal resources for estimating the size of the reservoir and production potential of the wells; and

(iii) Reservoir engineering techniques and models necessary for optimizing the utilization of the thermal energy content of the reservoir;

(b) Economics/Operations Research with emphasis in:

(i) Computer modeling of the cost/performance of energy utilization systems;

(ii) Optimization of the design and functioning of energy conversion/utilization plant. Experience in the application of operations research and economic modeling techniques in the area of energy cost estimation would be required.

(iii) Assessment of the impacts of new energy facilities on population, employment, need for social services, etc.

(c) Civil, Mechanical and Electrical Engineering with likely emphasis in:

(i) Residential and industrial HVAC designs;

(ii) Energy conservation systems design and evaluation;

(iii) Passive solar techniques;

(iv) Thermal energy transport systems design;

(v) Electrical systems design;

(vi) Plant component cost estimation;

(vii) Techniques for determining the energy load for different processes/facilities;

(viii) Design of geothermal energy extraction and utilization plants as well as other conventional energy systems;

(ix) Modeling of the performance characteristics of electrical and thermal energy utilization/conversion systems; and

(x) Computation/modeling of the aggregate energy requirements of different scenarios.

(d) Environmental Assessment with emphasis in:

(i) Environmental impact of energy extraction, conversion and utilization projects involving geothermal and conventional energy technologies;

(ii) Assessment and control of the environmental impact of the handling and disposal of geothermal fluids and other impacts; and

(iii) Control technologies for minimizing the multimedia impacts of the development and operation of projects involving geothermal energy.

(e) Agricultural/Food Engineering with emphasis in:

(i) The designs and energy requirements of agricultural processes requiring low temperature energy;(e.g. crop drying, greenhouse heating),

(ii) Modeling of the energy utilization system performance in the agriculture sector.

VII. Study Schedule

23. Part A should be completed eight weeks after the start of the project. A report will be due at the end of Part A.

24. Part B will commence once approval for starting it has been given. The period of performance will be 20 weeks. A report will be due at the end of Part B.

25. Once a system has been selected, Part C activities will begin. The period of performance is expected to be 10 weeks. A report is due at the end of Part C.

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JORDAN

ENERGY SECTOR STUDY

Renewable Energy

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ENERGY SECTOR STUDY

Renewable Energy

A. Resources

1. Solar Energy: Solar energy constitutes the major renewable energy resource in Jordan. The average daily global radiation is estimated to equal about 1,700 Btu/ft^2; this is slightly lower than the highest intensity (about 1,800 Btu/ft^2/day) recorded anywhere in the world. The direct component of the radiation in Jordan is also believed to be fairly high. Consequently, Jordan offers an excellent solar regime for deploying photovoltaic as well as low-to-high temperature solar thermal systems.

2. Wind Energy: Wind energy is not as abundant as solar energy. Jordan is characterized by a low-to-medium wind regime with the average wind speed ranging from 8-11 m.p.h. In coastal areas, the wind speed could reach as high as 13 m.p.h. The wind regime, therefore, is suitable essentially for water pumping and, to a limited extent, for electricity generation.

3. Biomass: Relatively little information is available on biomass resources in Jordan. However, it is believed to be minimal and pertains mainly to crop residues and animal waste. The crop residues are generally used for animal roughage and most of the animal waste is not collectible.

B. On-going Activities in Renewable Energy

4. Like in most developing countries, the renewable energy program is mostly in its formative stage. Most of the research and development (R&D) work is concentrated at the Royal Scientific Society (RSS) in Amman which serves as the lead center in the renewable energy field. During the past few years, the RSS has undertaken R & D work in the areas of solar radiation measurements, solar water heating, solar desalination, and passive systems. The main demonstration system is located at Aqaba and was established through assistance provided under the West German bilateral program. It is a solar-assisted desalination system which employs heat pipe collectors and desalinates on an average about 50 gallons/day of sea water. The system has been operational for about 5 years and has served as a valuable research tool for the Jordanian scientists. The West German Government has also expressed interest in establishing a 100-200 kW distributed receiver solar thermal power plant for generating electricity; the waste heat from the power plant could be used for desalinating sea or brackish water.

5. A potash project is also operating which utilizes both the brine reserves of the Dead Sea and solar energy to recover about 1.2 million tons per year of potash and other by-products. Three evaporation plants covering a total area of 76 km^2 have been constructed. The Dead Sea water is pumped into these ponds where the brine concentration and salt precipitation take place. The total amount of solar energy utilized in this process is estimated at about 1/8 quad per year.

6. Eighty-eight photovoltaic powered units have also been installed to operate radio telephone systems in rural and remote desert locations. These units were acquired by direct purchase from the USA. The units are providing a reliable and cost-effective source of communication for a very special application. The possibility for further expansion of this effort should be considered..

7. The only commercial activity in the renewable energy field relates to solar water heating. Jordan has a relatively well developed industry in this field, and the use of solar water heating systems for providing domestic hot water, and in a few cases, space heating needs, has steadily increased in the past few years. Currently, over 20 manufacturers are producing hot water systems in the country. The industry has a capital outlay of about US$2.0 million, employs over 100 technicians and has an annual production capacity of about one million square feet of collector area (equivalent to about 28,000 household units). However, the quality and reliability of its output need to be improved. Moreover, the development of the water collectors, which is currently limited to providing domestic hot water, could be extended to meeting space heating requirements in the residential sector as well as in commercial and institutional buildings. Solar collectors could also be utilized in the industrial sector to meet low temperature process heat requirements as retrofitted preheaters to existing conventional fuel-fired systems. Finally, the possibility of exporting collectors to the Gulf States, where increasing attention is being paid to solar energy applications, deserves active consideration.

8. On-going activities in renewable energy consist of a set of separate projects which were undertaken on an individual basis without being closely coordinated with one another. As a result, they lack coherence and do not represent an optimal plan of action whereby priorities would be established for the implementation of various technologies with regard to Jordan's specific energy requirements. Although RSS has access to excellent data processing equipment, to adequate laboratory facilities, and to a competent staff to operate them, its research and development effort remains limited in scope, mainly because of insufficient funding, and lacks a mission-oriented approach. There is however a potential for better utilization of RSS resources.

C. Proposed Plan of Action

9. An overall plan of action should be developed to adapt various renewable energy technologies, especially those relating to solar energy. The plan would involve four main tasks: a) assess Jordan's renewable energy resources in detail; b) undertake a planning study to establish priorities for the various renewable energy technologies which are most relevant to Jordan's energy needs; c) implement immediately a number of R & D and commercialization projects which have already been identified; and d) initiate additional projects in light of the findings of the aforementioned planning study.

a) Resource Assessment: An accurate assessment of Jordan's endowment with renewable energy resources is of fundamental importance in the planning and implementation of a meaningful renewable energy program. However, the present information on renewable energy resources falls far short of this goal. The actual measured data on solar insolation are available from only two stations. Wind speeds and direction are monitored throughout the country by meteorological stations but in conformity with the World Meteorological Organization (WMO) standards and as such have limited usefulness for wind energy applications. Finally, the data relevant to biomass and small hydro resources are minimal. Given the apparent significance of solar energy, the resource assessment program should place major emphasis on the development of a network for monitoring solar insolation in the country. The wind resource assessment should be accorded second priority, and limited attention be focussed on assessing the biomass and small hydro resources. The assessment would take about 3 years, of which 8 months would be devoted to the installation of solar and wind measuring sensors, as well as to the assessment of biomass and small hydro resources. Total cost is estimated at about US$130,000 (foreign US$105,00; local US$25,000).

b) Planning Study: The study would assess the potential of various renewable energy technologies, such as solar water heating, solar ponds, wind energy conversion systems, and set priorities for their application in Jordan. It would also identify, for the most viable ones, a strategy for research and development, demonstration and commercialization; related funding requirements and institutional framework; and a mode of interaction with various national and international agencies. The study is expected to take about 7 months, at a cost of about US$170,000 (foreign US$135,000; local US$35,000).

c) A number of renewable energy projects have already been identified as a complement to those currently underway at RSS, and could be implemented immediately:

(i) Testing facility for testing and standardization of solar water collectors: an indoor/outdoor testing facility should be built at RSS which would be used to test, standardize and certify the collectors. Through this facility, RSS will provide technical assistance to local collector manufacturers to ensure that their products maintain a technical and economic competitive edge, both in national and international markets. The facility would also be used to certify the products of various manufacturers in accordance with internationally accepted standards.

(ii) Solar Greenhouses: In Jordan the use of greenhouses has increased from 50 acres in 1970 to over 1,500 acres in 1980. However, conventionally designed greenhouses are characterized by excessive heating loads in winter and quite often high cooling loads in summer. A project is recommended to be undertaken which would develop inexpensive retrofitting systems to reduce heating/cooling needs of existing greenhouses. The project would also develop prototype passive greenhouses which would have a substantially reduced capital cost coupled with a corresponding reduction in recurring energy bills. Finally, the project would aim at developing ways and means for providing temporary protection to field grown vegetables during colder winter days by using principles of solar greenhouses.

(iii) Solar Air Collectors: Solar air collectors can be produced quite inexpensively and used to meet space heating needs. A project focusing on the development of inexpensive and efficient solar air collectors geared primarily for space heating needs is recommended to be undertaken. The collector design could be further simplified to meet the on-farm crop drying needs.

(iv) Solar Space Heating: A solar house serving essentially as a solar laboratory to test different air and water heating systems is recommended to be built at RSS. The data gathered from the solar house would be used with support from computer simulation to predict the output of various systems as well as their economics for operation in different parts of the country.

(v) Solar Water Heating Demonstration Projects: It is recommended that the use of solar water collectors be demonstrated in a hotel, a school, a hospital and an industrial building. Typically about 500-1,000 ft^2 of collectors could be used for each installation to provide partial hot water or industrial process heat requirements. The system should be instrumented and monitored so as to yield information which would assist in predicting the output and economics of similar systems in different parts of the country for varying applications.

(vi) Demonstration of Active and Passive Space Heating (and Cooling) Projects: It is recommended that the use of active space heating systems (employing water and air collectors) be demonstrated in a hotel, a hospital, a school and an industrial building to provide their partial heating loads. Additionally, a number of buildings would be chosen to demonstrate the retrofitting energy conservation technologies. Finally, a few of the buildings, which are currently in the planning stages, would be chosen to incorporate energy efficient passive designs to serve as models for future buildings.

(vii) Solar-Assisted Desalination System: A 10 or 50 m^3/day multi-effect evaporation system using solar pond or a solar collector array should be considered for desalinating sea or brackish water at a suitable isolated site. The economics of such systems especially when they operate in conjunction with solar ponds is competitive with fuel-fired systems.

(viii) Photovoltaic/Wind/Solar Thermal Electric Conversion System: It is recommended that at a suitable site (probably Aqaba) a 2-5 kW hybrid photovoltaic/wind water pumping system be installed. Also at RSS an 8 kW parabolic dish with a prime mover and generator is suggested to be installed. The systems should be used primarily for research purposes.

The projects listed in this section are generally of an (adaptive) research, development and demonstration nature. Given the evolving and site specific nature of solar energy technologies, such preparatory projects are almost invariably needed before large-scale projects can be embarked upon. The estimated cost of these projects for a 3-year period is US$2.5 million, of which about 70% will be needed in foreign exchange. The total completion time for the projects will be around 15-18 months. Since several bilateral assistance programs (U.S., French, German) have an interest in funding such preparatory projects, it may be advisable to seek part of the funding from them.

d) The completion of the above-mentioned planning study is expected to identify a number of large-scale projects requiring larger funding levels. It is expected that several of the projects listed under (c) would form the basis for these larger projects.

10. The type of projects that may result from the Planning Study could include:

(i) plans for solar pond development in Jordan leading possibly to a major facility at the Dead Sea at some future date;

(ii) establishment of a line of credit to support consumers and manufacturers of solar water heaters;

(iii) usage of solar greenhouses (retrofitted and/or new installations) to grow vegetables in cold/hot weather;

(iv) provision of fresh water from the existing potash works in Jordan by using inexpensive retrofitted systems (which will embody the principles of solar distillation). Theoretically speaking, upto about 15 million gallons/day of fresh water could be obtained for a cost of under US50 cents per thousand gallons;

(v) extension of the existing photovoltaic systems for remote-site applications;

(vi) technical assistance for design and installation of energy efficient buildings, etc.

The total cost of the various projects resulting from the Planning Study cannot be estimated at this point. However, projects well in excess of US$10 million can be expected to be identified.

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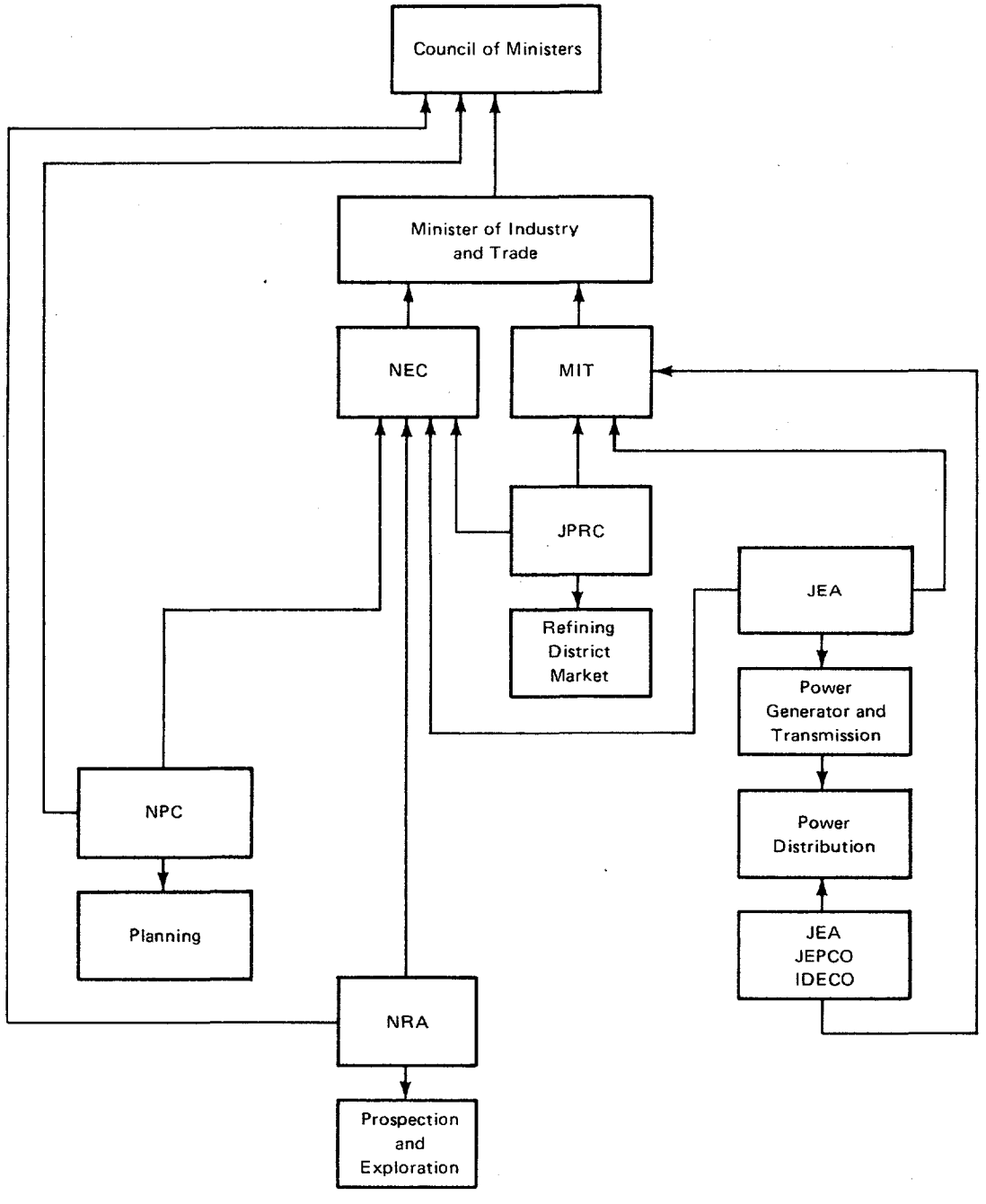
ENERGY SECTOR STUDY
Present Sector Organization



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JORDAN

ENERGY SECTOR STUDY

Historical Trends in the Consumption and Supply of Energy

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ENERGY SECTOR STUDY

Historical Trends in the Consumption and Supply of Energy

A. Consumption of Energy

Overall Consumption

1. Per capita consumption of energy increased at an average annual rate of about 16.5% for the period 1975-1981; from 471 kgoe in 1975 to 930 kgoe in 1981 (Attachment 1). In 1979, the per capita consumption of energy was 753 kgoe compared with 925 kgoe for the oil-importing middle-income countries and 5,261 kgoe for the industrial market economies. 1/, 2/ The growth in energy consumption during the period 1975-1981 averaged about 16.5% a year compared to an average annual rate of GNP growth of 12.3% a year; resulting in a coefficient of energy consumption to the GNP of about 1.3. 3/, 4/ Over the same period, the intensity by which energy was consumed increased at an average annual rate of about 4%; from 2.5 toe/1000 JD in 1975 to 3.1 toe/1000 JD in 1981. Table 6.1 summarizes the development of energy consumption and real GNP in Jordan since 1975.

Table 6.1

Consumption of Energy and Electricity, 1975-1981

Year	Total Energy Consumption ('000 Toe)	Electricity Consumption (GWh)	GNP JD Million (Const. Prices)	Energy Intensity (T/1000 JD)	Elec.Energy Intensity (kWh/1000 JD)
1975	853	356	343	2.49	1,038
1976	1,076	435	472	2.28	922
1977	1,214	513	487	2.49	1,053
1978	1,437	596	512	2.81	1,164
1979	1,620	723	561	2.89	1,289
1980	1,830	877	622	2.94	1,410
1981	2,130	1,028	687	3.10	1,496

1/ World Bank, World Development Report 1981, August 1981, pp 146-147.
2/ Data on the energy consumption of other countries was only available for 1979.
3/ The GNP is a better measure of the determinants of demand for energy than the GDP because of workers remittances which account for a relatively high proportion of the GNP; e.g., 25% in 1980.
4/ The coefficient of energy consumption to GNP is defined as the ratio of the growth rates of energy consumption and GNP.

2. The high rate of growth of energy consumption during the past six years was primarily due to: the increased access of the households, commerce and small industries to publicly supplied electricity; the initiation or expansion of relatively large energy intensive industries such as cement, phosphate, etc.; the increased remittances of the Jordanian workers which stimulated a higher demand for energy than would have otherwise prevailed; and the growth of the transportation sector particularly the road and air transport.

Petroleum Products

3. Overall: Consumption of petroleum products increased at an average annual rate of about 14.6% over the period 1970-1981. Among the products consumed, aviation fuel had the highest rate of growth (22.6%), followed by gas oil/diesel (17.1%), LPG (15.7%), fuel oil (15.4%), gasoline (10.5%), and kerosene (6.8%) (Attachment 2).

Table 6.2

Growth of Consumption of Petroleum Products, 1970-1981

	1970-1981	1970-1975	1975-1981
Aviation Fuel	22.6%	20.6%	24.7%
Gas Oil/Diesel	17.1%	15.6%	18.3%
LPG	15.7%	13.2%	17.8%
Kerosene	6.8%	9.8%	4.5%
Fuel Oil	15.4%	9.2%	20.8%
Gasoline	10.5%	10.9%	10.3%
Overall	14.6%	11.7%	17.0%

4. Aviation Fuel: Consumption of aviation fuel increased at an average annual rate of about 21% during the period 1970-1975 and 25% during 1975-1981. The acceleration of growth in the second period was largely due to the increased air travel of workers between Jordan and the Gulf states and Saudi Arabia; and the expansion of Alia's service routes to Europe and the USA.

5. Gas Oil/Diesel: The consumption of gas oil/diesel for the period 1970-1975 increased at an average annual rate of about 16% compared to 18% for 1975-1981. The higher rate of growth over the last six years was mainly attributed to: the increased activity in the commercial trucking subsector involving the transportation of goods and equipment to the Gulf states and Saudi Arabia; the civil unrest in Lebanon which increased the dependence of the area on the port of Aqaba; and the use by the power subsector of combustion turbines to meet the base load between 1976 and 1979 prior to the completion of the Hussein steam power plant.

6. LPG: The consumption of LPG between 1970-1975 increased at an average annual rate of about 13.2% compared to 17.8% for the period 1975-1981. The accelerated growth in the consumption of LPG over the past six years was due to its increased substitution for kerosene mainly in the urban areas.

7. Kerosene: The average annual rate of growth of kerosene consumption decreased from about 10% for the period 1970-1975 to about 4.5% for 1975-1981; principally because of the increased use of LPG for household purposes, and the shift to electricity for lighting in the villages connected to the national grid.

8. Fuel Oil: The consumption of fuel oil increased at an average annual rate of about 9.2% for 1970-1975 compared to 20.8% for 1975-1981. The doubling of the growth rate over the past five years is attributed to the increased consumption of electricity by industry, and the increased consumption of the product by the industrial sector (cement, phosphate, construction materials, etc.).

9. Gasoline: The average annual rate of growth in the consumption of gasoline has remained fairly stable over the past 11 years (10.9% for 1970-1975 and 10.3% for 1975-1981), principally because of the increase in its price. The domestic price of gasoline doubled in real terms between 1975-1981, which induced greater conservation in the use of the product.

Consumption of Petroleum Products by Sector:

10. In 1980, the transportation sector accounted for about 48 % of all the petroleum products consumed in Jordan. Of the products consumed by the transportation sector, 42% was in the form of gas oil/diesel, 31% in gasoline, 24% in aviation fuel, and the remaining 3% in fuel oil. The power subsector consumed about 17% of all petroleum products mainly in the form of fuel oil (77%), and to a much lesser degree, gas oil/diesel (23%). Table 6.4 summarizes the sectoral distribution of the petroleum products consumed in 1980, and the percentage consumed of the main fuels (gas oil/diesel and fuel oil). Details are presented in Attachment 3.

Table 6.3

Sectoral Distribution of Petroleum Products Consumed in 1980

Sector	Percentage of Total Products Consumed	Percentage of Total Gas Oil Consumed	Percentage of Total Fuel Oil Consumed
Transport	48	73	4
Electricity	17	13	50
Industry	13	7	42
Domestic	15	5	-
Other	7	2	4

Industry accounted for 13% of the petroleum products consumed principally in the form of fuel oil (79%). Domestic consumers accounted for an additional 15% of the total petroleum products, mainly in the form of kerosene (62%), LPG (20%), and relatively small quantities of gas oil (10%) and fuel oil (8%).

Electricity:

11. Overall: The consumption of electricity increased at an average annual rate of about 16% between 1970 and 1981. This relatively high rate of growth is attributed to the growth of electricity sales between 1975-1981 which averaged about 19% compared to 12% for 1970-1975. Electricity consumption increased at an average annual rate of about 19.4% during the period 1975-1981 compared to a real growth in the GNP of about 12.3%; resulting in a coefficient of electricity consumption to GNP of about 1.6. Consumption of electricity per unit of GNP has also increased from 1,038 kWh/1000 JD in 1975 to 1,496 kWh/1000 JD in 1981.

12. The rate of growth of electricity consumption over the past six years has been high principally because of: the commissioning of several large energy consuming industries (ceramics, steel pipes, etc); the expansion of some of the existing energy-intensive industries (cement, phosphate, refining, etc.); and the increase in the proportion of the population with access to publicly supplied electricity, from 39% in 1975 to 67% in 1980.

13. Bulk Sales: Prior to 1977, JEPCO and IDECO generated their own electricity for distribution at the medium and low voltage levels. In addition, the large industrial consumers such as the refinery, the cement,

etc, met their demand for electricity by operating small generating units (Attachment 4). 1/ However, since 1977 JEA started to take over practically all the public supply of electricity in Jordan. Between 1975 and 1981, JEA's electricity sales at the high voltage level increased at an average annual rate of about 65%; from 44 GWh in 1975 to 878 GWh in 1981.

14. Retail Sales: During the period 1975-1981, electricity sales at the medium and low voltage level were divided among JEA, JEPCO and IDECO. Over this period, sales increased at an average annual rate of about 24%, from 236 GWh in 1975 to 855 in 1981. The growth of sales by customer classes is summarized in Table 6.4 below.

Table 6.4

Growth of Electricity Sales by Customer Class between 1975-1980 (%)

	JEA	JEPCO	IDECO
JEPCO	21	-	-
IDECO	27	-	-
Industry	285 /1	18	27
Domestic	42	27	28
Commercial	-	18	38
Others /2	-	15	20

/1 Covers only 1979 to 1980 because prior to 1979, all of JEA's bulk sales were purchased by JEPCO and IDECO.

/2 Includes streetlighting, hospitals and public institutions.

15. The share of the various consumer classes of the total publicly supplied electricity in Jordan changed significantly between 1975 and 1980. The share of domestic consumers changed from 26% of total sales in 1975 to about 35% in 1980, the commercial consumers' share increased from 11% to 14% and the share of industry decreased from 46% to 36%. In 1980, JEPCO accounted for 80% of total electricity sales in Jordan, IDECO accounted for 8% and JEA for the remaining 12%. However, JEA generated about 99% of all the publicly supplied electricity, and IDECO the remaining 1%.

1/ In 1975, 407 GWh were generated in Jordan of which 212 GWh were generated by JEPCO, 30 GWh by IDECO, 45 GWh by JEA and 120 GWh by autoproducers.

B. Supply of Energy

Petroleum Products

16. Refining: Jordan continues to be totally dependent on imported crude oil for meeting its needs of commercial energy. Its supply of crude oil is taken from the Trans-Arabian pipeline (Tapline) which was constructed to transport Saudi Arabian Crude (34.5° API) across Jordan into Lebanon for export from the Mediterranean port of Saida. The Tapline has a capacity of about 450 thousand b/d (20 million tons/year); however, after the 1967 Middle East war and the closure of the Suez canal, Saudi Arabia shifted to the use of large tankers for the export of its crude. Consequently, the Tapline is currently being used only to supply the needs of Lebanon and Jordan. Virtually all the petroleum products consumed are produced domestically at the refinery operated by JPRC. The refinery is at Zarqa 35 km northeast of Amman and 43 km from the Tapline. Crude oil is transported from the Tapline to the refinery by two pipelines (8" and 12") specifically constructed for that purpose. The refinery started its operations in 1960 with a throughput capacity of 1,000 t/day of crude oil. By 1981, the capacity reached 13,000 t/day after three expansions: the first in 1970, the second in 1973 and the third in 1976. 1/ At present, the refinery is equipped to meet the projected demand for petroleum products until 1987. Thereafter, the Government would have to decide whether to expand the primary refining capacity at Zarqa, install secondary conversion facilities again at Zarqa, or construct a new refinery elsewhere. The decision would depend to a large extent on: a) the size and location of industries and power plants included in the development plans (Annex 7, para 12); and b) the ability of the Government to slow down the growth of demand for petroleum products and electricity by initiating a program for investment in conservation (Annex 10, Attachment 3). A study for the optimal development of the petroleum subsector should be commissioned for determining the likely forecast of demand for petroleum products and the most economic and efficient means of meeting that demand. Details of the elements of the proposed study are outlined in Annex 7, Attachment 11.

17. Distribution and Marketing: The refinery's output of gasoline, kerosene, aviation fuel, and gas oil are transported and distributed throughout Jordan by tanker trucks owned and operated by JPRC. Fuel oil is transported by the consumers, and LPG is transported and marketed by the retail distributors. At present, the transportation and distribution of petroleum products is totally dependent on the use of tanker trucks which use gas oil/diesel to transport fuel oil, a lower value product. There is need for Jordan to consider the formulation of an optimal plan for the

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1/ At present, the refinery is equipped with the following: i) 3 crude oil units of total capacity 12,000 t/day; ii) a distillate hydrotreater; iii) a light gas oil unifiner; iv) a kerosene merox; v) a fluid catalytic cracker (FCC) of capacity 600 t/day; vi) a platformer; vii) a hydrocracker of capacity 600 t/day; viii) two vacuum units; and ix) an asphalt unit.

transportation, storage and distribution of petroleum products (Annex 10, Attachment 4). These aspects should be dealt with in the study for the development of the petroleum subsector referred to in para 16.

Electricity

18. Generation: The installed capacity for public supply of electricity has increased significantly between 1975-1981. In 1975, the power subsector was essentially a group of isolated systems which were operated by JEPCO in and around Amman, IDECO in the Governorate of Irbid, some large municipalities (Aqaba, Karak, etc.) and JEA supplementing JEPCO's production in Amman. The main constraint to the growth of electricity consumption at the time was the shortage of generating capacity. For example, in JEPCO's service area, the maximum demand in 1975 was 65 MW compared with 52 MW of firm capacity which resulted in the continuous occurrence of supply interruptions. In 1976, JEA started, as a part of the 1976-1980 five-year plan, to gradually acquire and upgrade the generating capacities in the major load centers. By 1981, the peak demand in the interconnected system was 200 MW compared to an installed capacity of about 388 MW (Attachment 4), leaving a reserve margin of about 116 MW or about 30% of the installed capacity. 1/ However, this margin is expected to decrease between 1982 and 1986 to reach about 90 MW in 1985, and increase thereafter when the first phase of the Aqaba steam power plant is commissioned in 1986 (Annex 7, para 16). The projected decline in the reserve margin underscores the need for Jordan to place greater importance on its interconnection with Syria to ensure that the likelihood of supply interruptions in the future is kept to a minimum (Annex 10, Attachment 3).

19. Transmission: Since taking over the responsibility for generation in 1976, JEA has interconnected the main load centers to form what would eventually become the interconnected national grid. At present, Amman, Irbid, Balqa, Jordan Valley and Karak are connected by about 1,000 km transmission lines (132 kV and 33 kV). In 1977, the Jordanian national grid was interconnected with the national transmission grid of Syria by a 17 km transmission link (66 kV) which was reinforced in 1980 by another line (230 kV). By 1983, JEA intends to connect the Southern part of Jordan, covering the Governorate of Maan, including the city of Aqaba, with a transmission line at 132 kV (Map No. 16299). In addition, by 1986, Aqaba and Amman would be connected by a 400 kV line to evacuate the power from the new Aqaba power plant and deliver it to the main load center at and around Amman (Annex 7, para. 17).

20. Distribution: Since 1975, all three utilities JEA, JEPCO and IDECO have been expanding their medium and low voltage distribution network to keep up with the increased demand in both the urban and rural areas. However, losses continue to be high reflecting the concentration of the utilities on expanding their service to meet new demand in the rural areas rather than reinforcing the existing networks. This is particularly true in the case of IDECO whose losses in 1981 amounted to about 26% compared with 9% for JEPCO. A study should be undertaken to determine the sources of the relatively high losses in Jordan's distribution networks and outline a strategy by which these losses could be reduced (Annex 10, Attachment 4).

1/ 66 MW steam power plant was commissioned in November 1981.

21. Rural Electrification: The national program for rural electrification, initiated under the five-year plan for 1976-1981, set as its goal the extension of publicly supplied electricity to about 90% of the rural population by 1990. Since 1977, 150 villages have been electrified which increased the access of the rural population to electricity from 39% at the end of 1975 to 67% in 1981. At present only 14 villages are supplied by autogenerators, the rest are connected to the national grid. Another 140 villages would gain access to public electricity service between 1982 and 1986 (Annex 7, para 19).

22. Autoproducers: In 1975, the autoproducers in Jordan, other than JEPCO and IDECO, had a combined installed capacity of about 53 MW divided among the Municipalities and the large industrial enterprises. In 1980, autogeneration was only confined to 40 MW retained by the large industries, and principally used as back-up systems. However, a better management of these capacities in concert with the operation of JEA's system could provide substantial saving to the economy. A study for load research and demand management in the power subsector including the generation of electricity by the major electricity consumers should be undertaken. The purpose of the study would be to formulate a framework for the management of the generating facilities in the country to ensure that the demand for electriciy is met at least cost to the economy (Annex 10, Attachment 3). This study should be initiated after the study involving the audit of the major consumers of electricity and petroleum products (Annex 10, Attachment 2).

23. Consumption of Petroleum Products by the Power Subsector: In 1976, fuel oil comprised 44% of the energy used by the power subsector, and gas oil/diesel provided the remaining 56%. Since then, JEA adapted the large diesel sets to operate by burning fuel oil, and as a result, there has been a gradual shift towards the increased use of fuel oil for power generation in Jordan. In 1981 fuel oil provided about 77% of the energy used for power generation and diesel provided the rest. Table 6.5 summarizes the respective shares of fuel oil and gas oil/diesel in total fuel consumption by the power subsector between 1976 and 1981.

Table 6.5

Consumption of Petroleum Products by the Power Subsector
1976-1981

	1976	1977	1978	1979	1980	1981
Diesel	56	43	43	20	23	23
Fuel oil	44	47	47	80	77	77
Total	100	100	100	100	100	100

The increased use of fuel oil by the power subsector is expected to continue during the next five years where by 1987 it would provide 93% of the energy used for generation when the first phase of the Aqaba steam power plant is commissioned (Annex 7, para. 16).

C. Energy Balance:

24. The refinery has been able to provide the mix of petroleum products demanded in Jordan's domestic market. Small quantities of light petroleum products (LPG, aviation fuel, and gas oil) have been traded in some of the past years to supplement domestic production or dispose of surplus products. Table 6.6 below summarizes the product mix between 1975 and 1981. Details are in Attachment 5.

Table 6.6

Mix of Petroleum Products Consumed between 1975 and 1981 (%)

Product Category /1	1975	1976	1977	1978	1979	1980	1981
Light Distillates	22.1	20.3	21.6	21.1	20.2	18.2	16.4
Middle Distillates	52.0	53.1	53.9	50.8	48.2	49.8	50.8
Heavy Ends	25.9	26.6	24.5	28.1	31.6	31.9	32.8

/1 Light distillates - LPG and Gasoline.
Middle distillates - Kerosene and Diesel Oil
Heavy Ends - Fuel Oil and Bitumen

The mix of products produced has changed between 1975 and 1981 in response to the change in domestic demand by shifting slightly in favour of the heavy products. The share of the light distillates as a percentage of the products produced has decreased from about 22% to 16% while the share of heavy products increased from 26% to about 33%. An energy balance for 1981 is presented in Table 6.7. Imports of crude oil amounted to about 2,130 thousand tons and were processed by the refinery whose own consumption and losses amounted to about 157,000 toe. Part of the refinery production of fuel oil (269,000 toe) and gas oil/diesel (79,000 toe) were used for electricity generation with total losses of about 60,000 toe, including transmission and distribution losses. About 1,913 thousand toe were left for final use, of which 18% were consumed by industry, 53% by the transportation sector, 18% by households, and 11% by commerce and others.

Table 6.7

Energy Balance, 1981 /1
('000 toe)

1981	Crude Oil	LPG	Gasoline	Jet Fuel	Kerosene	Gas Oil/ Diesel	Fuel Oil	Fuel Gas	Asphalt	Electri-city /2	Total
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	2,130	-	-	-	-	-	-	-	-	-	2,130
Exports	-	-	-	-	-	-	-	-	-	-	-
Total Supplies	2,130	-	-	-	-	-	-	-	-	-	2,130
Oil refineries	(2,120)	58	278	273	153	619	573	9	107	-	(50)
Electricity gen.	-	-	-	-	-	(79)	(269)	-	-	288	(60)
Energy industries' own use & losses	-	-	-	-	-	-	(98)	(9)	-	-	(107)
Total Final Use	10	58	278	273	153	540	206	0	107	288	1,913
Industry	10 /3	-	-	-	-	62	183	-	-	98	353
Transport	-	-	278	273	-	434	23	-	-	-	1,008
Households	-	58	-	-	153	31	-	-	-	107	349
Commerce & others	-	-	-	-	-	13	-	-	107	83	203

/1 Brackets show transfer or input to other sectors.
/2 Electrical quantities were converted into their oil equivalent using the following factor: 1 kWh = 0.25 kgoe.
/3 Used by cement plants.

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Per Capita Consumption of Energy and Electricity 1971-1981

Year	Estimated Population (Million)	Energy Consumption ('000 Toe)	Energy Consumption Per Capita (kgoe)	Electricity Consumption (GWh)	Electricity Consumption Per Capita (kWh)
1971	1.56	539	346	204	131
1972	1.62	614	379	249	154
1973	1.68	690	411	281	167
1974	1.74	752	432	307	176
1975	1.81	853	471	356	197
1976	1.89	1,076	569	435	230
1977	1.97	1,214	616	513	260
1978	2.06	1,437	698	596	289
1979	2.15	1,620	753	723	336
1980	2.23	1,830	821	877	393
1981	2.29	2,130	930	1,028	443

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Consumption of Petroleum Products (1970-1981)
('000 Toe)

Year	LPG	Gasoline	Aftage /1	Aftour /2	Kerosene	Gas Oil	Fuel Oil	Asphalt	Total
1970	11.7	92.3	5.8.	22.5	73.9	109.0	119.0	24.4	458.6
1971	14.0	94.7	6.8	26.1	81.8	121.9	133.6	27.8	506.7
1972	16.2	107.6	7.3	30.7	90.1	143.8	159.2	21.8	576.7
1973	17.1	117.7	7.1	33.7	97.6	165.3	178.3	28.6	644.8
1974	18.2	133.5	8.3	47.6	105.6	179.6	189.6	23.7	706.1
1975	21.7	154.8	13.5	58.7	117.7	225.4	184.6	22.3	798.1
1976	26.3	183.0	16.6	80.9	131.5	319.5	225.2	49.8	1,032.8
1977	32.8	215.4	16.0	104.1	134.1	364.4	226.0	55.3	1,148.1
1978	41.6	245.4	16.4	122.9	143.1	409.2	293.8	89.1	1,361.5
1979	46.6	263.3	16.8	164.4	142.8	416.2	397.2	87.1	1,534.4
1980	51.2	270.0	17.4	192.0	160.0	509.0	469.0	94.0	1,762.6
1981	58.0	278.0	14.0	259.0	153.0	619.0	573.0	107.0	2,061.0
Average Annual Growth (%) Between 1970 and 1981									
	16	10	8	25	7	17	15	14	15

/1 Aviation fuel for the army
/2 Aviation fuel for commercial airlines

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Percentage Consumption of Petroleum Products by Sector
(1980)

Product	Transport	Industrial	Electricity	Domestic	Others
LPG	-	-	-	100%	-
Gasoline	100%	-	-	-	-
Aviation Fuel	100%	-	-	-	-
Kerosene	-	-	-	100%	-
Gas oil/Diesel	73%	6.6%	13.7%	5.2%	1.5%
Fuel Oil	4.5%	41.4%	49.7%	4.4%	-

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Balance of Electric Energy
(Interconnected System)

	Actual						
	1975	1976	1977	1978	1979	1980	1981
SALES (GWh)							
JEPCO	214	269	330	398	477	558	680
IDECO	22	33	45	54	67	74	78
JEA (Direct Sales)	2	17	19	40	59	125	219
Total	238	319	394	492	603	757	977
LOSSES (GWh)	59	65	80	68	127	152	82
GENERATION (GWh)							
JEPCO	212	161	12	5	1	-	-
IDECO	30	44	34	26	33	39	22
JEA	55	179	428	529	696	870	1,037
Total	297	384	474	560	730	909	1,059
Of which:							
Steam Plants							
Hussein 3x33 MW	-	-	118	301	460	589	597
Hussein 3x66 MW	-	-	-	-	-	-	73
Aqaba 1 2x130 MW	-	-	-	-	-	-	-
Total	0	0	118	301	460	589	670
Combustion Turbines							
Marqa	-	-	-	53	50	60	96
Zarqa	45	119	161	77	20	15	7
Karak	-	-	-	-	-	-	4
Total	45	119	161	130	70	75	107
Diesel Units							
Marqa	-	45	128	71	118	148	184
Karak	-	-	1	2	11	14	21
Ma'an & Tafila	-	-	-	-	3	4	7
Aqaba	10	15	20	25	34	40	48
JEPCO & IDECO	242	205	46	31	34	39	22
Total	252	265	195	129	200	245	282
Maximum Demand (MW) /1	57	71	81	107	153	164	200
Installed capacity (MW)	70	107	140	213	257	257	423

/1 Interconnected system only.

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Mix of Petroleum Products Consumed between 1970 and 1981
(%)

Product category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Light distillates /1	22.7	21.5	21.5	20.9	21.5	22.1	20.3	21.6	21.1	20.2	18.2	16.4
Middle distillates /2	46.0	46.7	47.2	47.1	48.3	52.0	53.1	53.9	50.8	48.2	49.8	50.8
Heavy ends /3	31.3	31.8	31.4	32.1	30.2	25.9	26.6	24.5	28.1	31.6	31.9	32.8

/1 LPG and gasoline
/2 Jet fuel, kersosene and gasoil
/3 Fuel oil and asphalt

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Forecast of Demand and Supply of Energy

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Forecast of Demand and Supply of Energy

A. Growth of the Economy

1. Jordan's economy experienced a relatively high rate of economic development over the period 1975-1980 during which GDP increased in real terms at an average annual rate of about 9.4%. According to Bank staff projections, the real growth of GDP is expected to increase slightly to about 10% for 1980-1985, then drop to about 7.6% for 1985-1990. These high rates of growth are primarily attributed to the historic and forecast development of the industrial sector whose share of the GDP has increased from about 10% in 1975 to 19% in 1980, and is expected to reach 29% by 1985. The real rate of growth of the industrial sector averaged about 17% for 1975-1980; and it is expected to rise to 20% for 1980-1985, then drop to 11% for 1985-1990. The real growth of the other sectors of the economy are also expected to rise slightly, with the exception of the transportation sector, whose growth would increase from 4% for 1975-1980 to 11% for 1980-1985 then drop to 7% for 1985-1990. The peaking of the growth rate during the period 1980-1985 is largely attributed to the continued dependence of the neighboring countries on the port of Aqaba and on Amman airport for the supply of imported goods and materials which are delivered to their ultimate destination by Jordan's trucking industry. This dependence is caused by the limited capacities of the ports in the neighboring countries; and was exacerbated more recently by the border war between Iraq and Iran. The reliance of the area on Jordan is expected to continue over the next five years as Iraq goes through a period of intensive post-war reconstruction; and as the port facilities in the other oil-exporting neighboring countries are expanded to accommodate a more stable inflow of imports. Thereafter, the demand for imports through Jordan is expected to subside, and as a result, the projected growth rate for 1985-1990 is expected to decrease to about 7%. The historical and projected real growth rates of the main sectors of Jordan's economy are presented in Table 7.1 below.

Table 7.1

Historical and Projected Real Growth Rates for the Main Sectors of Jordan's Economy /1
(%)

	1975-1980	1980-1985	1985-1990
Industry/2	17.0	20.0	11.0
Agriculture	3.0	5.0	5.0
Transport	4.0	11.0	7.0
GDP	9.4	10.3	7.6

/1 World Bank projections.
/2 Industrial sector includes mining and manufacturing.

2. The overall consumption of energy for 1975-1980 increased at an average annual rate of about 16.5% mainly because of the growth of the industrial and transportation sector. The rate of increase in the consumption of energy for 1980-1985 is expected to decline (paras. 3-10) because of the Government's plans to increase domestic energy prices to eliminate the subsidies for petroleum products, and the emphasis it would place on conservation and demand management for restraining the future demand for energy. Consequently, the forecast growth of energy consumption over the next 8 years depends, to a large extent, on the time horizon assumed for the elimination of the subsidies; the projected increase in the real price of crude oil; and the timing and effect on the industrial energy consumption of a program for conservation. These are discussed in detail in the section below which concludes with the most probable scenario for the growth of energy consumption between 1982-1990.

B. Demand for Energy

Forecast of Demand for Petroleum Products

3. The forecast of the demand for petroleum products, except for aviation fuel, was derived using the income and price elasticities for each product estimated from historical observations.1/ 2/ Elasticities for aviation fuel were borrowed from a study of the demand for fuel by international airlines. The projections for 1982-1990 of the real income generated in each of the major sectors of Jordan's economy were estimated by the Bank. Table 7.2 below presents the estimated income and price elasticities for each product.

1/ The elasticities were derived by relating the consumption of each product to the growth of the value added in the major consuming sector; e.g. transportation and electricity for diesel/gas oil; industry, mining, and electricity for fuel oil; etc.

2/ The projections were checked for their accuracy by applying the same methodology on historical data. Attachment 10 compares actual and predicted values for the consumption of gasoline, kerosene, gas oil/diesel, and fuel oil for the period 1971-1981.

Table 7.2

Estimated Income and Price Elasticities

Product	Income Elasticity		Price Elasticity		Coefficient of Determination
	Short-Term	Long-Term	Short-Term	Long-Term	
LPG	-	1.6	-	-0.7	.920
Gasoline	0.3	1.5	-0.3	-1.4	.994
Aviation fuel /a	-	1.5	-	-0.2	n.a.
Kerosene	0.2	0.5	-0.1	-0.3	.973
Gas oil/diesel	0.8	1.9	-0.03	-0.06	.984
Fuel oil	0.7	1.3	-0.03	-0.06	.979

/a Bohi, Douglas, Analyzing Demand Behavior: A Study of Energy Elasticity, Resources for the Future, Inc. Johns Hopkins University Press, Baltimore, 1981, p. 127.

The elasticities obtained in the case of Jordan are in line with what is observed in most other developing countries. It is expected, however, that the long-term price elasticities of demand for petroleum products would rise in the future as the economy shifts away from large and energy-intensive projects based on the extractive industries to relatively smaller privately-owned export-oriented industries; and the elimination of the prevailing practice of setting prices on a cost-plus basis, which was partly responsible for the modest decrease in energy consumption observed in the past as energy prices increased.

4. Four scenarios were considered for the growth of the future demand for energy. These are all based on identical rates of growth for the income generated in the major sectors of the economy. However, as stated above, the difference between the four scenarios depends on the assumptions made about: a) the time horizon for eliminating the subsidies for energy; b) the future increase in the real price of crude oil; and c) the timing and impact of conservation.

a) Time Horizon for eliminating the subsidy for energy: Two time horizons were considered to represent the two extremes in the plans of the Government to eliminate the subsidies for petroleum products. The most desirable date by which the subsidies would be totally eliminated was taken as 1985, thus providing a time horizon of about 3 years for the completion of the studies needed for assessing the impact of higher prices on some of the large consumers of energy (Annex 8, para. 13). On the other hand, 1990 was taken as the least desirable date for achieving

parity between domestic and border prices, representing a decision by the Government to slow down the pace of its past effort in eliminating the subsidy.

b) Future increase in real price of crude oil: Two variations were taken concerning the annual rate of increase in the real price of crude oil in the world market. The first projected an average rate of increase of about 3% for 1982-1990. The second forecast no real increase for 1982-1985 then, an average increase of about 1% for 1986-1990.

c) Investment in conservation: The projected impact of investment in conservation and better management of demand for energy was assumed to take place after 1985. This would allow about 3 years for the Government to initiate and complete energy audit studies, engineering designs for retrofitting, procurement of equipment and material, and completion of work. The effects of conservation were estimated on the basis of energy audits undertaken elsewhere of power plants, cement and building materials factories, and refineries which represent the major consumers of energy in Jordan. The overall impact of conservation was assumed to start taking effect in 1986 and reach 20% of the projected energy consumption for 1990 that would be expected if a conservation program is not undertaken. The 20% overall reduction in energy consumption was based on: (i) detailed energy audits of similar industries elsewhere (cement, fertilizers, etc.); and (ii) preliminary assessment by the mission of the potential saving in the major energy-consuming industries in Jordan. However, this reduction should be considered as a minimum because the potential for greater efficiency brought about by economic pricing of petroleum products and electricity, and an intensified program of investment in energy-efficient equipment for retrofitting and conservation has been known to bring about a greater reduction in overall consumption than assumed in this report (Sweden, France, etc.).

A summary of the assumptions used for each scenario is presented in Table 7.3 below.

Table 7.3

Forecast of Demand for Petroleum Products
Summary of Specific Assumptions

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Time horizon for achieving parity with border prices	1990	1985	1985	1985
Annual real rate of increase in world market prices for petroleum products	3% (1981-1990)	3% (1981-1990)	0% (1981-1985) 1% (1985-1990)	0% (1981-1985) 1% (1985-1990)
Investment in energy conservation	No	No	No	Yes

5. Scenarios 1 and 2 assume that the real price of crude oil would increase at an average annual rate of about 3% for 1982-1990 with domestic prices reaching parity with border prices by 1990 for scenario 1 and 1985 for scenario 2. Under these scenarios, the demand for petroleum products would grow at about 14% a year. For Scenarios 1 and 2 the length of the time horizon for eliminating the subsidies has no significant impact on the demand. Scenario 3, on the other hand, assumes that world prices for petroleum products would remain stable until 1985 and rise in real terms thereafter at an average annual rate of about 1%. Under these conditions, demand for petroleum products would grow at a higher rate (about 15%) which reflects the tendency for lower prices to slightly stimulate consumption.

6. The difference between scenario 3 (high case) and scenario 2 (low case) would amount to about 585,000 toe in 1990. The difference between the consumption under these scenarios stems from the assumed rate of increase in the real prices of crude rather than from the projected date for the elimination of the subsidies. However, the difference is small and points to the relatively minor impact higher prices would have on the demand for petroleum products. The elimination of the subsidies would result in significant increases in the prices of aviation fuel and gas oil/diesel, and to a much lesser degree, fuel oil; however, the demand for these products is not likely to be significantly altered by the higher prices. Gas oil/diesel is mainly consumed by the trucking industry (75%) whose demand for the product is primarily affected by changes in income rather than price as reflected in its long-run elasticities (income elasticity of 1.9 compared to price elasticity of about -0.06). The demand for aviation fuel is highly responsive to the changes in income and substantially less responsive to the changes in prices as indicated by its long-run elasticities (income elasticity of 1.5 and price elasticity of about -0.2). Fuel oil is consumed by the power subsector and industry and therefore increases in the price of the product are not

likely to reduce the growth of demand substantially. The demand for fuel oil is more responsive to changes in income than to changes in prices (income elasticity of 1.3 compared to price elasticity of -0.06). Therefore , in the case of Jordan, as indicated by the price elasticities, the setting of prices at parity to border prices would ensure the efficient allocation of energy resources, and would also mobilize resources for the Government; however, its impact in determining future demand would be limited compared to the impact of income growth (Annex 8, para. 11).

7. As seen from the forecast demand above, pricing cannot be relied upon entirely as a means of restraining the growth of future demand. Therefore, in order to slow down the growth of demand for energy, the Government should formulate a comprehensive plan for managing the demand for energy through energy audits of the major energy-consuming industries such as the refinery, the potash, steel, cement, fertilizer, and glass industries, and encouraging changes in the technologies currently being used and substituting between fuels to ensure a more efficient consumption of energy. Scenario 4 illustrates the significant impact that conservation would have on the growth of demand for energy. It assumes, in addition to the conditions set out under scenario 3, that investments in conservation in the industrial and power sectors would be undertaken between 1983 and 1985. Implementation of a conservation program as assumed above (para. 4) would reduce the annual growth of demand for petroleum products from about 14.8% for 1985-1990 (scenario 3) to 10%. This would save nearly 1.5 million toe in 1990, representing 20% of the total demand in that year in case the highest projected demand materializes (scenario 3).

8. The growth of demand for petroleum projects under each scenario is summarized in Table 7.4 below.

Table 7.4

Scenarios for the Demand for Petroleum Products, 1981-1990
('000 toe)

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	1985	1990	1985	1990	1985	1990	1985	1990
Light distillates	471	692	471	692	487	798	487	784
Middle "	1,768	3,215	1,725	3,177	1,799	3,558	1,799	2,750
Heavy ends	1,291	2,720	1,275	2,712	1,305	2,810	1,305	2,131
Total	3,530	6,627	3,471	6,581	3,591	7,166	3,591	5,665
	1981-85	1985-90	1981-85	1985-90	1981-85	1985-90	1981-85	1985-90
Growth rate of total demand for petroleum products(% p.a.)	14.5	13.4	14.0	13.7	15.0	14.8	15.0	10.0

Scenario 4 is adopted for this report in order to maintain consistency with the projections of the report covering the review of the five-year economic plan for 1981-1985. This scenario takes into account the effects on consumption of conservation but it assumes a lower rate of increase for the real price of crude oil (none for 1982-1985 and 1% thereafter) than projected by the Bank (3% for 1982-1990). If the Bank's current projection is taken into consideration in scenario 4, the projected consumption of petroleum products in 1990 would be reduced by about 400 thousand tons; that is 5.3 million ton instead of 5.7 million ton as detailed in Attachment 5 (Scenario 5). However, whether the increase in real prices of crude is taken to be 3% per year or less, the conclusion drawn in this report concerning the future balance of demand and supply are not altered, and consequently, the recommendations that follow would remain the same.

Forecast of Demand for Electricity

9. The forecast of demand for electricity sales at the high voltage level is also based on the long-run income and price elasticities. In addition, the expected demand by the major new industries or the expansion of some of the existing ones have been added after ascertaining whether these new blocks of demand would materialize as projected. The forecast of sales by JEA to JEPCO (80% of sales) has been derived for each of JEPCO's consumers based on the estimated price and income elasticities, then aggregated to constitute the sales of JEA to JEPCO in which losses in distribution have also been included (Attachment 9). The forecast of sales to IDECO has been derived using the same elasticities derived for JEPCO and then also aggregated. Table 7.5 below presents a summary of the forecast demand for electricity for 1981-1990.

Table 7.5

Forecast Demand for Electricity, 1981-1990
(Interconnected system)

	1981	1985	1990	Average Growth Rate (% p.a.) 1981-85	1985-90
Bulk Sales	----------GWh----------				
JEPCO	680	1,070	1,887	12.0	12.0
IDECO	78	183	333	23.8	12.7
Other JEA direct consumers	214	439	630	19.7	7.5
Total Northern Region	972	1,692	2,850	14.8	11.0
Central Region	5	319	450	182.7	7.1
Southern Region/1	-	107	175	-	10.3
Total Interconnected System	977	2,118	3,475	21.3	10.4
Transmission losses and station use	82	205	337	25.7	10.5
Total Generation Interconnected System	1,059	2,323	3,812	21.7	10.4
Maximum Demand	----------MW----------				
Interconnected system	200	461	736	23.2	9.8

/1 The Southern Region is planned to be connected to the interconnected system in 1984.

10. Total electricity generation would increase from 1,059 GWh in 1981 to 2,323 GWh in 1985 and 3,812 GWh in 1990, representing an annual growth rate of 15.3%. Maximum demand would increase from 200 MW in 1981 to 461 MW in 1985 and 736 MW in 1990. The high rate of load growth is mainly due to a rapid increase expected in JEA's direct sales to large industries and other consumers. A number of large projects are expected to require electricity supply from JEA during the next 10 years; some of the existing large consumers, notably the cement factory at Fuheis, are also expected to increase their demand for electricity because of planned expansion in their capacities. Attachments 6 and 7 present a detailed forecast of the demand by these consumers.

11. JEPCO accounted for almost 81% of the energy sold by JEA on the interconnected system in 1980. Demand in the JEPCO's supply area is therefore the major influence on total electricity demand in Jordan. JEPCO's forecast of energy sales by sector are detailed in Attachment 9. Sales to the households accounted for 36% of JEPCO sales in 1980. This share is projected to remain roughly constant until the end of the century. The growth in energy sold is projected to gradually slow down as most households in the company's concession area are connected to the public grid and the rate of increase in the installation of electrical appliances stabilizes. Industrial consumption of electricity at the medium voltage level is expected to be the fastest growing sector in the immediate future, as applications to JEPCO for new connections indicate. The forecast growth in JEPCO sales to industry over the 1981-85 Five-Year Plan period is expected to average 13.7% per year which is consistent with the projected growth for the manufacturing sector. Energy supplied by JEPCO for water and sewage pumping is expected to grow at much slower rates after 1985 because new water sources will lie outside its supply area and be supplied by JEA. The water authorities also wish to reduce the rate of extraction from the Amman and Zerqa well fields to enable the aquifer to be recharged, as soon as alternative supplies become available.

C. Supply of Energy

Future Supply of Petroleum

12. Unless a major discovery of oil and gas is made between 1981 and 1990, Jordan is expected to continue its total dependence on imported oil for meeting its demand for commercial energy. At present, the installed capacity at the refinery is about 4.3 million tons per year as a result of expansion that started in 1976. Under the most optimistic scenario whereby substantial investment in conservation would limit demand for refined products at about 5.8 million tons by 1990 (scenario 4), the capacity of the refinery would significantly fall short of providing Jordan's needs for petroleum products unless it is expanded. Imports of products would be necessary to supplement refinery production as early as 1987, and would gradually increase to reach 1.5 million tons by 1990. Of this total, nearly 975 thousand tons would consist of premium-value products. The last expansion (1979) of the refinery at Zarqa allowed in the design for the addition of facilities that would increase the refining capacity by another 1.3 million tons per year. This would increase the overall refining capacity to 5.6 million tons which would be capable of meeting the projected demand for petroleum products until 1990 (scenario 4). However, there is no assurance that such an expansion would represent the least cost alternative, particularly since the Government plans to locate the new large industries near the city of Aqaba which is about 360 km from the refinery. Before expanding the refinery, detailed assessment of the pattern of the future consumption of petroleum products and its location should be undertaken. This would provide the inputs needed for the design of a least cost system for refining crude oil, and transporting and distributing petroleum products.

13. The import of large quantities of mid-distillates as outlined above might not represent the optimal strategy to correct the projected imbalance. Moreover, the expansion of the refinery at Zarqa might result in the failure of the refinery to capture the economies of scale in terms of fuel efficiency and product mix. Several alternatives should be considered: a) the expansion of the existing refinery to increase its crude unit capacity; b) the construction of a second refinery at Aqaba; or c) the installation of secondary conversion facilities, such as a hydrocracking unit, to convert fuel oil to required distillates and the import of deficit fuel oil. However, there is a potential for importing coal for power generation at Aqaba. The potential for using the coal at a later stage has been allowed for in the design of the plant. If coal is imported for power generation, then its use by the new cement plants and other industrial users for steam would reduce the cost of handling it and lower the overall cost of energy of these industries. Moreover, there is the possibility of importing gas, via a pipeline, from Saudi Arabia for use as an alternative for petroleum products and coal. The import of coal or gas would have a significant impact on the required refining capacity and its configuration. Nevertheless, irrespective of the alternative selected, investment in expanding Jordan's refining capacity would be needed during the period 1982-1986 in order to ensure that by 1987, when large quantities of middle distillates would be required, adequate facilities would have to come on stream to meet the future demand for energy at least cost to the economy.

14. The transport and the distribution of petroleum products would also play a major role in determining the future investment in the energy sector. Under current plans the fuel oil produced by the refinery at Zarqa would be needed to operate the power plant at Aqaba (360 km). This would come in addition to the demand by large industries such as the new cement plant at El-Rashadia, the phosphate mining industry at El-Hassa and Shadiah, etc., which are between Zarqa and Aqaba. In order to meet the demand of these major consumers in the most economic way, a pipeline would be needed to transport and distribute the fuel oil.

15. The 1981-1985 plan for the refining of oil and transportation and distribution of petroleum products involves: a) the expansion of the storage facilities at Zarqa and in Aqaba; b) the construction of a third connection (18"-20" pipeline) to the Tapline to increase the capacity of the existing system for the supply of crude to the refinery, and the construction of a pipeline between the refinery and the new international airport (Queen Alia) to transport aviation fuel for the national and foreign airlines; c) the expansion of the capacity of the existing lubrication oil plant by another 15,000 tons a year; and d) the construction of a new plant for the recycling and upgrading of used lubrication oils with an initial capacity of also 15,000 tons. All of these projects are expected to be commissioned during the plan period (Annex 9, para. 15).

16. In addition, the NPC has initiated a study by Williams Brothers (UK firm) to determine the feasibility of constructing a multiproduct underground pipeline between Zarqa and Aqaba to supply the power plant and the major industries in between. Initially, the pipeline is intended to transport products (mainly fuel oil) to the south and crude oil from Aqaba to Zarqa. If a second refinery is constructed at Aqaba later on, the Government would like to use the pipeline to transport products to the north. However, such plans should be reassessed in light of a national strategy for the development and use of energy resources in Jordan. This strategy would be based on: a) the assessment of the impact of importing coal or gas for industry and for power generation at Aqaba on the future mix of petroleum products demanded and the location of the demand; and b) the design of optimal energy supply systems. Therefore, it is recommended that the Government consider undertaking a detailed study in the near future to determine the future patterns of energy consumption in Jordan and the location of the major consumers and outline a development strategy for the supply of energy which would ensure that the future demand for energy is met at least cost to th economy. Sample terms of reference are presented in Annex 7, Attachment 11.

Future Supply of Electricity

17. Generation: The 1981-1985 plan for the development of generation includes the expansion of the capacity at the Hussein steam power plant and the commissioning of the first phase of the steam power plant at Aqaba; both would be operated by burning fuel oil. The expansion of the Hussein plant would involve the addition of 4 generating units of 66 MW each of which three would be in commercial operation by 1982, and the fourth would be commissioned in 1984. The full development of the Aqaba power calls for the installation of a 900 MW steam plant at Aqaba on the Red Sea. The development is divided into three phases which would be staggered to coincide with the growth of demand for electricity. The first phase would involve the commissioning by 1986 of 2x130 MW; the second phase 1x320 MW by 1990; and the third phase 1x320 MW by 1993.

18. Transmission: About 300 km of transmission lines and 284 MVA in substation transformer capacities are under construction for completion by 1982. Another 643 km of transmission lines and 747 MVA in substation capacity are planned for 1982-1986. The 132-kV transmission line from Ma'an to Aqaba will complete the transmission link between the northern central and southern regions to allow for the integrated operation of the power system in Jordan. The Jordanian and Syrian power systems are connected through a 66-kV transmission line and Jordan has been importing electricity from Syria. A 230-kV line from Irbid to Damascus with a 100-MVA transformer substation at Irbid has been constructed, which would enable synchronous operation of the two power systems. This interconnection would enable better utilization of power system generating facilities in both countries through coordinated operation and maintenance, and also improve reliability of power supply by

giving the Jordanian system access to the much larger generation reserve of the Syrian power system. Reserve sharing would allow JEA to reduce its generating capacity by about 50 MW. However, the interconnection has not been brought into operation due to the current political situation. There are no immediate plans for other interconnections between the Jordanian power system and the neighboring systems.

19. Distribution: JEA's distribution network expansion to be implemented in the period 1981-1987, includes about 1,497 km of overhead lines and 165 MVA in substation transformer capacity. In the same period, JEPCO plans to construct 24 transformer substations with an installed capacity of 121 MVA and to install 74 km of cables and 36 km of overhead lines as well as to reinforce the existing 33-kV network by adding 130 MVA in power transformer capacity, 25.5 km of 33-kV cables and 9 km of 33-kV overhead lines. JEPCO will also build about 350 new distributrion substations in its concession area. Furthermore, JEPCO has started reinforcing the Amman urban distribution system by changing from 6.6 kV to 11 kV. Similarly, IDECO is also reinforcing the distribution network in the city of Irbid.

20. Rural Electrification: JEA has prepared a national plan for the extension between 1981-1993 of publicly supplied electricity to the rural areas covering about 500 villages and isolated settlements. At present, 284 villages with a total population of 290,000 are being electrified, and when the work is completed, 422 villages would be electrified or about 43% of the total number of villages having 91% of the total population in Jordan. The remaining villages would be electrified in three stages:

Stage	No. of Villages & Housing Schemes	Period
1	170	1984-1986
2	100	1987-1990
3	120	1991-1993

With the completion of the third stage, almost all the rural population in Jordan would have access to the public power supply.

November 1982
(0579P)

SCENARIO 1

Assumptions:
- Parity with border prices by 1990
- 3% annual increase in world market prices for petroleum products.

JORDAN

ENERGY SECTOR STUDY

Forecast Supply and Demand for Petroleum Products, 1982-1990
('000 toe)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supply										
Imports										
Crude oil	2,130	2,360	2,700	3,153	3,700	4,270	4,300	4,300	4,300	4,300
LPG/Gasoline	-	-	-	-	-	-	-	59	106	155
Middle distillates	-	-	-	-	-	-	450	617	984	1,340
Fuel oil/asphalt	-	-	-	-	-	-	90	410	674	1,030
Total supply	2,130	2,360	2,700	3,153	3,700	4,270	4,840	5,386	6,064	6,825
Demand										
Petroleum products										
LPG	58	65	73	81	91	100	110	121	133	147
Gasoline	278	310	330	353	380	409	440	473	508	545
Jet fuel	271	312	358	412	474	521	573	631	694	763
Kerosene	153	153	154	155	155	157	160	164	168	173
Gasoil/Diesel	619	709	822	964	1,139	1,323	1,525	1,748	1,998	2,279
Fuel oil	573	608	741	916	1,143	1,361	1,596	1,853	2,146	2,482
Asphalt	101	111	122	134	148	163	179	197	217	238
Total Products	2,053	2,268	2,600	3,015	3,530	4,034	4,583	5,187	5,864	6,627
Refinery losses & own consumption /1	77	92	100	138	170	236	257	199	200	198
Total Demand	2,130	2,360	2,700	3,153	3,700	4,270	4,840	5,386	6,064	6,825

/1 Including consumption of fuel gas.

November 1982
(0579P, p.78)

SCENARIO 2

Assumptions
- Parity with border prices by 1985
- 3% annual increase in world market prices for petroleum products.

JORDAN

ENERGY SECTOR STUDY

Forecast Supply and Demand for Petroleum Products, 1982-1990
('000 toe)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supply										
Imports										
Crude oil	2,130	2,360	2,700	3,156	3,675	4,220	4,300	4,300	4,300	4,300
LPG/Gasoline	-	-	-	-	-	-	-	59	106	155
Middle distillates	-	-	-	-	-	-	344	571	929	1,200
Fuel oil/asphalt	-	-	-	-	-	-	70	390	670	1,120
Total supply	2,130	2,360	2,700	3,156	3,675	4,220	4,714	5,320	6,005	6,775
Demand										
Petroleum products										
LPG	58	65	73	81	91	100	110	121	133	147
Gasoline	278	310	330	353	380	409	440	473	508	545
Jet fuel	271	306	346	391	442	486	535	588	647	712
Kerosene	153	153	156	162	168	175	181	188	195	202
Gasoil/Diesel	619	709	818	952	1,115	1,294	1,493	1,718	1,973	2,263
Fuel oil	573	608	738	909	1,127	1,343	1,576	1,835	2,132	2,474
Asphalt	101	111	122	134	148	163	179	197	217	238
Total Products	2,053	2,262	2,583	2,982	3,471	3,970	4,514	5,120	5,805	6,581
Refinery losses & own consumption /1	77	98	117	174	204	250	200	200	200	194
Total Demand	2,130	2,360	2,700	3,156	3,675	4,220	4,714	5,320	6,005	6,775

/1 Including consumption of fuel gas.

November 1982
(0579P, p.79)

SCENARIO 3

Assumptions:
- Parity with border prices by 1985
- Annual increase in world market prices for petroleum products:
  0% until 1985
  1% after 1985

JORDAN

ENERGY SECTOR STUDY

Forecast Supply and Demand for Petroleum Products, 1982-1990
('000 toe)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supply										
Imports										
Crude oil	2,130	2,360	2,700	3,136	3,700	4,300	4,300	4,300	4,300	4,300
LPG/Gasoline	-	-	-	-	-	-	25	100	188	263
Middle distillates	-	-	-	-	-	55	535	868	1,230	1,682
Fuel oil/asphalt -	-	-	-	-	-	-	120	412	752	1,120
Total supply	2,130	2,360	2,700	3,136	3,700	4,355	4,980	5,680	6,470	7,365
Demand										
Petroleum products										
LPG	58	65	73	81	91	102	114	128	144	161
Gasoline	278	310	331	360	396	435	478	526	579	637
Jet fuel	271	312	358	412	474	545	627	721	829	953
Kerosene	153	153	156	162	168	175	181	188	195	202
Gasoil/Diesel	619	709	825	973	1,157	1,354	1,571	1,815	2,091	2,403
Fuel oil	573	608	743	923	1,157	1,385	1,631	1,903	2,214	2,572
Asphalt	101	111	122	134	148	163	179	197	217	238
Total Products	2,053	2,268	2,608	3,045	3,591	4,159	4,781	5,478	6,269	7,166
Refinery losses & own consumption /1	77	92	92	91	109	196	199	202	199	199
Total Demand	2,130	2,360	2,700	3,136	3,700	4,355	4,980	5,680	6,470	7,365

/1 Including consumption of fuel gas.

November 1982
(0579P, p.76)

SCENARIO 4

Assumptions:
- Parity with border prices by 1985
- Annual increase in world market prices for petroleum products: 0% until 1985
  1% until 1985
- Investment in conservation after 1985.

JORDAN

ENERGY SECTOR STUDY

Forecast Supply and Demand for Petroleum Products, 1981-1990
('000 toe)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supply										
Imports										
Crude oil	2,130	2,360	2,700	3,147	3,700	4,110	4,300	4,300	4,300	4,300
LPG/Gasoline	-	-	-	-	-	-	-	-	25	55
Middle distillates	-	-	-	-	-	-	180	500	800	920
Fuel oil/asphalt -	-	-	-	-	-	-	-	80	215	565
Total supply	2,130	2,360	2,700	3,136	3,700	4,110	4,480	4,880	5,340	5,840
Demand										
Petroleum products										
LPG	58	65	73	81	91	100	110	121	133	147
Gasoline	278	310	331	360	396	435	478	526	579	637
Jet fuel	273	312	358	412	474	507	543	581	621	665
Kerosene	153	153	156	162	168	175	181	188	195	202
Gasoil/Diesel	619	709	825	973	1,157	1,275	1,405	1,550	1,708	1,883
Fuel oil	573	622	744	923	1,157	1,323	1,446	1,567	1,724	1,893
Asphalt	107	111	122	134	148	163	179	197	217	238
Total Products	2,061	2,282	2,609	3,045	3,591	3,978	4,342	4,730	5,177	5,665
Crude oil	10	-	-	-	-	-	-	-	-	-
Refinery losses & own consumption /1	59	78	91	102	109	132	138	150	163	175
Total Demand	2,130	2,360	2,700	3,147	3,700	4,110	4,480	4,880	5,340	5,840

/1 Including consumption of fuel gas.

November 1982
(0579P, p.77)

SCENARIO 5

Assumptions
- Parity with border prices by 1985
- 3% annual increase in world market prices for petroleum products.
- Investment in conservation

JORDAN

ENERGY SECTOR STUDY

Forecast Supply and Demand for Petroleum Products, 1982-1990
('000 toe)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supply										
Imports										
Crude oil	2,130	2,360	2,700	3,156	3,675	3,939	4,281	4,300	4,300	4,300
LPG/Gasoline	-	-	-	-	-	-	-	-	25	100
Middle distillates	-	-	-	-	-	-	-	263	535	730
Fuel oil/asphalt	-	-	-	-	-	-	-	50	150	310
Total supply	2,130	2,360	2,700	3,156	3,675	3,939	4,281	4,613	5,010	5,440
Demand										
Petroleum products										
LPG	58	65	73	81	91	100	110	121	133	147
Gasoline	278	310	330	353	380	409	440	473	508	545
Jet fuel	271	306	346	391	442	473	506	541	579	620
Kerosene	153	153	156	162	168	175	181	188	195	202
Gasoil/Diesel	619	709	818	952	1,115	1,216	1,326	1,447	1,579	1,722
Fuel oil	573	608	738	909	1,127	1,241	1,367	1,505	1,658	1,826
Asphalt	101	111	122	134	148	163	179	197	217	238
Total Products	2,053	2,262	2,583	2,982	3,471	3,777	4,109	4,472	4,869	5,300
Refinery losses & own consumption /1	77	98	117	174	204	162	172	141	141	140
Total Demand	2,130	2,360	2,700	3,156	3,675	3,939	4,281	4,613	5,010	5,440

/1 Including consumption of fuel gas.

November 1982
(0579P, p.80)

JORDAN

ENERGY SECTOR STUDY

Forecast for Bulk Supply Points
Central Jordan Interconnected System
(1981-1995)

Year	Potash Safi		Phosphate Hasa		Phosphate Eshadiya		Cement Rashadiya		Karak Shoubak & Tafila		Ma'an		Total	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
1981	8	35	-	-	-	-	-	-	-	-	-	-	8	35
1982	15	66	8	38	-	-	-	-	5	17	2	7	30	128
1983	15	66	8	38	-	-	-	-	5.5	19	2.5	8	31	131
1984	18	79	11	53	-	-	12	66	6	21	3	10	50	229
1985	20	96	11	53	-	-	24	134	6.5	23	3.5	13	65	319
1986	22	106	11	53	4	19	24	135	7	26	4	15	72	354
1987	22	106	11	53	8	39	24	137	7.5	28	4.5	17	77	380
1988	22	106	11	53	8	39	24	137	8	30	5	19	78	384
1989	22	106	11	53	11	53	24	137	9	34	6	22	83	405
1990	25	120	12	63	14	67	24	137	10	37	7	26	92	450
1991	25	131	12	63	17	89	36	205	11	41	8	29	109	558
1992	25	131	12	63	20	105	36	205	12	45	9	31	114	580
1993	25	131	12	63	23	121	36	205	13	49	10	34	119	603
1994	27	142	12	63	26	136	36	205	14	53	11	37	126	636
1995	27	142	12	63	28	147	36	205	15	59	12	47	130	663

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JORDAN

ENERGY SECTOR STUDY

Forecast for Bulk Supply Points
South Jordan Interconnected System
(1984-1995)

Year	Aqaba		Refinery Aqaba		Fertilizer		Wood Plant		Total	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
1984	16	59	-	-	1	5	-	26	22	90
1985	19	71	-	-	2	10	5	26	26	107
1986	21	81	-	-	3	14	5	26	29	121
1987	23	91	-	-	4	19	5	26	32	136
1988	25	100	-	-	5	24	5	26	35	150
1989	27	111	-	-	5	24	5	26	37	161
1990	30	123	-	-	5	26	5	26	40	175
1991	32	134	-	-	6	31	5	26	46	205
1992	34	146	3	14	6	31	5	26	48	217
1993	36	158	3	14	6	31	5	26	50	220
1994	38	166	5	24	6	31	5	26	54	247
1995	40	193	5	26	6	31	5	26	56	276

April 1982
(0429P)

JORDAN

ENERGY SECTOR STUDY

Forecast Generation Interconnected System (1981-1995)

Year	North		Central		South		Total		Trans-mission		Power Station		Generated		Load Factor
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	
1981	176	898	8	35	-	-	184	933	2	19	8	72	194	1,024	60.3
1982	196	1,018	30	128	-	-	226	1,146	2	23	14	88	242	1,257	59.3
1983	234	1,170	31	131	-	-	265	1,301	3	26	18	100	286	1,427	57.0
1984	291	1,439	50	229	22	90	363	1,758	4	36	20	134	387	1,928	56.9
1985	346	1,692	65	319	26	107	437	2,118	4	43	20	162	461	2,323	57.5
1986	383	1,863	72	354	29	121	484	2,338	10	47	28	179	522	2,564	56.1
1987	424	2,098	77	380	32	136	533	2,614	11	53	30	200	574	2,881	57.3
1988	465	2,315	78	384	35	150	578	2,849	12	58	31	218	621	3,125	57.4
1989	511	2,564	83	405	37	161	631	3,130	13	64	33	239	677	3,433	57.9
1990	560	2,850	92	450	40	175	692	3,475	11	71	33	266	736	3,812	59.1
1991	666	3,485	109	550	46	205	821	4,240	12	86	40	325	873	4,651	60.8
1992	717	3,743	114	560	48	217	879	4,520	13	92	43	347	935	4,959	60.5
1993	771	4,012	119	603	50	229	940	4,844	14	99	46	372	1,000	5,315	60.7
1994	829	4,294	126	636	54	247	1,009	5,177	15	106	49	398	1,073	5,681	60.4
1995	890	4,596	130	663	56	276	1,076	5,535	16	113	53	425	1,145	6,073	60.5
Growth Rates (% p.a.)															
1981-85	18.4	17.2	68.8	73.8			24.1	22.7					24.2	22.7	
1985-90	10.1	11.0	7.2	7.1	9.0	10.3	9.6	10.4					9.8	10.4	
1990-95	9.7	10.0	7.2	8.1	7.0	9.5	9.2	9.8					9.2	9.8	

April 1982
(0429P)

JORDAN

ENERGY SECTOR STUDY

Sales Forecast for JEPCO
(GWh)

	1980 (Actual)	1981 (Est.)	1982	1983	1984	1985	1990	1995	Av. Growth Rates (% p.a.) 1980-85	1985-90	1990-95
Households /1	202	228	256	289	322	370	630	1,040	12.9	11.2	10.5
Industry /2	123	128	142	179	214	234	472	845	13.7	15.1	12.4
Commerce	86	97	115	127	136	153	221	307	12.1	7.6	6.8
Institutions	78	80	84	89	95	100	134	176	5.1	6.0	5.6
Water Pumping	47	60	64	69	77	86	115	130	12.9	5.9	2.5
Rural	-	-	2	3	7	11	22	41	-	15.1	13.0
Other /3	22	27	29	31	33	35	45	53	9.7	5.2	3.3
Total Energy Sold	558	620	692	787	884	989	1,639	2,592	12.1	10.6	9.6
Energy purchased at bulk supply points	610	693	769	871	972	1,082	1,783	2,804	12.1	10.5	9.5
Distribution losses (%)	8.5	10.5	10.0	9.6	9.1	8.6	8.1	7.6			

/1 Excludes Government establishments billed at the domestic tariff which have been included under Institutions.
/2 Includes Sahab Industrial Estate.
/3 Comprises street lighting, radio and TV and electricity supply industry employees.

April 1982
(0429P)

JORDAN

ENERGY SECTOR STUDY

Projections of the Demand for Petroleum Products
Comparison of Actual and Predicted Consumption

1971-1981
('000 tons)

	Gasoline		Kerosene		Gas oil/Diesel		Fuel Oil	
	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted
1971	94.7	100.6	81.8	84.1	121.9	133.8	133.6	133.6
1972	107.6	102.2	90.1	90.6	143.8	144.9	159.2	149.3
1973	117.7	117.4	97.6	97.4	165.3	162.7	178.3	168.0
1974	133.5	132.8	105.6	105.2	179.6	179.5	189.6	184.6
1975	154.8	155.1	117.7	113.9	225.4	202.1	184.6	201.5
1976	183.0	184.5	131.5	128.6	319.5	295.5	225.2	232.3
1977	215.4	207.3	134.1	139.6	364.4	365.0	226.0	260.0
1978	245.4	248.2	143.1	145.5	409.2	430.0	293.8	293.4
1979	263.3	265.2	142.8	148.3	416.2	472.3	397.2	366.8
1980	270.0	278.0	160.0	147.4	509.0	504.7	469.0	463.0
1981	278.0	286.8	153.0	156.7	619.0	585.8	573.0	513.0

May, 1982
(0429P)

JORDAN

ENERGY SECTOR STUDY

Draft terms of reference

for an engineering study to determine the least cost option of meeting future energy requirements

I. Introduction

1. The Hashemite Kingdom of Jordan wishes to contract the services of experienced specialized consultants to carry out a detailed comparative study of all the indentifiable alternatives for minimizing the cost of meeting the country's energy requirements. The domestic requirements of Jordan are currently being met by the existing refinery of Jordan Petroleum Refinery Co. Ltd., (JPRC) at Zarqa.

II. Background

2. The petroleum refinery had been built during the period 1957-1960 and had come on stream in late 1960. Since its construction, the refinery has undergone three expansions, increasing its capacity from 1,000 metric tons per day to 12,300 metric tons per day. The refinery complex now consists of the following major units: 3 crude units, a distillate hydrocracker, a light gasoil unifiner, a kerosene merox, a fluid catalytic cracker, a hydrocracker, two vacuum units and an asphalt plant. Crude oil is supplied by Saudi Arabia through a spur line, off the Tapline.

3. The cost of imports has risen from JD 23 million (US$61.9 million) in 1975 to JD 114 million (US$281.2 million) in 1980. Imports for 1980 are expected to cost JD 159 million (US$410.0 million) and are estimated to be equal to the total anticipated export earnings. If energy demand projections made by Jordan are reached, then the cost of petroleum imports could exceed US$800 million by 1985 and about US$1.3 billion in 1990. Concerned with the escalating cost of crude oil imports, the Government has proposed a detailed comparative study to determine the most economic and reliable means of meeting the country's petroleum fuels requirements.

III. Objectives

4. The main objectives of the study are the following:

(i) to identify and carry out a comparative economic analysis of all the practical and reliable economic options available to Jordan

for meeting its petroleum fuels requirements to the year 2000, taking into account the proposed Aqaba thermal power projects stages I and II, and the extent to which fuel oil could be imported or substituted with either coal or natural gas;

(ii) to provide a comprehensive and documented compilation of all detailed facts concerning the optimum option; and

(iii) to present an appropriate plan for project implementation complete with engineering design data, equipment lists and manpower requirements to a degree of detail sufficient for an accurate prediction of costs and benefits.

5. The consultants will develop the projected fuels requirements to year 2000 under three scenarios--low, medium and high growths--taking into account projected GDP growth, proposed development strategy of the various sectors of the economy, and projected real increase in transportation.

6. The consultant firm should carry out inter alia preliminary basic design and engineering work to enable it to prepare realistic (i.e., with sufficient accuracy to permit a subsequent investment decision) capital and operating cost estimates for the project.

7. To ensure that the objectives of the study are fully met, the consultants would provide the services of highly qualified experts with in-depth knowledge of the structure, economics, technologies and legal aspects of the petroleum industry. If the consultant firm is deficient in any area, it would be required to consider associating itself with a highly competent specialized firm to overcome the deficiency.

IV. Schedule of Study Implementation

8. It is expected that the consultant firm's work will take about 15 months to complete from date of contract onward. Within 6 months from the start of work, the consultant shall submit to the Government of Jordan (with copies to the World Bank) a report outlining its preliminary findings. The preliminary report shall include estimated petroleum fuels requirements to year 2000 and a compilation of all the facts relating to objective (i) above. Subsequently, it is proposed to have several interim reviews at key stages of the execution of the study, as agreed with the Government of Jordan, in order to ensure the achievement of the objectives of the study. The work under the study is divided into two phases. Phase 2 will be initiated only if the conclusions/recommendations emerging from the Phase 1 study require the modification/expansion of the existing refinery and/or the construction of a new refinery, and the Government of Jordan and the World Bank accept these recommendations.

V. Scope of Work

9. The specific areas to be covered by the study shall include, but not be limited to, the following:

Phase 1

A. Demand/Supply of Petroleum Products

(i) review all available information on energy consumption in Jordan with particular emphasis on the extent of the demand served by petroleum fuels; examine past trends (1964-1981) and discuss the extent to which these trends have been modified or constrained by crude oil prices, interfuel substitution program and economic conditions in the country as well as neighboring Arab states;

(ii) review in detail, giving investment required and estimated prices, the prospects for Jordan to import either natural gas or coal as a substitute for fuel oil;

(iii) prepare a forecast for petroleum fuels demand to year 2000 under low, medium and high scenarios, taking into account economic indicators such as projected GDP growth rate and the results of the review in (i) and (ii) above;

(iv) review crude oil types and sources, examine availability of such crudes to Jordan and assess the extent to which heavier crudes like Arabian Heavy may become dominant in crude oil markets;

(v) prepare a price forecast in real terms for the major types of crude oils and refined products up to the year 2000, taking into account only expected real price increases. All assumptions used should be clearly stated; and

(vi) review historical and current price relationship between refined products and crude oil; identify any factors likely to affect the relationship in the future.

B. Marketing and Distribution of Petroleum Products

(i) describe the organization and institutional framework for the marketing and distribution of petroleum products in Jordan (companies involved, ownership, size, geographical/product coverage, etc.);

(ii) review the physical facilities used for internal transportation, storage and distribution of petroleum products; indicate the volumes transported by each transport mode, the size and locations of storage facilities, and recommend any changes necessary to improve the system; and

(iii) prepare a breakdown, by region or major consumption centers, of the retail price for each refinery product into: (a) CIF cost, (b) wholesale price, (c) dealer/retailer margin, and (d) taxes; compare retail prices with those prevailing in neighboring countries.

C. Least Cost Analysis

(i) review the existing product specifications with respect to distillation range, flash and smoke points, cetane and research octane numbers and sulphur content and examine the extent to which these specifications can be changed without harmful effects on user equipment life, cost of operation and the environment; identify/quantify any economic benefits to be derived from changes in specifications;

(ii) based on the projected petroleum products requirements to year 2000 in Section A and the recommended changes in product specifications in Section C (i) above, identify all practical, economic options available to Jordan for meeting its petroleum fuels requirements. The options shall be designed and costed on the basis of the high growth scenario but its benefits evaluated on the basis of the low growth projected requirements in Section A for the base case analysis; relevant sensitivity tests should be carried out. The options considered shall include, but not be limited to:

(a) supplying petroleum fuels requirements using existing facilities;

(b) substituting coal or natural gas for fuel oil in the thermal power plants and supplying other petroleum fuels requirements using existing facilities, and exporting surplus fuel oil;

(c) substituting coal or natural gas for fuel oil and installing conversion facilities;

(d) importing fuel oil required for the Aqaba thermal power plants and modifying/expanding existing facilities to meet other petroleum fuel requirements; and

(e) constructing a new refinery principally to meet Aqaba fuel oil requirements, and modifying existing facilities to supply other petroleum fuels requirements.

(iii) describe in sufficient detail the scope, configuration and technology of each option considered; identify existing facilities, any debottlenecking necessary and all new facilities required to ensure the operating viability of each option; all assumptions associated with each option shall be clearly stated;

(iv) prepare preliminary design of adequate detail to enable estimation of capital and operating cost and working capital requirements of sufficient reliability (±15%) for each option;

(v) prepare an efficient and economic implementation plan and provide a schedule of expenditures for each option considered; and

(vi) by means of comparative present value analysis, using a range of opportunity cost of capital (12%-20%), rank the various options beginning with the least cost; evaluate the relative merits of each option (reliability, risks, security, etc.) and recommend the most appropriate option fo the consideration of the Government of Jordan.

10. Phase 2. The Phase 2 work will commence following review of the Phase 1 work and recommendations, and after receiving approval from the Government of Jordan to proceed. The Phase 2 work shall include the following:

A. Development of Project and Engineering Design Package

(i) provide detailed description of the scope and configuration of the option approved by the Government, including size of facilities, process/technology/licenses to be used, rationale for its selection, existing facilities to be rehabilitated, and how new facilities are to be integrated into existing facilities. If the option approved by the Government is a new refinery or installation of additional conversion capacity at the existing refinery, describe:

(a) the source and type of feedstock to be utilized;

(b) the utility facilities (water, power, coal, steam, etc.) to be provided or expanded under the project--their size, the inputs to be used, the source of energy, reliability or external supply of utilities, and type of contracts for the external supply of utilities;

(c) the offsites and infrastructure facilities required by the project; and

(d) management, training and technical assistance requirements.

If the option approved by the Government is imports of refined products, describe:

(a) procurement sources and reliability;

(b) mode and facilities for transportation and freight; and

(c) storage and infrastructure facilities required (if any), e.g., pipelines, pumping stations, etc.

(ii) analyze the environmental impact of the project such as hydrogen sulphide, sulphur oxides, and nitrogen oxide emissions and the devices and controls that will ensure that the project will be constructed and operated in accordance with international and local environmental and safety standards;

(iii) determine infrastructure needs of the project during implementation such as access roads, ability of bridges to carry maximum loads, port facilities, etc.;

(iv) prepare a detailed project engineering package (as appropriate) including process flow diagrams showing major process lines, equipment and material balances, piping and instrumentation diagrams showing all process equipment, process piping, line sizes, vessel sizes, instrumentation and line index, reference drawings for each process unit where applicable, standard drawings for individual process units and equipment and material specifications with complete basic process and mechanical information for purchase and/or detailed design by others. Existing units/facilities should be clearly identified. Where appropriate, detailed specifications should be developed for offsites and utilities.

B. Capital and Operating Cost Estimate

(i) prepare detailed revised estimates of the capital cost of the project broken down into foreign exchange and local costs, with equipment, utilities, infrastructure, offsites, freight, engineering, erection, construction, pre-operating costs, customs duties, physical and price contingencies, interest during construction and permanent working capital shown separately;

(ii) provide an expenditure/disbursement schedule; and

(iii) prepare a detailed operating cost estimates with detailed breakdown into local and foreign exchange costs, and showing specific consumption of all inputs and utilities; assumptions used for the estimates should be clearly stated.

C. Legal and Equity Aspects

(i) without committing the Government, identify potential investors with proven operating experience in operations similar to the proposed project who may be interested in equity participation in the proposed project;

(ii) discuss the terms and conditions of standard participation agreement normally offered in international ventures for participation of foreign operating firms in projects similar to the proposed project;

(iii) recommend a series of proposed incentives, changes in existing legislation, and other measures that could be taken to induce potential foreign partners to participate in the project and to ensure that the Government will maintain control of key developments of the project; and

(iv) prepare a mode concession agreement that could be used as a basis to negotiate the participation of a foreign partner; and

(v) advise the Government on concessional arrangements with potential investors.

D. Financial and Economic Analysis

(i) evaluate the financial viability of the project on the basis of discounted cash flow projections and internal financial rate of return calculations. The basic assumptions used in the financial evaluation should be fully explained. The computation should include a risk analysis to evaluate the sensitivity of the project to critical factors;

(ii) evaluate the economic viability of the overall project on the basis of internal economic rate of return. For this purpose, all inputs and outputs should be evaluated at their economic opportunity cost, rather than at domestic market prices which may reflect market imperfections. For

internationally tradeable goods and services, CIF international prices can be used as representative of opportunity costs. Appropriate risk analyses should also be made; the assumptions used in the evaluation should be fully explained;

(iii) prepare projected financial statements (balance sheet, income statements and cash flows) for 15 years, in current prices; and

(iv) evaluate the impact of the project on the region of the country in which the project is located and identify direct and indirect social and economic benefits. Consider possible changes in some of the parameters of the project and its infrastructure that could have favorable impact on the region. Analyze the social and economic benefits and costs of these changes in order to permit a decision on the desirability of executing them.

E. Project Implementation Arrangements and Schedule

(i) propose arrangements for procurement, construction, commissioning and operations, including guarantees and bonuses/penalties for process performance, schedules, feed and utilities consumption, etc.;

(ii) design suitable organization and administrative arrangements for the efficient management and supervision of project construction and operations, including a detailed assessment of needs of foreign staff and consultants by categories and by duration;

(iii) indicate total staffing requirements for the new facilities as appropriate, identify sources and provide a training program which will lead to effective eventual Jordanization of the operation;

(iv) develop a practical economic and expedient plan for the implementation of the project, and draw up a realistic and detailed time schedule for project implementation; and

(v) prepare invitations to bid documents.

JORDAN

ENERGY SECTOR STUDY

Forecast Energy Balance, 1985 /1
('000 toe)

1985	Crude Oil	LPG	Gasoline	Jet Fuel	Kerosene	Gas Oil/ Diesel	Fuel Oil	Asphalt	Fuel Gas	Electri-city /2	Total
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	3,700	-	-	-		-	-	-	-	-	3,700
Exports	-	-	-	-	-	-	-	-	-	-	-
Total Supplies	3,700	-	-	-	-	-	-	-	-	-	3,700
Oil refineries	(3,700)	91	396	474	168	1,157	1,157	148	12	-	(97)
Electricity generation	-	-	-	-	-	(58)	(522)	-	-	480	(100)
Energy industries' own use & losses	-	-	-	-	-	-	(170)	-	(12)	-	(182)
Total Final Use	0	91	396	474	168	1,099	465	148	0	480	3,321
Industry	-	-	-	-	-	170	393	-	-	232	795
Transport	-	-	396	474	-	848	46	-	-	-	1,764
Households	-	91	-	-	168	58	-	-	-	121	438
Commerce & others	-	-	-	-	-	23	26	148	-	127	324

/1 Brackets show transfer or input to other sectors.
/2 Electrical quantities were converted into their oil equivalent using the following factor: 1 kWh = 0.25 kgoe.

November 1982
(0579P, p.74)

JORDAN

ENERGY SECTOR STUDY

Forecast Energy Balance, 1990 /1
('000 toe)

1990	Crude Oil	LPG	Gasoline	Jet Fuel	Kerosene	Gas Oil/ Diesel	Fuel Oil	Asphalt	Fuel Gas	Electri-city /2	Total
Production	-	-	-	-	-	-	-	-	-		
Imports	4,300	37	18	-	-	920	565	-	-	-	5,840
Exports	-	-	-	-	-	-	-	-	-	-	-
Total Supplies	4,300	37	18	-	-	920	565	-	-	-	5,840
Oil refinery	(4,300)	110	619	665	202	963	1,328	238	15	-	(160)
Electricity generation	-	-	-	-	-	(48)	(905)	-	-	809	(144)
Energy industries' own use & losses	-	-	-	-	-	-	(198)	-	(15)	-	(213)
Total Final Use	0	147	637	665	202	1,835	790	238	0	809	5,323
Industry	-	-	-	-	-	385	795	-	-	386	1,475
Transport	-	-	637	665	-	1,318	54	-	-	-	2,674
Households	-	147	-	-	202	94	-	-	-	210	653
Commerce & others	-	-	-	-	-	38	32	238	-	213	521

/1 Brackets show transfer or input to other sectors.
/2 Electrical quantities were converted into their oil equivalent using the following factor: 1 kWh = 0.25 kgoe.

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JORDAN

ENERGY SECTOR STUDY

Energy Pricing

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JORDAN

ENERGY SECTOR STUDY

Energy Pricing

A. General

1. The formulation of policies for the pricing of petroleum products is the responsibility of the "Committee for the Pricing of Combustibles (CPC)", composed of representatives of the Ministry of Finance, the Ministry of Industry and Trade, the Directorate of the Budget and JPRC. CPC's pricing proposals are submitted for approval to the Ministerial Committee for Development (MCFD) in which the major sectors of Jordan's economy are represented; e.g. manufacturing, agriculture, mining, transportation, etc. However, the concurrence of the Council of Ministers (CM) is required, prior to the implementation of the pricing proposals approved by MCFD. The formulation of policies for the pricing of electricity is the responsibility of JEA which outlines its pricing proposals in close consultation with JEPCO and IDECO. JEA's tariff proposals are submitted to the MCFD for approval, then as is the case with the pricing of petroleum products, the concurrence of the CM is required before the new tariffs are officially adopted.

B. Petroleum Products

Historical Overview

2. Prior to the oil embargo of 1973, domestic prices for petroleum products were set at levels that, as a minimum, reflected the cost to the Government of importing and refining the crude oil, and transporting and distributing the products. The petroleum subsector was a net contributor to the national budget through the taxes levied on gasoline and gas oil/diesel. This contribution started eroding, and eventually turned into a net subsidy by 1975, as the price of imported crude continued to increase and domestic prices of petroleum products were held at their 1972 level. In 1976, the Government raised the prices of petroleum products, for the first time since 1973, to reduce the burden of the subsidy on the national budget. In 1977 the price of gasoline was again increased to provide additional tax revenues. By the end of 1978, the net subsidy for petroleum products reached JD 22 million (US$66 million) which represented about 14% of the Government's domestic revenues for that year 1/2/. Following the second round of significant increases in the price of oil at the end of 1978 and early 1979, the Government projected that if domestic prices remain unchanged, the subsidy for petroleum products would reach levels unsustainable by the national budget. Consequently, it decided to gradually phase out the subsidy, starting 1979, by raising the prices of petroleum products to ultimately close the gap between domestic and border prices. Domestic prices of petroleum products were since increased five

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1/ The Government total domestic revenue, which includes tax revenues, fees, licenses, etc., amounted to JD 156.5 million.

2/ Detailed records of the total subsidy extended to the consumers of petroleum products were not kept by the Government; as a result, the estimates given here are based on reconstructed figures based on the little information that was available.

times: in March and July of 1979, February of 1980 and February and November of 1981. However, despite the two increases that took place in 1979, the subsidy for petroleum products in that year reached JD 37 million (US$11 million); the highest level since 1975 and representing 20% of the Government's domestic revenue.

3. The prices of petroleum products have increased in nominal terms at an average annual rate of about 19% between 1973 and 1982. These increases were not uniform across products. The highest increase was in the price of fuel oil (24%) followed by gas oil (17%), kerosene (15%) and gasoline (15%). In real terms, however, the average annual rate of increase for all products was about 7%, ranging from 3% for gasoline to 11% for fuel oil as summarized in Table 8.1 below. (Details are given in Attachment 1) Over the 10-year period, all real prices of petroleum products, with the exception of gasoline, decreased between 1973 and 1979, then started increasing thereafter.

Table 8.1

Average Annual Rate of Increase
Between 1973 and 1982 in Nominal and Real Terms

	Nominal Terms	Real Terms
Gasoline	14.6%	3.1%
Kerosene	14.8%	3.3%
Gas oil/diesel	17.2%	5.4%
Fuel oil	23.7%	11.2%

4. In nominal terms, the net subsidy for petroleum products increased from JD 17 million (US$51 million) in 1975 to JD 37 million (US$111 million) in 1979; then as a result of the substantial increases in the prices since 1979, it steadily decreased thereafter to reach JD 20 million (US$60 million) in 1981. As seen from Table 8.2 below, the net subsidy decreased in real terms to JD 10 million (US$30 million) in 1981, representing 59% of its level in 1975 and 42% of the 1979 level.

Table 8.2

Government Subsidy for Petroleum Products /1 /2
(JD million)

Year	Net Subsidy (nominal terms)	Net Subsidy /3 (real terms)
1975	17	17
1976	17	15
1977	18	14
1978	22	16
1979	37	24
1980	31	18
1981	20	10

/1 Reference is made to net subsidy because detailed data on the commission for refining and marketing are not available except for 1981.
/2 Rounded to the nearest million.
/3 in 1975 prices.

The Level and Structure of Prices for Petroleum Products

5. According to the prevailing policy for pricing petroleum products, the Government taxes motor gasoline, LPG and aviation fuel sold to the foreign air carriers, and subsidizes the prices of all other products.

Table 8.3

Relationship of Domestic and Border Prices for Petroleum Products
(January 1982)
(US$/ton)

Product	Border Price	Domestic Price	Tax or (Subsidy)	Domestic Price as % of Border Price
LPG	390	394	4	101
Gasoline /1	360	683	323	190
Jet fuel /2	338	201	(137)	59
Jet fuel /3	338	449	111	133
Kerosene	320	221	(99)	69
Gas Oil/Diesel	318	213	(105)	67
Fuel Oil	169	150	(19)	89

/1 weighted average of premium and regular gasoline
/2 for national airline
/3 for foreign airlines

Source: Petroleum products average spot prices, Petroleum Economist, The International Energy Journal. Volume XLIX, No. 1, January 1982, p. 36.

In January 1982, the weighted average domestic price for petroleum products was at about 95% of the average border price; US$272/ton compared with US$285/ton. However, the relationship of domestic and border prices varied considerably from gasoline which continues to be highly taxed at about 190% of its border price, to gas oil at about 67% of its border price. Table 8.3 compares domestic and border prices for petroleum products.

6. The Government buys the crude oil from Saudi Arabia which is delivered to the refinery at Zarqa by special pipelines connected to the Tapline (Annex 6, para 16). JPRC refines the crude oil, and markets the petroleum products in exchange for commissions that vary with the product. These commissions are reviewed and adjusted periodically to ensure a fair return to the owners of the refinery. A summary of JPRC's commissions for each product is provided in Table 8.4 below.

Table 8.4

Domestic Cost of Petroleum Products (1981)
(US$/ton)

Petroleum Product	Share of Total Consumption	Refinery Commis./1	Distr. & Marketing Comm.	Domestic Price /4
LPG	2.8	-	71.6	394
Gasoline (prem.)	0.5	104.5	8.4	755
Gasoline (reg.)	13.1	68.1	8.4	633
Jet Fuel/2	10.7	67.5	-	201
Jet Fuel/3	2.5	68.5	-	449
Kerosene	7.5	37.1	6.0	207
Gasoil/Diesel	30.2	44.1	3.7	179
Fuel oil	27.9	22.7	-	134
Asphalt	4.9	30.7	-	120

/1 Including transportation for the industrial and aviation fuels.
/2 For national airline
/3 For foreign airlines
/4 Average for 1981, since prices were increased twice (February and November).

Source: Jordan Petroleum Refinery Company.

The Government pays JPRC a distribution and marketing commission for LPG, gasoline, kerosene and gas oil/diesel. The cost of delivering fuel oil and aviation fuel are individually arranged with and covered by the consumers. JPRC collects the revenues from the sale of petroleum products and forwards them to the Government on a monthly basis. The Government, in turn, reimburses the company for commissions due.

7. In 1981, the Government paid an average price of US$32.8/barrel (US$236.3/ton) for the imported crude oil, including the cost of delivery to the refinery of about US$0.5/barrel (US$3.6/ton). In addition, it paid JPRC about US$6.9/barrel (US$49.7/ton) in commissions for refining and distribution, and collected from the company a service charge of US$2.0/barrel (US$14.4/ton) of crude refined. Therefore, on the average, the reconstituted barrel in 1981 cost the Government US$37.7/barrel (US$271.6/ton) compared to a revenue of about US$33.6/barrel (US$242.2/ton), leaving a net deficit of about US$4.1/barrel (US$29.4/ton) (Attachment 2).

Distribution of Subsidies for Petroleum Products

8. Net Subsidy: The net deficit of US$4.1/reconstituted barrel consumed in 1981 amounted to a net subsidy for petroleum products of about US$60 million (JD 20 million), of which US$38.7 million accrued to the transportation sector (64%), US$4.3 million to the industrial sector (7%), US$7.1 million to the power subsector (12%), US$9.4 million to the households (16%), leaving about US$0.5 million (1%) which was divided among all other sectors. Details are provided in Table 8.5 below.

Table 8.5

Distribution of Net Subsidy by Sector and Product in 1981
(US$ million)

Product	Transport	Industry	Power	Domestic	Others	Total
Jet Fuel	14.9	-	-	-	-	14.9
Kerosene	-	-	-	7.5	-	7.5
Gas oil	23.5	2.1	4.4	1.7	0.5	32.2
Fuel oil	0.3	2.2	2.7	0.2	-	5.4
Asphalt	-	-	-	-	-	-
Total	38.7	4.3	7.1	9.4	0.5	60.0

9. Total Subsidy: So far, the review of the subsidies since 1975 was set in net rather than total terms because historical costs of refining and marketing, with the exception of those pertaining to 1981, were not made available. The total subsidy for petroleum products in 1981 amounted to about US$120 million (JD 40.0 million) representing almost double the net subsidy of US$60 million (JD 20 million) calculated above. The difference between the total and net subsidy represents the tax revenue associated with the sale of LPG, gasoline, jet fuel 1/, which were diverted from other uses to cover part of the total subsidy for petroleum products. The distribution of the overall subsidy among the sectors and products is summarized in Table 8.6 below.

1/ Sold to foreign airlines.

Table 8.6

Distribution of Total Subsidy by Sector and Product in 1981
(US$ million)

Product	Transport	Industry	Power	Domestic	Other	Total
Jet Fuel	29.8	-	-	-	-	29.8
Kerosene	-	-	-	15.0	-	15.0
Gas Oil	47.0	4.2	8.8	3.4	1.0	64.4
Fuel Oil	0.6	4.4	5.4	0.4	-	10.8
Asphalt	-	-	-	-	-	-
	77.4	8.6	14.2	18.8	1.0	120.0

Strategy for the Future Pricing of Petroleum Products

10. The subsidy for gas oil/diesel accrues mainly to the transportation sector, the power subsector, industry and households (Annex 6). The subsidy for jet fuel benefits the national airline, while the subsidy for fuel oil accrues to industry (cement , oil refining, etc.,) and the power subsector. These subsidies are maintained by the Government in the hopes that: a) they would be indirectly passed on to the consumers through relatively lower prices for goods and services produced by the transport, industrial and agricultural sectors; and b) the price competitiveness of Jordanian exports would be ensured. The subsidy for kerosene is passed on directly to the household consumers through the reduced price paid for the product in the market. Given the fact that the bulk of the subsidies accrue to consumers who generally can absorb the higher prices for petroleum products without significantly increasing the prices of their output (trucking, air transport, power generation); and that, for consumers who could be adversely affected by the higher prices (industry), there are other direct means of cushioning the adverse impact of higher prices (retrofitting, conservation), the subsidies are not justified on social and economic grounds. However, the subsidy for kerosene is socially justified and could be maintained, if desired by the Government. Therefore, it is recommended that the Government continue its past effort to phase out the subsidies, and that it set the end of 1985 as the target date for achieving parity between domestic and border prices for gas oil/diesel, fuel oil, and aviation fuel to ensure that these fuels are consumed in an economically efficient mix, and to mobilize some of the surplus currently accruing to the consumers of energy.

11. Increases in domestic prices needed to achieve parity with border prices by 1985 would have a relatively small impact on restraining the future growth of the demand for petroleum products, because the long-run price and income elasticities of demand have shown that the consumption of petroleum products in Jordan is more responsive to changes in income than to increases in prices (Annex 7, Table 7.2). Therefore, in the case of Jordan, the elimination of the subsidy would result in a greater resource mobilization for

the Government, and to a much lesser extent, would restrain the growth of future demand for energy. However, from a resource allocation point of view, parity with border prices is essential in inducing consumers to use petroleum products and electricity efficiently. The elimination of the subsidies for petroleum products by 1985 would mobilize about US$170 million as shown in Table 8.7 below.

Table 8.7

Resources to be Mobilized by the Elimination of the Subsidies for Petroleum Products by 1985
(US$ Million)

Aviation fuel	47.0
Fuel Oil	18.0
Gas Oil/Diesel	105.0
Total Resources	170.0

12. The potential for interfuel substitution which higher prices for petroleum products could bring about, is rather small. In the transportation sector, the import of diesel-operated passenger cars for private or commercial use is not allowed. This rule also covers buses for mass transit. Therefore, the potential of the trucking industry moving from diesel to other fuels is virtually zero. In industry, almost all autogeneration has been converted to operate by burning fuel oil (para. 8.22). In addition, JEA has been shifting away from gas oil/diesel to fuel oil by converting its diesel units (Annex 6, para. 23). This is demonstrated by the fact that consumption of diesel oil by JEA has dropped from 56% of total fuel in 1976 to 23% in 1981 and would reach only 10% by 1990. Therefore, the potential for substitution in the power subsector is also negligible. Substitution could possibly take place in the household demand for diesel or gas oil for heating where, if the price increases, there could be a shift to electricity. However, given the high level of electricity tariffs and the recommendations that it be increased to reach parity with marginal cost (para. 6.16), it is unlikely that consumers would switch to electricity and away from diesel oil despite its higher prices. Only if Jordan imports coal or gas would there be substantial potential for interfuel substitution in industry and power generation.

13. The higher prices for petroleum products would raise the prices of the goods and services produced in Jordan. The extent of that rise largely depends on the share of energy in the total inputs used to produce each good. Detailed information on the pattern of energy consumption is needed in order to assess the impact of closing the gap between domestic and border prices. Otherwise only generalized assessments could be made which would be meaningless for policy formulation. The Government should give high priority to the compilation of energy data which would serve as a basis for expanding the recently constructed input/output model (35x35). The data base would also provide the necessary input for monitoring energy consumption and relating it

to norms established in the industrialized countries. The compilation of energy data and its organization into a data base would take about two years to complete. In the interim, however, the Government could follow a strategy whereby prices for energy are raised for some selected consumers, on which the impact of higher prices would be easily ascertainable. For that purpose the Government should concentrate on the major consumers of petroleum products and electricity and collect detailed information on the energy consumption of each plant or consumer and the contribution of energy to the overall cost of their products. This would enable the Government to assess, within a relatively short period of time (6 months), the impact of the proposed strategy for the elimination of the subsidies for petroleum products on the major consumers and make possible the setting of the framework for moving the prices of petroleum products on a selected basis.

14. A proposed strategy for an interim policy for pricing petroleum products would entail the following:

Aviation fuel: The impact of raising its price is most easily ascertainable. The entire subsidy for aviation fuel accrues to the national airline (Alia). A detailed analysis of Alia's energy consumption and an estimate of its contribution to the overall cost of operations can be undertaken within a relatively short period of time. An agreement on a timetable for reaching parity with border prices possibly coupled with the institution of an improved system for fuel management would provide Alia the time needed to absorb the higher prices while improving its energy efficiency. However, should the Government decide to continue subsidizing the airline, it would be preferable to do so through direct budgetary allocation rather than indirectly via the price paid for fuel. The indirect nature for transmitting the subsidy to Alia does not provide the incentives for the airline to improve the scale or efficiency of its operations. Therefore, it is recommended that the Government consider undertaking a detailed assessment of the patterns of Alia's consumption of energy and ascertaining the impact of eliminating the subsidy for aviation fuel over the next 3 years on the cost and competitiveness of the airline.

Fuel Oil: The assessment of the impact of higher prices for fuel oil on the economy is relatively simple to undertake because the product is consumed by few large consumers who can be easily identified. JEA accounts for almost 50% of all the fuel oil consumed in Jordan. Consumption by industry is divided among the cement plant, the refinery, the potash complex and the fertilizer plant. The impact on JEA's tariffs of higher prices for fuel oil is readily available; that is, for each 10% increase in the price of fuel oil, the average tariff would have to be increased by about 4%. This would provide the means of assessing the primary and secondary (electricity tariffs) impact on industry of increasing the price of fuel oil. Since the consumers of fuel oil are few, the compilation of information on their financial and operational settings, and the analysis of the impact of higher prices for energy on

the prices of their output could be completed in less than 6 months. Therefore, in view of the concentration of the consumption of fuel oil among few large consumers, the Government should consider undertaking a detailed review of the operations and cost structure of each to ascertain the likely impact of higher prices for energy on the prices of the products produced by each.

Gas Oil/Diesel: This fuel is mainly consumed by the transportation sector (73%). The rest is shared among the power subsector (13%), industry (7%) and household consumers (15%). Agriculture accounts for less than 1%. The subsidy extended to the power subsector could be eliminated without significantly affecting the tariffs because JEA's consumption of gas oil as a percentage of total fuel used is expected to decrease from 20% in 1982 to less than 10% by 1985 when the subsidy is projected to be eliminated. Similarly, as in the case of fuel oil an assessment can be easily undertaken of the impact of phasing out the subsidy over a 3 year period on the prices of the affected industries. Moreover, since the gas oil is not used as a feedstock but as a source of energy for power generation at the industrial sites, there is a scope for the Government to cushion the impact of rising prices for diesel by providing incentives to industry to adapt the isolated generating facilities to burn fuel oil and reduce their dependence on JEA for power supply during peak hours (paras. 8.22-8.23). This underscores the importance of the power subsector's demand management study and the industrial conservation study proposed in this report (Annex 10, Attachment 2). As for the transportation sector, it is difficult to ascertain the impact of higher prices for fuels on the transportation cost of goods and services, and in turn, the price of the goods and services transported. However, if experience gained elsewhere is applied to Jordan, the higher prices for energy would raise the transportation cost, but since transportation constitutes a small percentage of the total cost of the goods and services delivered to the market (usually between 3%-5%), the impact of higher costs for transportation is unlikely to significantly raise the general price level in the economy. The only risk of raising the prices for gas oil to the transportation sector is the round of unjustified increases in the general price levels which could be triggered by attributing the increase to the higher cost of energy. Therefore, it is prudent for the Government to examine in detail the impact of eliminating the subsidy on the cost of transportation within Jordan and the likely effects of higher transportation costs on the general price level. A preliminary assessment of the impact of higher energy prices on the transportation sector is expected to be available by March/April 1983 when the results of a national transportation study, undertaken by a team of consultants, are submitted for review to the Government. As for gas oil consumed by households, the fact that it is used for home heating by a small proportion of the population with a relatively high income would limit, to a great extent, the social impact of higher price brought about by the elimination of the subsidy.

15. Kerosene is almost exclusively consumed by the low-income urban and rural consumers for cooking and lighting. The long-run demand for kerosene is fairly inelastic to changes in price and income estimated at -0.1 and 0.2 respectively, which reflects its use as a necessity by the low-income consumers. Socially, therefore, there is justification for subsidizing kerosene. However, it is recommended that the Government consider maintaining the overall burden of the subsidy constant in real terms until 1985 by transmitting all future increases in the cost of production to the consumers, and then gradually phasing out the subsidy over the period 1985-1990.

C. Electricity Tariffs

Historical Overview

16. In nominal terms, the average revenue from the sale of electricity has increased at an average annual rate of about 12.7% between 1975 and 1981; from 16.7 fils/kWh (US5.0c/kWh) in 1975 to 34.2 fils/kWh (US10.2c/kWh) in 1981. In real terms, however, the average annual rate of increase was less than 1%; from 16.7 fils/kWh in 1975 to 17.6 fils/kWh in 1981. The real price of electricity has been oscillating since 1975 because of the variation in the length of the time period during which the Government allows JEA to reflect the rise in the general price level including the increase in JEA's fuel bill, in its tariffs. It is noteworthy to mention that although JEA's fuel bill increased, in real terms, at an average annual rate of about 10% between 1975 and 1981, which would have required an annual increase in the average revenue of about 5%, the average revenue had increased by less than 1%. This had the effect of lowering the self-financing capabilities of the power subsector (para. 19). JEA has been able to absorb the significant increase in its fuel bill because of its gradual shift since 1978 towards more intensive use of fuel oil to replace the more expensive gas oil.

Table 8.8

The Development of the Average Revenue for Electricity
In Current and Real Terms, 1970-1981
(fils/kWh)

	Average Revenue in Current Prices	Average Revenue in 1975 Prices
1975	16.7	16.7
1976	16.7	15.0
1977	23.0	18.0
1978	24.0	17.6
1979	24.0	15.4
1980	34.2	19.7
1981	34.2	17.6

Level and Structure of Electricity Tariffs

17. Bulk Tariffs: The bulk tariffs apply only to JEA's sales to the large industrial consumers and the electricity distribution utilities (Attachment 4). These tariffs are based on a time of day structure (peak and off-peak) with no seasonal variation. They also differentiate between consumers in the district of Irbid and those in the other districts. The tariff for the peak periods involves a capacity charge of JD 2.4/kW (US$7.2 kW) for all districts, and an energy charge of 17.5 fils/kWh for Irbid and 18.5 fils/kWh for the other districts. The tariff for the offpeak hours involves only the energy charge as is the practice in electric utilities around the world. JEA's tariffs also include a fuel adjustment clause which is supposed to automatically transmit to consumers the increase in the cost of fuel used to meet their demand. However, the Government has maintained control over JEA's right to activate the clause, and as a result, tariffs at present do not fully reflect the prices paid for fuel used for generation (para. 20).

18. Retail Tariffs: The tariff structure for electricity sales to the low-voltage consumers is identical for all three utilities (JEA, IDECO and JEPCO). It is based on a uniform block rate for each customer category classified according to the end use of electricity (domestic, commercial, small industries, water pumping, etc.). However, the tariff level for each category differs slightly among the three utilities (Attachment 4) to reflect the cost incurred by each utility in providing electricity service.

19. JEA is expected to cover about 25% of the annual cost of its investment program through revenues generated from the sale of electricity. This financial target was to a large extent achieved during the period 1975-1980 through periodic increases in tariffs. In keeping with its 1979 decision to gradually phase out the subsidy for petroleum products (para. 2), the Government raised, in 1981, the prices of fuel oil by 66% and gas oil/diesel by 73%, but JEA was not allowed to pass on these increases to its consumers through the fuel adjustment clause. As a result, JEA's internal cash generation for 1981 dropped to about 11%. Early 1982, the Government extended a grant to the corporation of about US$3 million to bring the internal cash generation to 25%. Although budgetary allocations from the Government would maintain JEA's internal cash generation at 25%, these would have two negative impacts on the power subsector: a) it would hinder the development of JEA into an autonomous self-financing public enterprise; and b) it would lower the prevailing tariff levels relative to the economic cost of supply which would ultimately result in the uneconomic use of electricity. Therefore, it is recommended that the Government consider allowing JEA to reflect in its tariffs all future changes in its fuel bill through the fuel adjustment clause without requiring the intervention of the authorities.

Tariff Level and Economic Cost of Supply

20. The decision taken by the Government not to allow JEA to cover the higher cost of fuel from its consumers stemmed from its belief that such an

increase would have been socially unacceptable and would not have allowed the electricity-intensive industries sufficient time to fully adjust to the earlier increase of 1980. This has had the effect of lowering the tariffs relative to the economic cost of supply (LRAIC).1/ Table 8.9 summarizes the relationship between the average tariff at each voltage level and the average economic cost of supply.

Table 8.9

Relationship of Prevailing Tariffs and the Economic Cost of Supply - January 1982
(fils/kWh)

	Prevailing Tariff	Economic Cost
Bulk Supply		
Direct, JEPCO, IDECO	23.4	26.2
Retail Supply		
Pumping MV	28.0	27.7
Large Industries MV	28.5	26.8
Urban Households	37.0	48.9
Rural Households	37.0	71.6
Small Industries LV	30.6	35.7
Commerce LV	45.0	41.2
Institutions LV	34.3	41.2

21. In January 1982, the average economic cost of electricity, based on LRAIC, for sales to the bulk consumers was about 26.2 fils/kWh compared to an average revenue for sales to JEPCO, IDECO and the large industrial consumers of about 23.4 fils/kWh. The average revenue was about 34.2 fils/kWh representing about 91% of the average economic cost of supply of 37.6 fils/kWh, which implies that the prevailing tariffs fall slightly short of conveying to consumers the economic cost of the resources used in meeting their demand for electricity. As discussed above, this difference is largely attributed to the inability of JEA to pass on the increases in the domestic prices for fuel oil and gas oil/diesel to the consumers. If JEA was allowed to reflect in its tariffs the increases in its fuel bill during 1981, the

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1/ The economic cost of electricity is equal to the long run marginal cost (LRMC). LRMC is derived from the least cost program for the development of the power subsector. It refers to the increase in the capital and operating costs (generation, transmission and distribution) needed to meet the demand for additional kWh in the future. However, because of the lumpiness of investment in power facilities (indivisibilities), the long run average incremental cost (LRAIC) is taken as a proxy for the LRMC. See Munasinghe, Principles of Modern Electricity Pricing, World Bank reprint series No. 185.

average tariff would have been 39 fils/kWh, or on the average about 5 fils/kWh higher than the prevailing average tariff, and 2.6 fils/kWh above the average economic cost of supply.

Subsidy to Electricity Consumers

22. In 1981, the economic subsidy to the consumers of electricity amounted to about US$13.4 million, of which US$12.7 million accrued to some of the low-voltage consumers, namely the households (rural and urban), and the remaining US$0.7 million accrued to the large industrial consumers. Among all the consumer categories, the medium voltage industrial consumers and the commercial consumers, were taxed while all other consumer categories were subsidized. The distribution of the subsidies between the various consumer categories is summarized in Table 8.10 and details are presented in Attachment 3.

Table 8.10

Net economic subsidy for electricity, 1981
(US$ million)

A. Subsidy	
Bulk consumers	
Cement	0.6
Refinery and potash	0.1
Total(1)	0.7
Retail consumers	
Domestic	13.0
Industrial /1	1.9
Institutions	1.4
Total (2)	16.3
Total subsidy (3) = (1) + (2)	17.0
B. Tax	
Retail consumers	
Industrial MV	2.1
Commerce	1.5
Total tax (4)	3.6
C. Net subsidy (3)-(4)	13.4

Of the total economic subsidy of about US$17.0 million, 77% (US$13 million) accrued to the domestic consumers and 11% (US$1.9 million) to the low-voltage industrial consumers, 8.2% (US$1.4 million) to the institutions (Government and private), and the remaining 4% (US$0.7 million) to the large industrial consumers. However, about 21% (US$3.6 million) was covered by the

medium-voltage industrial consumers and the commercial consumers, leaving a net subsidy of about US$13.4 million. This was accounted for by the fact that the utilities have been selling electricity to the domestic rural and urban consumers at a tariff below economic cost of supply.

23. The prevailing tariff structure for electricity sales at the low voltage is based on uniform block rates; that is, consumers who use electricity for the same end use, pay the same rate irrespective of the kWhs consumed. The income elasticity of electricity demand by the domestic consumers is estimated at about 1.5 compared with a price elasticity of about -0.4. This implies that by increasing tariffs to cover the economic cost of electricity, the household consumption would not be reduced significantly; however, the higher tariffs would mobilize more resources for the utilities (JEA, JEPCO and IDECO). The net effect of rising real income and rising real tariff would be increased consumption of electricity by domestic consumers but at a lower rate of growth than if the real tariff was not increased. This has been demonstrated by the growth of consumption in 1980. After a 40% increase in the average tariff in that year, the growth of consumption slowed down for the first 2 months following the increase, then resumed its historic rate of growth. There are strong indications that the consumption of electricity by the domestic consumers in Jordan is affected by the relatively high remittances from Saudi Arabia and the Gulf States which accrue to the households. However, the impact of these remittances is not measurable. In 1981, 90% of the domestic consumers consumed an average of 360 kWh or less per annum which amounted to 65% of the overall consumption. The remaining 10% of the consumers, with consumption higher than 360 kWh per annum, accounted for 35% of total household consumption. Table 8.10 below summarizes the distribution of electricity consumption within the household category. From a resource allocation point of view, tariffs for domestic consumers should be set at parity to the economic cost of supply. This would constitute an objective that the Government should plan to achieve, at the latest, by 1985. At present, the economic pricing of electricity sold to the household consumers, which account for 36% of total sales, would imply that the tariff should be raised from 37 fils/kWh to 48.9 fils/kWh for urban consumers, and to 71.6 fils/kWh for rural consumers. However, should the Government desire to cross-subsidize the low-income rural and urban consumers, the tariff could be restructured to ensure a minimum consumption at a tariff equal to the weighted marginal cost of supply 1/, and charge higher consumption at a tariff that is above marginal cost to recover all or part of the subsidy.

1/ equal to the average of the marginal costs of supply to urban and rural consumers weighted by these consumers' respective share in total low-voltage sales.

Table 8.10

Distribution of Electricity Consumption Within the Household Category

% of Household Consumers	Monthly Consumption kWh	Total Energy Sold in MWh	% of Total Energy Sold
30	0-100	25,267	12.5
40	100-200	60,225	29.9
20	200-360	44,269	21.9
10	more than 360	71,722	35.7

24. In the interim, however, and since the Government is concerned that higher tariffs would be socially unacceptable, the increasing block rates structure could be achieved by: a) maintaining the tariff at its current level of 37 fils/kWh for the first 360 kWh per annum since all domestic consumers are presently willing to pay this price; and b) charging 52 fils/kWh for consumption higher than 360 kWh per annum, which consumers have already demonstrated their willingness to pay in IDECO's concession area. In addition and in order to achieve parity between the same consumer class in both Irbid and the other Governorates, the tariffs for consumers in Irbid with annual consumption less than 360 kWh per annum should be lowered to 37 fils/kWh. The adoption of the proposed tariff structure would mobilize about JD 1.01 million (US$3.3 million). Therefore it is recommended that in view of the fact that the demand for electricity by the households is unresponsive to increases in the tariffs, the Government should consider increasing the tariffs to the large domestic and commercial consumers as a means of mobilizing revenues for the power subsector. However, prior to the restructuring of tariffs, a detailed study of the likely impact on the consumers and the utilities should be undertaken. This study would involve the compilation of detailed data on time, pattern, and duration of consumption; end-use of electicity; and disposable income of the average household (Annex 10, Attachment 1).

25. The tariff for water pumping is also based on a uniform block rate. As a result water pumping continues during the peak periods when JEA has to operate the combustion turbines by burning diesel oil, rather than during the off peak period when JEA meets the demand by operating power plants that burn fuel oil which has a much lower economic cost. Under the prevailing tariff, the Amman Water and Sewage Authority and Water Supply Corporation have no incentive to shift the pumping to the offpeak period and storing the water in larger storage facilities. The introduction of peak/off peak rates for water pumping could result in a net saving to the economy; however, a study is needed to assess the costs and benefits to the economy of restructuring the tariffs and building larger storage facilities for water pumping.

January 1983
(0429P)

JORDAN

ENERGY SECTOR STUDY

Development of Domestic Prices of Some Petroleum Products
1970-1981 in Current and Constant Terms
(Constant Prices in 1975 Values)

	Gasoline		Kerosene		Gas Oil		Fuel Oil		
Year	Current JD/TOE	Constant JD/TOE	Cur. JD/TOE	Const. JD/TOE	Cur. JD/TOE	Const. JD/TOE	Cur. JD/TOE	Const. TD/TOE	Deflator
1970	52.0	87.2	19.37	32.5	17.05	28.6	7.4	12.4	59.6
1971/1	59.0	94.4	21.25	34.0	17.05	27.3	7.4	11.8	62.5
1972/2	66.0	98.1	21.25	31.6	17.05	25.3	7.4	11.0	67.3
1973	66.0	88.2	21.25	28.4	17.05	22.8	7.4	9.9	74.8
1974	66.0	73.9	21.25	23.8	17.05	19.1	7.4	8.3	89.3
1975	66.0	66.0	21.25	21.25	17.05	17.05	7.4	7.4	100.0
1976/3	83.3	74.7	25.00	22.4	18.23	16.3	8.0	7.2	111.5
1977/4	104.2	81.6	25.00	19.6	18.23	14.3	8.0	6.3	127.7
1978	104.2	76.3	25.00	18.3	18.23	13.3	8.0	5.9	136.6
1979/5	131.9	84.5	30.00	19.2	22.35	14.3	9.0	5.8	156.0
1979/6	145.8	93.5	37.50	24.0	28.23	18.1	11.0	7.0	156.0
1980/7	180.5	104.0	50.0	28.8	41.17	23.7	30.0	17.3	173.5
1981/8	211.3	108.9	70.0	36.1	59.25	30.5	45.0	23.2	194.0
1981/9	225.3	116.1	73.5	37.9	71.1	36.6	50	25.8	194.0

Source: Jordan Petroleum Refining Corporation.
Deflator from CPI index.

/1 February 2, 1971.
/2 August 5, 1972.
/3 April 4, 1976.
/4 November 11, 1977.
/5 March 1, 1979.
/6 July 27, 1979.
/7 February 7, 1980.
/8 February 2, 1981.
/9 November 7, 1981

April, 1982
(0429P)

JORDAN

ENERGY SECTOR STUDY

Estimate of Subsidy for Petroleum Products
1981

Petroleum Product	Approx. Share of Total Consumption %	Refinery Commis. US$/Ton	Distr.& Marketing Comm. US$/Ton	Domestic Price /1 US$/Ton
LPG	2.8	62.7	71.6	394
Gasoline (premium)	0.5	104.5	8.4	755
Gasoline (regular)	13.1	68.1	8.4	633
Jet Fuel /2	10.7	67.5	-	201
Jet Fuel /3	2.5	68.5	-	449
Kerosene	7.5	37.1	6.0	207
Diesel	30.2	44.1	3.7	179
Fuel oil	27.9	22.7	-	134
Asphalt	4.9	30.7	-	120

The cost of reconstituted ton	=		$242.2
- Cost of crude oil and transportation	=	$236.3/ton	
Plus - Commission for refinery & distributors	=	$ 49.7/ton	
Less - Revenue from refinery ($2.0/bb)	=	$ 14.4/ton	
Net cost of crude, refining and distribution			$271.6
Net subsidy per ton			$ 29.4
Total subsidy for 1981 29.4 (2,053,000)	=		$ 60.4 million
	=		JD 20.0 million

/1 average for 1981
/2 for domestic airline
/3 for foreign airlines

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JORDAN

ENERGY SECTOR STUDY

Economic Subsidy to Electricity Consumers
1981

Consumer	Energy Sold (GWh)	Economic Subsidy (US$ Million)
Bulk Consumers		
Cement	74.3	0.6
Refinery	11.5	0.09
Potash	2.6	0.02
Total		0.7
Retail Consumers		
Domestic	382.4	13.0
Industries (MV)	130.4	(2.1)
Industries (LV)	130.4	1.9
Commerce	140.0	(1.5)
Institutions	72.2	1.4
Total	855.4	12.7
Grand Total		13.4

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ENERGY SECTOR STUDY

Electricity Tariffs
(February 1982)

		All Districts	Irbid Districts
I.	Bulk Supply Tariff		
	a. Maximum demand	2.4 JD/kW	2.4 JD/kW
	b. Day energy	18.5 Fils/kWh	17.5 Fils/kWh
	c. Night energy	13.5 Fils/kWh	12.5 Fils/kWh

		JEA	JEPCO	IDECO
II.	Retail Tariff			
	a. Domestic	37 Fils/kWh	37 Fils/kWh	52 Fils/kWh
	b. Commercial	45 Fils/kWh	45 Fils/kWh	57 Fils/kWh
	c. Small industries:			
	1-2 500 kWh/month	39 Fils/kW	39 Fils/kW	44 Fils/kW
	over 2,500 kWh/m	27 Fils/kWh	37 Fils/kWh	34 Fils/kWh
	d. Large Industries:			
	1. Maximum demand	3.05 JD/kW	3.05 JD/kW	3.05 JD/kW
	2. Day energy	23 Fils/kWh	23 Fils/kWh	22 Fils/kWh
	3. Night energy	15 Fils/kWh	15 Fils/kWh	14 Fils/kWh
	e. Water pumping	28 Fils/kWh	28 Fils/kWh	28 Fils/kWh
	f. Streetlighting	No charge	No charge	No charge
	g. Minimum charge:			
	1. Domestic	1 JD/month	1 JD/month	1 JD/month
	2. Small industries	1.25 JD/month	1.25 JD/month	1.25/month

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Resources to be Mobilized by the Elimination of the Subsidies for Petroleum Products by 1985

Summary of Assumptions

1. World market prices for petroleum products would remain stable until 1985.

2. Domestic prices for aviation fuel, fuel oil, and gas oil/diesel would be increased in three steps to reach parity with border prices by 1985.

3. Consumption of aviation fuel, fuel oil, and gas oil/diesel for each year of the period 1983-1985 would be as follows:

			('000 tons)
	1983	1984	1985
Aviation Fuel	289	333	383
Fuel Oil	743	923	1,157
Gas oil/diesel	825	973	1,157

April, 1982
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JORDAN

ENERGY SECTOR STUDY

Investment

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ATTACHMENTS

JORDAN

ENERGY SECTOR STUDY

Investment

A. Investment in the Energy Sector between 1976 and 1980

Overview

1. Investments in the energy sector for the period 1976-1980 amounted to about JD 153.8 million (US$461.5 million) of which JD 87 million (US$261 million) for the development of the power subsector, JD 65 million (US$195 million) for the expansion of JPRC's refining and marketing capacities, and JD 1.03 million (US$3.1 million) for geological work relating to the exploration for oil and gas, and JD 800 thousand (US$2.4 million) for geological work covering the development of oil shale reserves at El-Lajjun. These investments represented about 13% of total investments over the five year period.

Table 9.1

Investment by Subsector, 1976-1980

	Amount (JD million)	Percentage Share in Total
Power	87.0	57.0
Refining and marketing	65.0	42.0
Petroleum Exploration	1.0	0.6
Oil Shale Exploration	0.8	0.4
Total	153.8	100.0

The Power Subsector

2. Investment in the power subsector constituted the major share of the program for the development of the energy sector, amounting to 57% of the overall investment. Table 9.1 summarizes the allocation of the investment in the power subsector between the various functions involved in the delivery of electricity to consumers. Details of the projects completed are presented in Attachment 1.

Table 9.2

Allocation of Investments in the Power Subsector, 1976-1980

	Investment (JD million)	Percentage Share in Total
Generation	42.0	49
Transmission	16.0	18
Urban distribution	8.0	9
Rural distribution	21.0	24
Total	87.0	100

The relatively high share of the investment in generation reflects JEA's emphasis since 1976 on developing power generation by taking over the overall responsibility for the public supply of electricity. The share of investment in transmission was only 18%, reflecting the initiation of what essentially would evolve into the national transmission grid interconnecting the whole country, and connecting the Jordanian network to the national grid of Syria. During 1976-1980, two (northern and central systems) of the three original systems that existed in 1976 were connected (Attachment 2). The southern system would be connected to the rest of the system during the 1981-1985 plan.

3. Investment in urban distribution has taken the lowest share of the total investment (13%) mainly because, prior to 1976, the networks in the main demand centers existed (Attachment 3). This is particularly true for JEPCO which accounted for about 80% of all the electricity sold in Jordan between 1976-1980. The investment in rural electrification was relatively high reflecting the Government's intensified program for rural electrification. The program resulted in the connection of 99 villages to the national grid which provided about 207 thousand inhabitants with access to public supply of electricity (Attachment 3).

4. All the projects initially included under the 1976-1980 plan were executed in time with virtually no cost overruns. The financing of the projects was covered by the internal sources of the utilities (about 25% for JEA, 35% for JEPCO and 30% for IDECO), Government loans, foreign and local commercial and bilateral aid loans, and supplier's credits.

The Petroleum Refining and Marketing Subsector

5. The 1976-1980 investment program for the development of the petroleum subsector covered mainly the expansion of the refining facilities at Zarqa and the storage capacities at the refinery. The refining capacity was increased from 1 million tons per year to about 4 millon tons. The implementation of the program was completed in 1981 as was originally planned at a cost of about JD 65 million (US$195 million). The cost of the program was financed from JPRC internal sources, commercial loans and supplier's credits.

6. Oil and Gas Exploration: This covered NRA's program for the preparation of the geological data aimed at attracting foreign firms to undertake exploration work in Jordan. The program involved the interpretation of about 2,150 line-km of new seismic data and 820 line-km of old seismic, and the completion of studies covering gravimetric surveys, photogeological and detailed structural geological analysis. The overall cost of the program which was financed by NRA amounted to JD 1.03 million (US$3.1 million) of which JD 870 thousand (US$2.2 million) was for seismic work and the remaining JD 160 thousand (US$0.4 million) covered the cost of the geological studies.

7. Oil Shale: The investment program covered work done by Kloeckner/Lurgi for assessing the potential for using the shale at El-Lajjun for power generation and the production of shale oil. The cost of the study amounted to about JD 800 thousand (US$2.4 million). In addition, the work done by BGR (Germany) for the geological assessment of the reserves at El-Lajjun, and Technopromexport (USSR) for evaluating the possible use of the shale for power generation by conventional combustion were financed under bilateral aid arrangements with the countries involved.

B. Planned Investment in the Energy Sector, 1981-1985

8. The planned investment in the development of the energy sector for 1981-1985 would amount to about JD 225.9 million (US$677.7 million) of which JD 163.4 million (US$490 million) would be for power, JD 37.5 million for petroleum refining and marketing, JD 23 million (US$ 69 million) for petroleum exploration, JD 1.5 million (US$4.5 million) for oil shale exploration and development and JD 400 thousand (US$1.2 million) for geothermal exploration. The investment program would amount to 7% of total projected investment for the five-year period. Table 9.3 below summarizes the investment by subsector.

Table 9.3

Investment by Subsector
for 1975-1980 and 1981-1985

	1976-1980 JD million	Percentage Share in Total	1981-1985 JD million	Percentage Share in Total
Power	87.0	57.0	163.4	72.3
Refining and marketing	65.0	42.0	37.5	16.6
Petroleum Exploration	1.0	0.6	23.0	10.2
Oil Shale Exploration	.8	0.4	1.6	0.7
Geothermal Exploration	-	-	0.4	0.2
Total	153.8	100.0	225.9	100.0

9. The planned investment in the energy sector for 1981-1985 (expressed in 1981 prices) would increase by about 47% relative to the investment for 1976-1980; that is, from JD 153.8 million to JD 225.9 million. In addition, the distribution of investment between the various subsectors is expected to change significantly. The power subsector would continue to absorb the largest share; however, its share as a percentage of total investment in the sector would increase from 57% for 1976-1980 to 72% for 1981-1985. The share of refining which accounted for 42% of the investment in the previous five-year plan would decrease to about 16.6%, the planned outlays for petroleum exploration would increase significantly from less than 1% of the total investments for 1976-1980 to 10.2% for 1981-1985, investment for oil shale exploration and development would double but it would continue to account for less than 1% of total investments, and finally, investments in geothermal exploration are for the first time planned for 1981-1985 but it would account for only 0.2%.

Planned Investment in the Power Subsector

10. According to the plan, investment for the development of the power subsector is expected to increase as a percentage of the total investment in the energy sector (para. 9). However, the allocation of the planned investments within the power subsector would change significantly for the low-voltage distribution category. The share of rural distribution would decrease to 4% compared to 24% for 1976-1980, while the share of urban distribution would increase from 9% for the previous plan to 24% for the new plan. The allocation of the planned investments in the power subsector is summarized below:

Table 9.4

Allocation of Investments in the Power Subsector, 1981-1985

	Investment (JD million)	Percentage Share in Total
Generation	84.2	52.0
Transmission	32.8	19.6
Urban distribution	41.1	25.2
Rural distribution	5.3	3.2
Total	163.4	100.0

11. The share of generation would continue to be high because of the planned construction of the Aqaba thermal power plant (2 x 150 MW) and the installation of the seventh unit at Al-Hussein power plant (1 x 66 MW). Aqaba is expected to require about JD 60 million between 1981 and 1985, the rest of the cost would be covered in the forthcoming plan for 1986-1990. The expansion of Al-Hussein power station would cost about JD 13 million. In addition, the sum of JD 11.2 million covering the earlier expansion (3 x 66 MW) of the same power plant that started in 1978 was covered under the investment of the 1981-1985 plan.

12. The investment in the development of the national transmission network would cover the connection of Amman and Aqaba (400 kV) to transport power from the new Aqaba power plant to Amman, the main center of the demand for electricity. The line is expected to cost about JD 12.3 million. In addition, the 1981-1985 plan calls for the expansion and reinforcement of the 132 kV network including the dispatch center, at a total cost of about JD 19.5 million, and the completion of the second stage of the interconnection with Syria which is expected to cost about JD 1 million.

13. The total cost for 1981-1985 of developing the low-voltage urban distribution is expected to amount to about JD 41.1 million. Of these, JD 26.6 million would be financed by JEPCO to cover the cost of expanding and reinforcing the network in and around the city of Amman and IDECO would finance an additional JD 12.5 million for the extension of the network throughout the Governorate of Irbid, and the remaining JD 2 million would cover the cost of expanding the network in the city of Aqaba which would be financed by JEA.

14. The development of the rural distribution network for 1981-1985 would amount to about JD 5.3 million which would be financed by JEA and the Government.

Petroleum Refining and Marketing Subsector

15. The planned investment for the development of the petroleum refining subsector would amount to about JD 37.5 million. Of these, JD 11 million would cover the cost of enlarging the storage capacity at the refinery and Aqaba, and the construction of a third pipeline to connect the refinery to the Tapline and a pipeline for the delivery of aviation fuel to the airport. Another JD 6 million would cover the cost of expanding the capacity of the existing lubrication oil plant, and the remaining JD 20.5 million would cover the portion of the cost to be incurred between 1983 and 1985 of the pipeline intended for the transport of petroleum products between Aqaba and the refinery. 1/

1/ The cost of constructing the pipeline would be covered by the Government.

Petroleum Exploration

16. The planned investment for petroleum exploration of JD 23 million would cover the cost of geological and geophysical studies to identify potential sites for petroleum drilling and the purchase of a drilling rig. However, there is a high probability that the Government would postpone the plans to purchase the rig.

Oil Shale Development

17. The planned investment in the exploration and development of oil shale amounting to about JD 1.6 million would cover studies for the detailed assessment of the reserves at Al-Qatranah and Al-Husseineyyah (Annex 1, para. 2). NRA is also counting on an additional JD 250 thousand being financed through bilateral aid. In addition, a supplementary budget of about JD 100 million is being considered to cover part of the Government program for the development of oil shale. The total cost of the program, which would cover the construction of a retorting plant and a 200-MW oil shale based power plant, would amount to about JD 265 million.

Geothermal Exploration

18. The planned investment for geothermal exploration would cover the cost of drilling four exploratory wells at Zarqa Main and Al-Zarah for a depth ranging between 10-150 meters, and the cost of work on the geophysical and geothermal characteristics of the two springs. In addition the Government plans to secure an additional JD 125 thousand through bilateral aid.

C. Financing Plan for the 1981-1985 Program

19. Jordan's energy sector is expected to contribute about 26% of the cost of the investment program for energy from internal sources and customer contributions, 19% from the national budget, and the remaining 55%, from local and foreign loans and grants as summarized in Table 9.5 below.

Table 9.5

Financing of the 1981-1985 Plan for Energy

Sources	Amount (JD million)	Percentage Share in Total
Internal cash	54.2	24
Customer contributions	4.8	2
Government	43.0	19
Loans	123.0	54
Grants	0.4	1
	225.9	100%

20. The internal cash contribution would be provided by the revenue-earning entities in the sector (JEA, JEPCO, IDECO and JPRC). If the investment program of these entities is separated from the overall investment program for the sector, internal cash generation and customer contributions would provide about 29% of the cost of the investment program (JD 59 million out of JD 200.9 million) (Attachment 4). The Government contribution to the investment program of the revenue-earning entities would amount to JD 18.4 million, representing only 9% of the program. The Government contribution would cover the infrastructural or the socially-oriented parts of the investment program. The rest of the financing would come from local and foreign loans. In view of the fact that most of the projects included in the 1981-1985 investment plan of the revenue-earning entities have either started or are about to be initiated, and given the past success experienced by these entities in securing loans and supplier's credits, the likelihood of their success in securing all the financing for their investment plan is high and consequently significant slippage is not expected.

21. By contrast, the implementation of the investment plan of the non-revenue earning entities in the sector, namely NRA, would depend almost totally on the national budget. According to the current financing plan, the Government is expected to cover the entire sum of JD 23 million for petroleum exploration (Attachment 4) and JD 1.6 million of the JD 2 million for oil shale and geothermal exploration. As for the supplementary budget for oil shale development, it is to be financed by bilateral aid and supplier's credits although no details about the availability of funds have been provided yet.

D. Alternative Investment Plan for 1981-1985

22. The issue is not whether the Government would be able to provide the financing for petroleum exploration but whether it should finance the purchase of a drilling rig and the drilling of exploratory oil wells without adequate geological and seismic interpretation as discussed in Annex 2 (paras. 27-30). A more cautious exploration program is recommended in this report which would involve a more detailed seismic work and the postponement of the plans to purchase a drilling rig. The proposed plan would cost about JD 3.5 million (Annex 2, paras. 32-42). Therefore, in view of the risks involved in initiating an extensive petroleum exploration program before further geological work is undertaken after which foreign firms could be induced to resume exploration drilling in Jordan, it is recommended that the Government reduce its allocation for oil exploration from JD 23 million to not more than JD 5 million which would be more than adequate for financing the work program proposed in this report.

23. As for the exploratory work planned for oil shale, the Governmment should freeze disbursements for oil shale until the results of the ongoing studies are completed in order to provide the input needed for determining the next step to be taken in the development of the shale. Furthermore, in view of the recommendation that plans to build a retorting pilot plan and a

commercial size power plant be postponed, the Government should delay disbursing any fund from the supplementary budget until the late 1980's. The work program for exploration for geothermal should be completed before the Government starts disbursing its funds for the exploitation of the resource. Moreover, as with other countries, the Government should intensify its efforts in securing financing from bilateral aid agencies to cover a greater proportion of the cost of the strategy proposed in this report.

24. As for the refining subsector, the investments planned do not allow for the expansion of capacity. As the report points out, Jordan's refining capacity is expected to fall short of meeting the forecast demand for petroleum products starting 1987 (Annex 7, paras. 12-16). Consequently, it was recommended that a study be undertaken to formulate a program for expanding the country's refinery facilities. Investments to be undertaken during the 1981-1985 five-year plan would depend on the configuration proposed by the study. The minimum that would be required would correspond to the addition of facilities which have already been allowed for in the design of the existing refinery and which would increase its capacity by another 1.3 million tons per year. Although financing for this additional investment would be covered partly by JPRC's internal cash generation, partly by foreign loans and supplier's credits, the planned investments for 1981-1985 should include an additional JD 60 million to cover either the cost of expanding the refinery at Zarqa and part of the pipeline to Aqaba, or to cover the initial payment for the construction of a second refinery (the rest of the payments would be covered under the plan for 1986-1990). Therefore, it is recommended that the Government's investment plan for the petroleum refining sector be increased from JD 37.5 million to JD 97 million.

25. Finally, in order to improve the management of energy demand and restrain the future growth of energy consumption, a program for conservation should be undertaken during the 1981-1985 plan. The program would include the initiation of energy audit studies in power plants and in the major energy-intensive industries, namely the cement and building-materials factories, the refinery and the phosphate plant. These studies would be followed by engineering designs for retrofitting and the procurement of equipment and material. Therefore, it is recommended that provisions be included in the 1981-1985 plan to cover the cost of this program. The cost of the program, expected to fall within a range of JD 25-40 million, is estimated on the basis of experience gained in similar retrofitting and conservation projects undertaken in other countries. The final cost would depend on the results of the energy audits and on the speed at which the recommended investments are undertaken. Financing for these investments, which typically have a short payback period, would come from supplier's credits for the imported equipment, and from the national budget, possibly through low-interest loans to the industrial consumers concerned.

26. The aforementioned recommendations would result in a revised investment program for the 1981-1985 five-year plan. Total investments in the

energy sector 1/ would amount to JD 306.4 million, distributed among the various subsectors as indicated in Table 9.6 below:

Table 9.6

Proposed Investment Program for the Energy Sector, 1981-1985

	Amount (JD million)	Percentage Share in Total
Power	163.4	53.3
Refining and Marketing	97	31.7
Petroleum Exploration	5.0	1.7
Oil Shale Exploration	0.6	0.2
Geothermal Exploration	0.4	0.1
Conservation /1	40.0	13.0
Total	306.4	100.0

/1 Based on the higher estimate for the cost of the program.

This would represent an increase of nearly 36% over the investment program proposed by the Government, from 7% of total investment to 10%. However, the share of the energy sector in total investments under the investment plan proposed in this report would still represent a lower percentage than 13% observed in the previous plan (1976-1980).

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1/ Including the higher estimate for the cost of the investment program in conservation.

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Generation Projects 1976-1980

	Type of Units	Installed Capacity (MW)	Date Operation
Hussein Thermal Power Station (HTPS)	Gas	1x14	1975 /1
	Gas	1x18	1976
Zarqa	Steam	2x33	1977
	Steam	1x33	1978
Marka Power Station	Gas	2x20	1978
Aqaba Central Power Station	Diesel	2x3.5	1978
Aqaba Old Power Station	Diesel	2x1.1	1977
Karak Power Station	Diesel	3x1.5	1978
Ma'an Power Station	Diesel	1x0.5	1978
	Diesel	2x0.65	1980

1/ December 1975.

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Transmission Projects 1976-1980

		Date of Operation
1. National Grid		
(a) First Stage:	38 km of 132 kV double circuit (A.C.) overhead lines, between HTPS, Marka and Bayader.	1977
(b) Second Stage:	1) 7 km of 132 kV A.C. overhead lines between the Bayader Substation and the cement factory at Fuhais, including the substation.	1978
	2) 56 km of 132 kV A.C. overhead lines between HTPS and Irbid with a substation at Irbid.	1979
(c) Third Stage:	40 km of 132 kV A.C. overhead line between HTPS and Amman South with a substation at Amman South.	1980

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Distribution Projects 1976-1981

			Date of Operation
1.	JEA	Rehabilitation and development of the distribution networks at Aqaba.	1978
2.	JEPCO	This project includes the rehabilitation and development of the distribution network belonging 1976/1980 to JEPCO, by adding 107 km of 33 kV underground cables, 129 km of 33 kV, overhead lines, 21 main substations, 411 distribution substations and 1,083 km of low voltage networks.	

Rural Electrification Projects 1976-1981

Ninety nine villages and population centers were electrified during the period 1976-1980, and 361 thousand rural inhabitants are now supplied with electricity, representing about 40% of the total rural population.

District	No. of Villages	Population ('000's)
Amman and Balqa	10	19
Irbid	37	96
Karak	20	28
Jordan Valley	32	64
Total	99	207

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Financing for the 1980-1985 Plan
(JD million)

Power		163.4
Utilities	50.2	
Customer contributions	4.8	
Government	10.9	
Loans and Credits	97.5	
Petroleum refining and marketing		37.5
JPRC	4	
Government	7.5	
Loans	26.0	
Petroleum Exploration		23.0
Government	23.0	
Loans	-	
Oil Shale Exploration		1.6
Government	1.3	
Grants	0.3	
Geothermal Exploration		0.4
Government	.3	
Grants	.1	
Total		225.9

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ENERGY SECTOR STUDY

Energy Planning and Development Strategy

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ATTACHMENTS

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ENERGY SECTOR STUDY

Draft terms of reference for the establishment of an energy data base.

I. BACKGROUND

1. The objective of this activity is to provide technical assistance to the Government of Jordan in the establishment of an energy planning data base. The data base is to be comprehensive, covering all components of the energy supply and demand system. It is to be flexible enough to permit the use of a variety of energy planning techniques (e.g. statistical analyses, energy models, trend analysis, etc.). It is to be operational on either existing or new Jordanian data processing equipment.

2. The goal of this activity is to review the current energy data available in Jordan, to determine the data requirements and computational needs for energy planning, and to develop a plan for implementing the data base system, assembling the data, and testing the procedures.

II. TASKS

3. There are five major tasks in this activity. All will require extensive cooperation between the consultant's staff and Jordanian counterparts.

Task 1: Review Characteristics of the Existing Energy System

The consultant will review the existing energy supply and demand system in Jordan. The purpose of the review is to identify how the energy data base needs to be structured to fit the available information.

The review of the energy supply system will include fossil fuels, electricity, renewable resources, and any other significant energy sources. The review will address the entire energy supply system including energy reserves, extraction procedures, processing and conversion facilities, energy transportation and distribution, etc.. The consultant will develop the structure of the supply portion of the data base using the results of this review. The consultant will define what categories of supply systems need to be included in the data base, what geographical disaggregation is necessary, what level of detail is appropriate, and other items of interest to structuring the data base.

The review of the demand portion of the energy system will address all appropriate demand categories (e.g. industry, agriculture, residential, transportation, etc.). The consultant will develop a

classification scheme for energy users and will define the necessary structure of the demand portion of the data base. The level of disaggregation of the demand sectors (e.g. into industrial subsectors, into geographical regions, etc.) will be specified.

The output of this task will be a preliminary description of the structure of the energy data base for Jordan. This structure may be modified in subsequent tasks.

Task 2: Identify Data Needed for Planning Efforts.

The consultant will prepare a list of the data that would be necessary to include in the energy data base. This will be a comprehensive tabulation of all the information that should be included in the data base. Included in the list will be the following items:

- Energy flows - resource production rate, imports/exports of energy, processing and conversion flows, total energy supply and consumption, useful energy demand, etc.

- Economic data - energy prices, cash flow in energy facilities, energy facility operating costs, capital expenditures, etc.

- Ancillary data - data that are not directly energy-related but that are important parameters for energy analysis (e.g. population, industrial output, automobile travel, etc.).

The consultant will develop this data list to match the structure developed as part of Task 1. Extensive interactions will be necessary with Jordanian staff to identify all of the data that are desired to be included in the data base.

Task 3: Review Potential Sources of Data

The consultant will review and evaluate potential sources of data for providing information for the data base. Jordanian counterparts will be necesssary to assist in identifying sources and in evaluating the validity of the sources. Included in this review will be routine energy reports such as might be associated with billings, tax reports, and other government data gathering; special energy surveys, either comprehensive data-gathering efforts or spot surveys; and surrogate estimators that are not direct energy data but can be used to estimate energy flows.

After reviewing existing data sources, the consultant will prepare a list of recommended data gathering activities. These activities will be designed to supplement existing data sources and to expand the information available.

Task 4: Evaluate Computational Needs.

The consultant will review and evaluate existing Jordanian computer equipment and software to determine their capability of supporting the data base. The review will focus on the ability of current equipment to store and process the data to be included in the data base and on the availability of appropriate software to manage the data base. The consultant will also evaluate the computer capabilities for using various computer-based energy planning methodologies (e.g. energy models).

If the evaluation indicates that existing computer facilities are inadequate to handle the data base and/or use the energy planning methodologies, the consultant will prepare a set of recommendations on the type of additional hardware or software that is required. The consultant may also recommend alternative ways that existing equipment might be more effectively utilized to meet the energy planning needs.

Task 5: Prepare Implementation Program.

The consultant will prepare a final report documenting the results of the previous tasks and defining a program to implement the installation of the data base. The final report should contain the following items:

- Proposed data base structure - resulting from the activities of Task 1.
- List of data elements - resulting from the activities of Task 2.
- Recommended list of data sources - including existing sources and proposed new data collection activities; results from the activities of Task 3.
- Recommended computer hardware and software needs - resulting from the activites of Task 4.
- Recommended plan for designing and loading the data base system on to Jordanian computers
- Recommended plan for loading data and testing the system.

III. OUTPUTS

4. The principal output of this activity will be the final report described in Task 5. Interim reports on intermediate results of other tasks may also be prepared.

IV. SCHEDULE AND RESOURCE REQUIREMENTS

5. Figure 1 shows the schedule for the activity. The final report is to be delivered at the end of the seventh month of the project. Significant field visits to Jordan are anticipated in the first, fourth, and seventh months.

Table 1 shows the effort distribution.

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Figure 1. Program Schedule

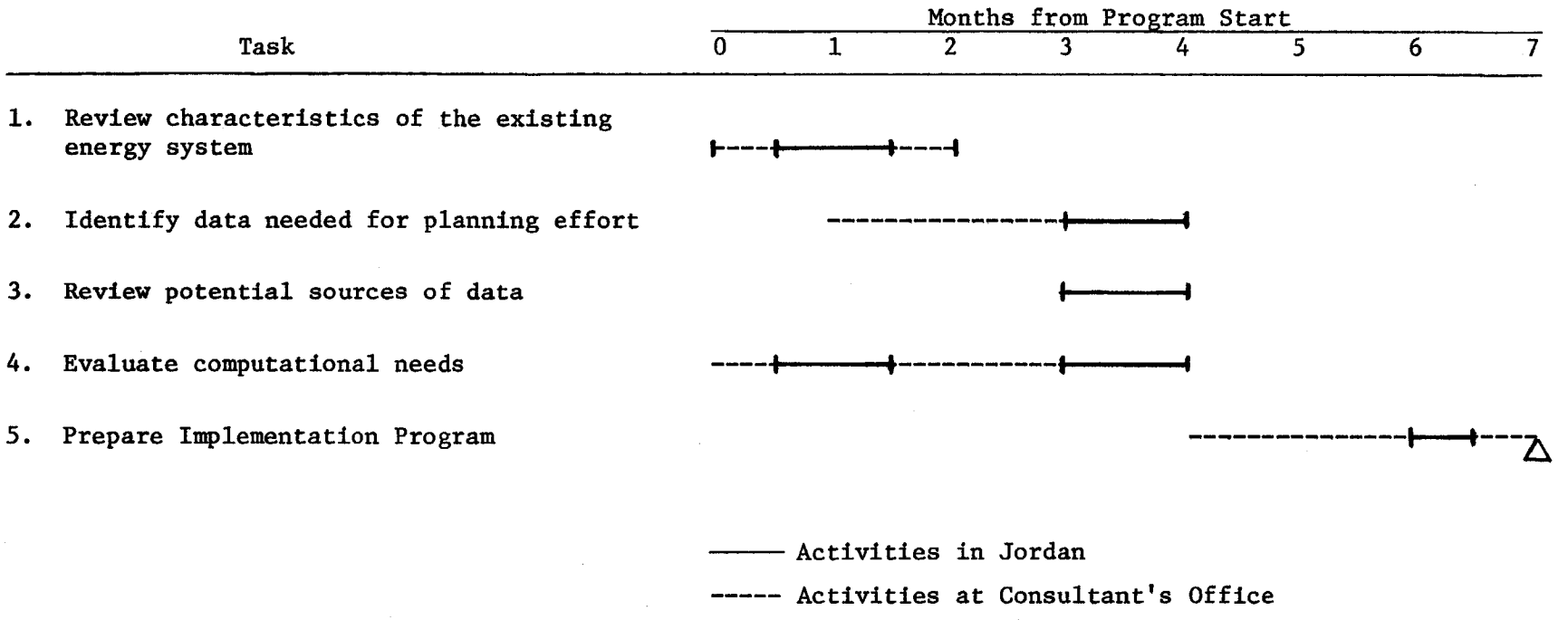

Table 1

Effort Distribution

Task	Total Time (Months)	Total Effort (Person-Months)	Time in Jordan (Person-Weeks)
1. Review characteristics of the existing energy system	2	4	8
2. Identify data needed for planning effort	3	6	8
3. Review potential sources of data	1	2	8
4. Evaluate computational needs	4	3	8
5. Prepare implementation program	3	10	4

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ENERGY SECTOR STUDY

Draft Terms of Reference for Energy Conservation Study

I. Overview

1. The National Planning Council (NPC) of the Hashemite Kingdom of Jordan has identified the improvement of energy demand management as one of the main policy objectives for the development of the energy sector. Two policy instruments would be pursued over the next five years to constraint the growth of demand for energy in Jordan: (a) the improvement of the structure and levels of energy prices after detailed studies for the assessment of the impact of higher prices on the major sectors of the economy; and (b) the initiation of a program for the improvement of the efficiency of energy consumption by the industrial sector and the power subsector. These terms of reference pertain to the conservation aspect of the Government's energy policy.

2. The NPC has identified five main energy consuming industries where improved energy efficiency can be achieved by better energy management (delivery of energy to the plant user, use of energy within the plant and delivery of output to markets) and in some cases, changes in equipment and processes used at present. These industries fall under three groups:

Group I: Power generation and petroleum refining
Group II: Fertilizers and phosphates
Group III: Cement, ceramics and other building materials.

3. In order to implement the energy conservation program, the NPC would commission a comprehensive study whose purpose would be: (i) to review the energy consumption data developed by NPC, (ii) to identify industries where substantial savings could be effected, (iii) detailed engineering design specification of equipment and bidding documents for industries identified as likely to result in substantial savings and (iv) the outline of a program for training engineers in the identification of energy saving potential. The NPC wishes to contract the services of specialized consultants/consulting engineering firm to carry out the proposed study.

II. Scope of Work

Review of Energy Consumption Data:

4. (a) Review the energy consumption data which NPC compiled for the three industrial groups and revise this data through plant and field visits.

(b) Prepare a comparable table giving the energy consumption in Jordan of each industry of the plants covered in the study and the norms for similar industries in other parts of the world.

Identification of Industries with Potential for Conservation:

5. (a) Identify from the comparative table given in (b) above those industries that the consultant, from his experience and knowledge of the industry, identifies as the most likely candidates where energy savings in excess of 5% of current consumption could be effected.

(b) In making the evaluations under (b) and (c), the consultant shall perform the following, as well as any other reviews considered pertinent in each industry studied:

(i) audit all energy-consuming production units and major equipment within each such unit in each industry. This audit should include a comparison with current norms of a) the energy consumption per unit of product for each production unit for similar production units designed to minimize energy consumption and operating costs, and b) the energy consumption in major equipment within each such production unit.

(ii) review all major process furnaces with respect to their overall efficiency, combustion characteristics, current flue gas temperatures and potential for increasing efficiency by heat recovery from flue gases and air preheating;

(iii) review all major heat exchanges to determine the efficiency of heat recovery and estimate net benefits and investment required to increase heat recovery;

(iv) review all major rotating equipment to a) determine equipment that are either old and consequently consume excessive energy or replaceable with more efficient systems and analyze benefits and costs, b) possibly redesign fluid circuits in which the equipment is placed so as to result in a lower consumption of energy (e.g., elimination of unnecessary recycle or depressuring);

(v) assess potential for co-generation of power and steam so as to reduce purchase of electricity (if any). This should also include a technical and economic evaluation of replacing large horsepower electric motors with steam turbines, if steam can be generated out of process streams, and in processes where steam is required, the feasibility of using back-pressure turbines.

(vi) review product storage temperatures and determine those products such as fuel oil which could be stored hot and delivered hot by pipeline and possible savings both at refinery (by not having to cool) and at consumption centers.

(vii) review all major equipment in high temperature service for heat conservation by improving quality/thickness of insulation;

(viii) review process operations instrumentation and process control with a view to more efficient control of process parameters that affect energy consumption.

(ix) review potential for substitution using a lower economic value fuel.

(c) Economic Justification: The consultant is required to make a technical and economic evaluation of all energy conservation measures proposed, whether pertaining to an item of machinery or a process unit in the industry studied on the basis of net economic benefits that will accrue from the proposed modification/replacement/ redesign. NPC requires incremental investment associated with energy conservation to be recoverable over a maximum 4-year period after modifications have been made. The economic justification must be supported with the following:

(i) An energy consumption table for each industrial project, broken down into production areas showing current consumption of energy (fuel, electricity, steam, etc.), industry norms and estimated savings for each production segment.

(ii) a technical and economic evaluation of energy conservation measures proposed for each industrial project and for each item of equipment for which a modification is proposed, justifying the estimated incremental investment.

(iii) an implementation plan giving details of any engineering design work required for each industrial project, estimates of time and expenditure for such work and a schedule for the complete implementation of energy conservation measures proposed.

(iv) a list of equipment to be purchased for continued auditing and monitoring of energy consumption in each industrial project studied and the estimated cost of such equipment.

(d) Preparation of Detailed Engineering Design and Bidding Documents: On completion of the above phases of the energy consumption study, the consultant shall submit a detailed report with a summary of recommendations. If the recommendations are approved, the consultant shall then prepare invitation to bid documents for the selection of an engineering contractor to perform the necessary detailed engineering, procurement and installation of equipment for the implementation of the recommended engineering conservation measures with respect to those items that require plant modifications.

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JORDAN

ENERGY SECTOR STUDY

Draft Terms of Reference for Load Management and Research Study

I. General

1. The purpose of the study is to develop methods and procedures for managing the magnitude and timing of the customer loads served by the nationa power system. The reduction of peak load decreases the amount of generation and, to some extent, transmission and distribution facilities required. An additional benefit is reduced utilization of less efficient generating units, which minimizes both costs and fuel consumption. An increase in off-peak consumption improves the utilization of plant and equipment. This reduces the cost of a unit of energy by dividing the total cost by more energy units supplied. The study should include load management techniques, non-technical impediments and research aspects.

II. Load Management Techniques

2. Various forms of load management should be investigated and their application in the Jordanian power system analyzed.

a) Rate Structure Modifications. This form of load management, which recognizes the economics of off-peak usage, should be studied in detail. The impact of the promotional rates applied for the power supply which naturally occurs or is scheduled off-peak, together with the cost of producing off-peak energy, needs to be analyzed, particularly reduction if total fuel consumed of more electricity is produced using efficient generating units.

b) Selective Load Shedding. The study should investigate the possibility of central control of individual customer power consumption. This control could be through either radio signals or high frequency power line carrier devices.

c) Storage Devices. The prospects for use of storage devices as an effective load management technique, such as underground air storage, batteries, fuel cells, pumped hydro storage should be analyzed and their possible application in Jordan assessed.

d) Load Curtailments. In a case of extreme circumstances of capacity deficiencies or fuel shortages, the study should investigate the load management techniques involving voltage and frequency reduction, rotating curtailments and energy rationing through allotment of energy beyond which a surcharge would be applied.

e) Voluntary Consumer Cooperation. In collaboration with JEA, JEPCO and IDECO the use of this technique, particulary in the short term, would be explored. The appeal of this method is that the consumer decides which power usage is wasteful or unnecessry in meeting his own needs.

III. Non-Technical Impediments

3. The impact of load management and energy conservation techniques on the consumers' way of life should be studied. In general, incentives to change usage patterns should be explored, particularly modifications in rate structures, legislative changes and other non-technical measures.

IV. Research Aspects

4. Load management has a wide range of opportunities for research, development, and invention of improved load monitoring and management systems and devices. Factors which should be addressed in the study include:

a) Sociological. How would users respond to various voluntary or enforced load management schemes? What would be the impact upon commerce, business, employment?

b) Policy Related. How should the rate structures be designed to discourage waste or nonessential use of electrical energy, and to compensate the user for his sacrifices?

c) Load Modeling and Data Base. What are the various components of electrical usage and what are their service priorities? For how long can certain classes of load be curtailed? What should be the relation between demand and the rate structure?

d) Implementation. What are the devices and systems that need to be developed to implement satisfactory forms of load management?

e) Effect Upon Utilities. What are the benefits to the utilities in terms of operating and capital costs? What are the penalties?

f) Forecasting. What is the effect upon long-term capacity and energy demand forecasts of various load management and energy storage schemes?

V. Implementation of Load Management Schemes

5. The study should propose load management systems and procedures for their implementation. These systems might require complex telemetering and remote control facilities by which load can curtail selectively from the local control center. In order to determine the effectiveness of any proposed load

management scheme, it would be necessary to evaluate the composition and characteristics of the load as well as the importance of various types of load to the comsumer. A detailed engineering analysis is required to ascertain the economic viability of the proposed load management schemes.

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ENERGY SECTOR STUDY

Draft Terms of Reference for a Study of Power Distribution Losses

I. General

1. The total electricity losses in the Irbid District Electricity Company (IDECO) are over 20% of generation and electricity purchased because of a still underdeveloped distribution network, small and inefficient generating units, inappropriate electricity metering equipment and unbilled consumption of electricity. The purpose of this study is to analyse the possibility of minimizing electricity losses through improved network expansion planning, more efficient operation and load-management procedures, and the application of appropriate equipment. The study will examine the potential for improvements and changes needed to achieve greater savings of scarce resources, and greater economy and reliability in electric power distribution. Furthermore, it will outline the financial/economic implications of strengthening IDECO's distributions system and organization in order to reduce electricity losses.

II. Distribution Network Engineering

2. The study shall include an assessment of IDECO's planning, designing and construction methods and techniques, and necessary recommendations for their improvements and modifications. Furthermore, it should review the use of engineering, construction and material standards as essential tools for minimizing costs; particularly criteria for estimating customer loads, introducing new system voltage levels, sizing conductors and transformers, spacing substations, arranging supply circuits and providing satisfactory voltage regulation. The study should also review IDECO's plans for the reinforcement of the existing distribution system to provide capacity for the growing load requirements as well as the company's decisions as to capacity, location and timing of the facilities to built or reinforced.

III. Distribution Voltage Levels

3. Part of IDECO's distribution network operates at the 6-kV voltage level which causes substantial power losses in distribution facilities. In order to expand the capabilities of distribution circuits and minimize power losses the study should analyse the appropriateness of increasing circuit voltage and conductor sizes. To realize the economy of the higher circuit voltage it would be necessary to study the use of fewer step-down transformers of larger capacities and potential effects of expanded conversion of existing overhead lines to underground lines.

IV. Unauthorized Use of Electricity

4. In cooperation with IDECO's technical services the consultant should investigate possible manners of the unauthorized uses of electricity and propose specific technical and legal measures for their elimination and prevention.

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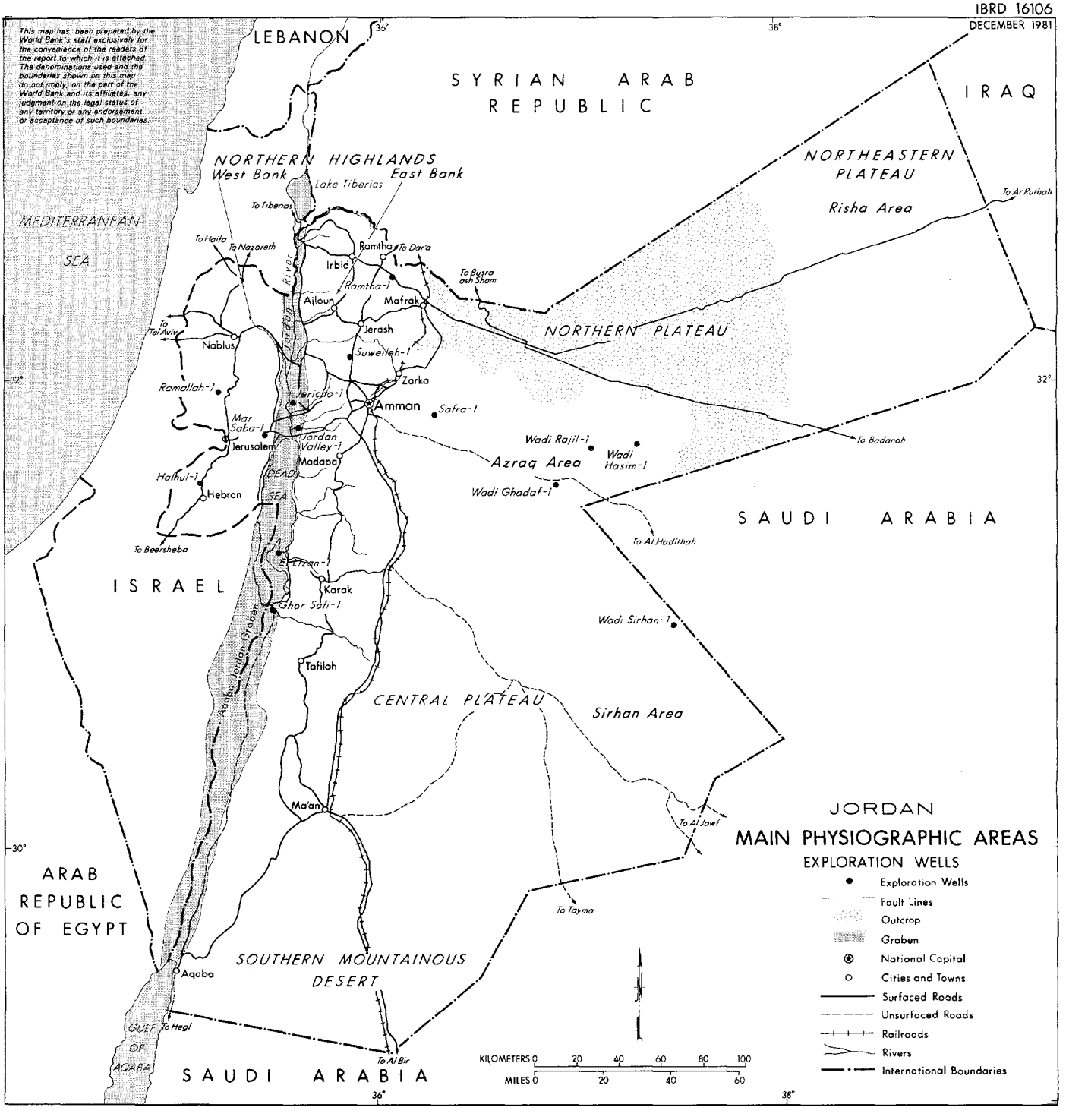

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