Report No. 5822-SYR

Syria: Issues and Options in the Energy Sector

May 1986

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

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Report No. 5822-Syr

SYRIA

ISSUES AND OPTIONS IN THE ENERGY SECTOR

MAY 1986

ABSTRACT

The rapid rise in energy demand of over 10% per year during the last decade and the stable production of oil have sharply reduced net earnings from oil exports and contributed to the shortage of foreign exchange and to the slowdown in economic growth. Urgent action is required to increase energy supplies and slow the growth of demand. On the supply side action is required to accelerate the development of gas, maintain oil production in the oil fields, redirect exploration efforts, and change the pattern of refined product output to produce more middle distillates. In the electric power sector, prices should be increased, time of day pricing implemented, losses reduced and least cost development plans prepared and implemented with emphasis on gas for power generation. There is scope to increase efficiency in energy use, particularily in the domestic and industrial sectors. Two of the most important issues are accelerated gas development and action on electricity prices.

An accelerated program of gas development could increase gas utilization (for use primarily as a substitute for fuel oil in power and industry) to one-third of the country's annual energy consumption by the early 1990s. Refinery modifications which would allow them to utilize surplus fuel oil for conversion into more valuable products, along with more flexibility in crude oil intake, would improve the overall profitability of refinery operations. In addition, substantial oil resources are present in the northeast oil fields and oil production could be maintained or even increased with technical inputs. The benefits of an accelerated program of gas development and efficiency improvements could amount to an estimated annual increase in the GDP growth rate of 1-2% over the next decade.

Growth in electric power generation has been extraordinarily rapid, 18-21% per year over the last decade. This rapid growth is largely due to unusually low electricity prices, high commercial and technical losses and rapid growth in the number of new connections under the rural electrification program. Electricity prices have fallen in real terms and do not even cover operating costs, much less capital costs. Electricity prices need to be raised by an average of about 75% above inflation to cover short run costs as a first step toward economic pricing, then additional sales revenues of about SL 7.0 billion plus further savings of SL 3 to 4 billion could be expected through reduced investment and fuel requirements because of the likely impact of higher prices on electricity demand. The net government contribution to the sector's finances would drop to a much more manageable level.

CURRENCY EQUIVALENTS
(as of end 1984)

Currency Unit = Syrian Pound (SL)

Official Rate	**US$1 = SL 3.95**	**SL 1 = $0.253**
Parallel Market Rate	**US$1 = SL 5.45**	**SL 1 = $0.183**
Tourist Rate	**US$1 = SL 8.0**	**SL 1 = $0.125**

FISCAL YEAR

January 1 - December 31

CONVERSION FACTORS

Fuel	TOE/Metric Tonne	Million Kcal/Metric Tonne
LPG	1.0588	10.8
Gasoline/Naphtha	1.0294	10.5
Kerosene	1.0098	10.3
Gas Oil	1.000	10.2
Fuel Oil	0.96	9.6 to 9.9
Gas	0.81	
Other Petroleum Fuels	0.96	

1 Kcal = 3.968 Btu
1 Kcal = 4.19 Kilojoules
1 toe = 10.2 million Kcal = 40.5 million Btu = 42.7 million Kilojoules
1 toe = 4,000 KWh on a thermal replacement basis

PARTICULAR CONVERSION FACTORS FOR GAS

1 TCF (trillion cubic feet) gas = 28.3 billion m^3
1 kg LPG = 1.829 liters
BCM wet gas x 0.873 = 1 Thousand toe
BCM dry gas x 0.814 = 1 Thousand toe

Gas use in:

Cement - 0.24 BCM/yr for 5000 tonne per day plant (320 days/yr)
Fertilizer - 1 tonne naphtha = 0.92 tonnes gas = 920 CM
Power - Steam - 34% efficiency, 10,000 Btu/kWh, 304 CM/kWh
- Gas Turbine - 24% efficiency, 12,000 Btu/kWh, 365 CM/kWh
- Combined Cycle - 43% efficiency, 8,500 Btu/kWh, 258 CM/kWh

MMBTU = million Btu
MCF = thousand cubic feet
BCM = billion cubic meter

This report is based on the findings of an energy assessment mission which visited Syria in February/March 1985. The members were N. Prasad (Consultant, Mission Leader), Dale Gray (Economist, Deputy Mission Leader), A. El-Mekkawy (Petroleum Engineer), J. Schweighauser (Geologist), W. Kupper (Consultant, Power Engineer), D. Spottiswood (Consultant, Gas Specialist), J. Wood (Consultant, Engineer), J. Freidliffson (Consultant, Geothermal Specialist), A. Hunter (Consultant Refinery Specialist). Secretarial assistance was provided by Holly Mensing.

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Introduction

1. Energy consumption in Syria consists almost entirely of oil, with 5.5% supplied by hydro and a negligible amount from biomass. Rapid growth in energy consumption of over 10% per year during the last decade has caused the trade balance in petroleum to recently turn negative. Future growth in consumption will be primarily oil and gas based, as most of the hydro resources already have been developed and shale oil is unprofitable to develop at present.

2. Gross commercial energy consumption (including conversion and distribution losses) between 1974 and 1983 has grown at an annual rate of 10.9% to 7.7 million tonnes of oil equivalent (toe). This decade has been a period of rapid GDP growth averaging almost 10%, so the energy elasticity to GDP has been about one, which is slightly lower than for most developing countries. Petroleum product consumption during the same period has grown at an average annual rate of 9.6%, of which fuel oil has grown at 30%. The growth rate of petroleum products for power generation has been 15.4% p.a. while for other sectors it has been 8.6% p.a. The high demand for fuel oil is due primarily to the rapid growth in electricity generation of 21% p.a. This high rate is due partly to unusually high losses, which peaked at 31% in 1983, and the rapid growth in electricity sales (18.7% per year from 1974 to 1983) caused by a rapid increase in the number of new connections and low electricity prices.

3. Syria is reasonably well endowed with energy resources, particularly oil and gas. Oil production peaked at 10 million tonnes in 1976 and has gradually declined since then. Current production is 8.5 million tonnes (165,000 bpd). Syria has two refineries with a total throughput capacity of 12 million tonnes. Oil imports are 6.3 million tonnes of Iranian light crude a year (under concessional terms) and exports are about 5.8 million tonnes of domestic heavy crude and 1.6 million tonnes of products. The oil and oil product trade balance turned from a positive US$600 million in 1980 to negative US$40 million in 1983. In volume, the net trade balance in oil and oil products has also dropped, from net exports of 3.4 million tonnes in 1980 to 0.9 million tonnes in 1983.

4. Recently there have been significant oil and gas discoveries which are likely to lead to higher levels of total production. The recoverable reserves of oil in the presently producing oil fields are estimated at over 200 million tonnes. The discovery of a large field at Thayyem in 1984 by Shell-Pecten, a foreign contractor, opens up an important new oil province and this discovery alone may add about 90 million tonnes to reserves and may allow for the additional production of four million tonnes by 1990. However, attention is needed to prevent a decline in the production of the older oil fields.

5. The potential for natural gas as a low cost substitute for valuable oil has not been fully recognized. Official proved natural gas reserves are 104 billion m^3. The Palmyra Basin (in Central Syria), where at least four gas fields have been discovered, may increase these reserves by a factor of two or more. Natural gas is likely to be as important as oil in the next decade. An accelerated program of gas development could increase gas utilization from zero in 1983 to 30% of all energy consumed by 1995. Substantial amounts of LPG will be produced along with the gas. These supplies will satisfy the rapidly rising demand (18% p.a.) and cut costly imports.

6. The current level of petroleum product prices in Syria, compared to international border prices, depends on which of the three exchange rates are used for comparison. The Syrian government has taken positive steps by substantially increasing the prices of most petroleum products in September 1985. Fuel oil prices and LPG prices are slightly (10%-15%) below international prices in 1985 when compared using the parallel exchange rate. There are however, serious problems with the level of electricity prices, which need to be increased at least 75% to cover short-run costs as a first step toward economic pricing. Such a price increase is expected to reduce electricity demand and save SL 3 to 4 billion over the next five years in reduced investment and fuel savings as well as ease the power sector's financial situation.

Major Problems and Recommendations

7. The rapid rise in energy demand of over 10% per year during the last decade and the stable production of oil have sharply reduced net earnings from oil exports and contributed to the shortage of foreign exchange and to the slowdown in economic growth. Urgent action is required to increase energy supplies and slow the growth demand. On the supply side action is required to accelerate the development of gas, maintain oil production in the old oil fields, redirect exploration efforts, and change the pattern of refined product output to produce more middle distillates. In the electric power sector, prices should be increased, time of day pricing implemented, losses reduced and least cost development plans prepared and implemented with emphasis on gas for power generation. There is scope to increase efficiency in energy use, particularly in the domestic and industrial sectors.

8. If an appropriate integrated energy sector investment and pricing strategy can be carried out it will convey substantial benefits to the economy. Total petroleum and power sector investment requirements during the next five years are estimated to be a minimum of SL 15 billion in constant 1985 prices.

9. The highest priority for new investment is in the petroleum sector where a minimum of SL 9.2 billion would be required during the next five years. A major emphasis should be to develop low cost natural gas and LPG which could substitute for more valuable oil products and

reduce import costs. An accelerated program of gas development could increase gas utilization (for use primarily as a substitute for fuel oil in power and industry) to one-third of the country's annual energy consumption by the early 1990s. Refinery modifications to utilize surplus fuel oil for conversion into more valuable products, along with more flexibility in crude oil intake, would improve the overall profitability of refinery operations. In addition, substantial oil resources are present in the northeast oil fields and oil production could be maintained or even increased with technical inputs. The benefits of an accelerated program of gas development and efficiency improvements could amount to an estimated annual increase in the GDP growth rate of 1% to 2% over the next decade.

10. The power sector investment over the next five years is estimated to be about SL 8 billion, but only if electricity prices are increased substantially. Investment requirements would be higher, about SL 11 billion, if prices are not increased. Because electricity tariffs have not risen in proportion since 1980, the electricity sector has received increasing subsidies from general public resources to cover operating costs and to provide funds for investment in a new plant to meet the ever growing demand for electric power. If electricity prices are not increased now, the electricity sector during the next five years will require SL 10.5 to 11 billion for capital expenditure and a further SL 4 to 5 billion for operating subsidies from the Government. If these funds cannot be mobilized, as appears likely because of macroeconomic constraints, then the result will be worsening shortages of power and the accompanying economic disruption. On the other hand, if prices were raised by an average of about 75% above inflation to cover short run cost as a first step toward economic pricing, then additional sales revenues of about SL 7.0 billion plus further savings of SL 3 to 4 billion could be expected through reduced investment and fuel requirements because of the likely impact of higher prices on electricity demand. The net government contribution to the sector's finances would drop to a much more manageable level of about SL 5 billion over the five-year period 1986-90.

11. A summary of the major recommendations is given below. A concise summary in tabular form is given at the end of this section.

Gas Utilization

12. Present gas utilization is much too low compared to potential. An accelerated program of gas development could increase gas production to 2.8 BCM (2.5 million toe) by 1990 and 5.3 BCM (4.7 million toe) by 1995. Demand for gas for use in power, in fertilizer manufacture and in cement is estimated to be 4.3 million toe by 1990 and 6.5 million toe by 1995, or greater than even this expanded supply.

13. Several years ago two gas projects were started, one to accumulate associated gas for power generation in the northeast oil fields, the other to pipe a small amount of non-associated gas from the northeast to Homs for fertilizer. Total gas utilization from these two ongoing

projects is expected to grow to 0.63 BCM/Y (66 MMCF/D) in 1987. There is tremendous scope for increasing gas production from other gas fields, particularily in the Palmyra Basin, the potential of which has not been adequately assessed so far. Gas reserves near Palmyra are likely to be 60 to 230 BCM (2-8 TCF). A program to develop this new gas province quickly could lead to production of at least 2.0 BCM per year (200 MMCF/D) produced by the early 1990s and possibly another 2.0 BCM by the mid-1990s. There is scope to expand the production from the Jebisse area by about 0.5 billion m^3 per year. There may be associated gas produced from the new Shell-Pecten oil discovery at Der-el-Zor, and potential supply of non-associated gas in the Souedie area is estimated at 0.5 billion m^3 per year. The cost of gas from the Palmyra Basin delivered to Damascus is estimated to be less than US$1/MCF, or one fourth of the cost of fuel oil. These large quantities of gas, at low cost, can beneficially be utilized in power generation and industry.

14. Developing gas has important benefits in the form of financial savings from additional oil exports, reduced LPG imports and its impact on more efficient investment in power using combined cycle gas turbine technology. Using an estimated production profile for new gas and approximate investment figures, based on international costs, the mission has estimated the benefits of gas development. For capital investments of US$640 million from 1985 until 1990 and US$313 million until 1995 the net present value is US$2.6 billion. The internal rate of return is over 43% and payback time is five years using a gas value of US$3.50/MCF and LPG value of US$200/ton. Cumulative net earnings over 10 years until 1995 (revenues minus costs) are US$2 billion (1985 dollars), or an addition of 1.0% to the annual GDP growth rate. The gas development program would cut LPG imports substantially and Syria may even become an LPG exporter. Another benefit will be more efficient electricity generation from combined cycle plants using gas. Syria urgently needs to accelerate the development of gas from the Palmyra region. Each year of delay is a loss of US$150 to US$250 million dollars, measured by present value cost.

Recommendations on Natural Gas Development and Utilization

15. Main recommendations are below, details are in Chapter IV.

(a) Given the high cost of delaying the development of Palmyra Basin gas, considerable exploration, delineation and evaluation work should be done immediately. If possible, an agreement should be reached expeditiously with the foreign companies who made some of the above discoveries, so that these companies may solely or jointly [with Syrian Petroleum Company (SPC)] exploit these fields. Agreements with the foreign companies might be mutually beneficial due to the high cost of investment and managerial and technical expertise required.

(b) Develop and evaluate least cost plans for utilizing large quantities of gas with a comprehensive gas utilization study, particularly for gas from the Palmyra area. Emphasis should be placed on plans to pipe this gas to Damascus for use primarily in power generation and secondarily in industry. Development plans may be designed for production and transport in two stages, the first for Damascus and the second for gas piped to Homs, Tartous, Banias and possibly other cities. Primary use of this gas should be for power generation.

(c) Use the Jebisse gas for the fertilizer plant in Homs as planned. If the supply of gas is not fully utilized in the near-term, utilize the extra gas for electricity generation and study the possibility of cogeneration using process steam for the fertilizer plant.

(d) Enlarge the supply of gas to Homs to as large a throughput as possible given the pipeline in place. Supplement the present supply with additional gas from Jebisse and/or Souedie. At times this pipeline may also be able to take associated gas from Der-el-Zor. Develop plans to utilize this gas in power generation in gas turbines that can be retrofitted to combined cycle power plants.

(e) Initially gas should be priced marginally (10-20%) below fuel oil such as to encourage its efficient substitution for fuel oil and other more valuable oil products.

Oil Production

16. While total oil production is expected to increase through the 1980s as new discoveries come on stream, attention is needed to reverse the decline in production from the older fields, which now stands at 8.5 million tons per year. The old northeast oil fields operated by SPC have been producing for 15 years. They are past their peak and productivity per well has decreased substantially. However, considerable reserves still could be produced from these fields but if sharply declining production in these old fields is to be avoided, an accelerated drilling effort along with new equipment, studies and laboratories is needed. Oil production from the major reservoirs in Souedie and Karatchok is a difficult operation due to the complexity of the fields. The density of the producing wells has been low. Maintaining production in the old oil fields should be a top priority. SPC has launched a program of development drilling during the last four years. The sixth five-year plan calls for drilling some 300 development wells. Considering the wide spacing (particularly in Souedie and Karatchok, Masif and Jbeseh Jeribe) this development effort is not sufficient to address reservoir complexities. An accelerated program with an approximate investment cost of $800-900 million over the next five years could result in additions to proved reserves and additional production with a present value of $2,000 million or more.

Recommendations on Oil Production

(a) The planned development drilling effort should be doubled if the SPC objective is to increase production, and improve recovery from the old fields.

(b) Numerous studies are required to support this development effort. These are studies on performance of various reservoirs, optimization of recovery mechanism, enhanced recovery for heavy oil, surface facilities design, and restructuring, etc. SPC has included all these studies in its plan. Priority should be placed on increasing the recovery from larger fields, vis-a-vis the smaller fields, where returns are likely to be higher.

(c) An intensive training program and the provision of supporting modern technology is required.

Hydrocarbon Exploration

17. At present, about 50% of the country is covered by production sharing contracts. A recent discovery by the Shell-Pecten will probably lead to increased interest in other parts of Syria. Given the pragmatic attitude of the Government of Syria, additional production sharing contracts may well be concluded in the near future.

18. SPC explores in practically all areas not covered by service contracts. Drilling remains concentrated in the northeast with intermittent operations in the Aleppo/Palmyra areas. Its operations include two seismic parties. SPC operates 10 exploration drilling units which are completing about 20 wells per year. This slow progress is due to lack of modern equipment and spare parts.

19. SPC needs to update its seismic and drilling equipment. Updated equipment will result in faster drilling progress which will allow for additional exploration and delineation drilling in the producing areas and also drilling for key tests in geologically prospective areas. The size and scope of these programs is the maximum SPC can undertake efficiently. Additional exploration operations in Syria should be executed by means of joint ventures with foreign companies as operators.

Recommendations on Hydrocarbon Exploration

(a) Given the increasing complexity of prospects in the northeast, SPC needs to increase seismic acquisition from a planned level of 800 km to at least 4,000 km over the next five years.

(b) It is recommended that, for optimum planning of seismic operations, a regional resource appraisal be undertaken; the results would assist in a realignment of the seismic acquisition programs.

(c) SPC's study/evaluation effort should be increased to include geologic studies, regional geochemical studies, evaluation of Paleozoic prospects, etc.

(d) Exploration drilling provisions are made for ten drilling rigs to drill 100 exploration wells under the five-year plan. With provision of new equipment, drilling time could be reduced and at least half of the additional capacity should be used for additional exploration/delineation drilling in the producing areas and drilling of key wells for Paleozoic prospects.

Refining Sector

20. Several changes in the refinery sector would improve profitability and operations. It is estimated that US$10 to US$50 million could be saved annually by optimizing refinery operations. Improved profitability would result by establishing more flexible crude inputs to minimize cost and holding down the throughput level in order to increase the combined value of crude and product exports. There is an urgent need to evaluate the benefits of installing some type of cracking facilities at the Banias refinery to increase the output of high value middle distillate (diesel and kerosene) by utilizing low value surplus fuel oil. Rough calculations show a rapid payback on about a US$100 million investment. There are also several low cost operational efficiency improvements and debottlenecking options which could reduce losses and improve yields. These improvements would result in immediate savings of around $50 million per year. These improvements should be implemented immediately.

21. While modifications to the present refineries are likely to result in substantial benefits, there is clearly no need now to consider a third refinery for several reasons. First, there is currently excess capacity. Second, it appears more economically beneficial to run the two existing refineries at less than full throughput and export heavy crude. Third, refineries in the region (such as Italy) cannot even cover operating costs, which implies that a new refinery could not begin to cover interest, depreciation or operating cost. Interest cost alone would be US$2-4/bbl. Fourth, the export refineries in the Persian Gulf are likely to export products much more cheaply than Syria. Fifth, large gas reserves in Syria will produce large quantities of LPG and provide gas for power generation, thereby reducing demand for fuel oil in power generation and industry. The combination of accelerated gas investment plus cracking facilities at the refinery should allow fuel oil supply to roughly match demand by 1990.

Recommendations in the Refining Sector

22. The mission has the following recommendations for the refining sector.

(a) Postpone consideration of a third refinery.

(b) A detailed study of the Banias refinery configuration should be made and the benefits of installing cracking facilities (FCCU or hydrocracker) should be evaluated for early implementation.

(c) In the Syrian context refinery throughput and crude mix need to be evaluated on a continuous basis to ensure maximum gain to the economy. For this purpose a refinery economic model should be developed for management to take appropriate decisions. Given the prevailing world prices of crude and petroleum products, it would be advantageous to restrict refinery throughput to a level near where fuel oil production meets demand so that exports are minimal. This would result in more exports of higher value crudes while reducing exports of lower value products.

(d) Until cracking facilities are installed at the Banias refinery, it should process only light crude (not Souedie crude).

(e) Present plans under study to improve efficiency and debottleneck Homs and Banias refineries should proceed as soon as possible. The potential benefits in increased throughput, reduced operating expense and increased yield could easily amount to US$50 million per year and capital investment requirements are unlikely to exceed US$25 million. The total cost of the feasibility study would probably be less than US$500,000. Modifications of the visbreaker at Banias should be completed immediately. The cost is not likely to exceed several hundred thousand dollars and benefits could be as high as $7 million per year.

Electric Power

23. Growth in electric power generation has been extraordinarily rapid, 18 to 21% per year over the last decade. This rapid growth is largely due to unusually low electricity prices, high commercial and technical losses and rapid growth in the number of new connections under the rural electrification program. Electricity prices have fallen in real terms and do not even cover operating costs, much less capital costs. Losses are very high, in 1983 they were 31% of gross generation. In 1984, they have been reduced to 28%, but an efficiently run system should not have losses exceeding 15 to 17% of gross generation. In spite of the rapidly growing demand, investment has been unbalanced. Investment in generation and transmission facilities has been decreasing, resulting in current power shortages. Expenditures on the rural electrification program however, have been increasing, leading to rapid growth in the number of new connections but a simultaneous decline in the quality and reliability of supply. Power sector planning has not been well integrated into national planning and investment is less than required.

24. Demand forecasts prepared by the Public Establishment for Electricity (PEE) result in demand projections which are too high; the

forecast is for generation to increase from 6,218 GWh in 1983 to 15,917 GWh by 1990 and 27,469 GWh by 1995. The mission estimates that due to slower economic growth and saturation effects in rural electrification, the highest growth which can be expected would lead to demand of only 14,000 GWh by 1990 and 21,900 GWh by 1995 (Alternative I). Still, this rate of demand growth indicates deficits of around 200 MW in 1985-86 and energy shortfalls of 8-10% in a dry year. Investment requirements would need to be SL 11.0 (excluding investment on nuclear) over the next five years to meet this demand. These investment levels are much too high given available resources. If serious power shortages are to be avoided, losses must be reduced, electricity prices must be raised substantially, availability improved and a shift of investment emphasis away from transmission and distribution to generation. Success in achieving these goals could reduce the growth rate for generation. A lower scenario for power demand is 12,200 GWh by 1990 and 18,000 GWh by 1995. Investment requirements for the next five years to meet this demand are still substantial (SL 8.0 billion) but manageable.

Recommendations in the Power Sector

25. Losses and Availability. The benefits of reducing losses are large -- SL 14 million per year or more. For this reason, it is obvious that the engagement of consultants for a loss reduction study would be highly profitable. Their tasks would be:

(a) to clarify the losses according to type i.e. technical and commercial (PEE estimates are 23.7% and 7.3% for 1983);

(b) to prepare a comprehensive action-oriented program for reducing non-technical loss including improvements in metering, billing and commercial operations;

(c) to prepare a comprehensive program for reducing technical losses including optimizing real and reactive power dispatch, adding capacitors if required, changing design criteria, changeout of transformers, etc.; and

(d) PEE should commission an experienced firm to design a comprehensive maintenance management system. The firm should also be responsible for introducing the enhanced maintenance procedures to PEE operations and for the associated training of PEE's staff.

26. Electricity Pricing. The following immediate actions are required.

(a) Increase tariffs to generate sufficient revenues to achieve short-term cost recovery. To reach this target at present requires an average tariff increase of about 75%. This could be achieved in one single step or in several annual installments and need not be uniform for all categories of consumers (see paras. 6.21 and 9.9). Such an increase would have the effect of reducing demand growth by some 1 to 2% p.a. In that case, benefits would include savings over the next five years of about SL 1.0 billion in fuel cost, savings in delayed investment of SL 2.7 billion, and increased revenues to PEE of about SL 7 billion.

(b) Adjust the rates for various consumer categories to the proper level of the economic cost in the medium-term. In order to ensure equity a social rate could be established for the poorest consumers of perhaps up to 50 kWh/month, cross-subsidized by all other consumer categories, but particularly domestic. The impact of the price increase on middle to higher income households would be small, no more than a few percent of income. For these consumers, the first 100 kWh of consumption amounts to only about US$5/month (SL 20/mo), or less than 2% of household income.

(c) Introduce effective time of day electricity pricing. By eliminating peak demand in the cement sector alone (if necessary, by installing additional grinding capacity of 100 MW SL 300 million could be saved. In all sectors, including large agricultural pumping, up to 300 MW may be saved.

27. <u>Study Least Cost Development</u>. Appoint consultants to assess the immediate short-term development requirements for power. The study should be completed in three to five months at a relatively low cost. Subsequently, a more comprehensive longer-term least cost development plan should be prepared. Short-term requirements are to:

(a) determine the capacity, timing and location of gas turbines needed to fill the capacity and energy gap until new plants are operational;

(b) determine physical and financial requirements for fueling of gas-turbines by gas and for their operation (location, type of gas, gas cleaning, supply lines, possible gas compression, substations, transmission, stability, logistics, etc.);

(c) provide a preliminary plan and cost estimates for locating and constructing the next generation of power stations;

(d) evaluate options for further expansion of Banias and Rabil, assuring least cost to the extent possible within the time frame of availability of gas; and

(e) prepare terms of reference for a comprehensive least-cost development study for power until the year 2000, including assessment of supplies and phasing through time of gas supplies for power in the context of the priorities to be set for the use of gas at least cost to the economy as well as other options such as possibilities for using imported coal.

Petroleum, Product Pricing and Energy Conservation

28. It is difficult to provide an accurate comparison of international border prices of oil products and the Syrian prices because of the three different exchange rates.

29. Note that since the green cover version of this report was prepared in August 1985, the Syrian Government has taken very positive steps with major increases in the prices of most petroleum products on September 20, 1985. The price increases announced in September were a 27% increase for super gasoline (SL 2.8/1), a 30% increase for regular gasoline (SL 2.65/1), a 47% increase for kerosene (SL 1.55/1), a 50% increase for gas oil (SL 1.5/1), and a 63% increase for LPG (SL 18/12 kg bottle). At these new prices only LPG and fuel oil are about 20% below international prices when comparisons are made at the parallel exchange rate. (These new prices and price ratios are given in Table 3.1 along with the previous prices.)

30. A full detailed study of energy conservation options was not in the terms of reference of the mission. The mission did, however, visit a cement and fertilizer plant. It appears that there may be significant scope for improving energy efficiency in the industrial sector, particularly in the fertilizer industry, certain manufacturing enterprises, and some cement factories. The improvement of energy efficiency must be seen in the broader context of improving industrial capacity utilization as well as options for substituting natural gas for oil products. Given the large share of energy used in transport and in households, even small efficiency improvements would yield large financial savings.

Recommendations on Pricing of Petroleum Products and Energy Conservation

31. Petroleum Product Prices

(a) The recent increases in petroleum product prices result in a substantial improvement in the level of petroleum product prices; however, LPG and fuel oil are still below international prices (in 1985) when compared at the parallel exchange rate. All petroleum product prices should be set to reflect average international border prices at an exchange rate which reflects the economic cost of foreign exchange.

32. Energy Conservation

(a) A detailed energy rationalization activity should be undertaken for the fertilizer industry. The interrelationship of improved capacity utilization, switching to natural gas, cogeneration opportunities and improved efficiency needs to be analyzed. This activity should proceed as soon as possible since gas is expected to arrive in 1986.

(b) Detailed energy audits and energy rationalization activities should be undertaken for the cement industry and energy intensive manufacturing industries. This should be done in the broader context of improving capacity utilization and efficiency. In the cement sector particular emphasis should focus on options for gas and coke fuel use.

(c) Given the large share of energy used in transport a detailed study of energy conservation options in this sector should be undertaken. Potential savings may be 5-10%, or about $20 million/year.

(d) Surveys should be undertaken of household electricity and energy consumption patterns in urban and rural areas. The possibility of increased use of solar energy for water and space heating should be examined and appropriate policy decisions taken. An evaluation of the efficiency of domestic appliances, particularly gas oil heaters, and their standardization should be undertaken.

Energy Development Expenditure Requirements

33. Energy development forms part of the government's five-year plan. The current fifth plan ends in 1985. Planning for the sixth plan (1986 to 1990) is ongoing. Major emphasis for energy investment in the next five-year plan should be placed on the high priority and high rate of return investment options in the petroleum sector, particularly accelerated gas development, maintaining oil production in northeast oil fields, and some modifications to present refineries. The minimum new investment for this sector is estimated to be SL 9.2 billion. Of this about 40% is for oil production in the northeast oil fields, 30% for gas development, 16% for exploration and 14% for refining and distribution. Oil production from the new Der-el-Zor oil discovery is of course not included since development is undertaken by the foreign contractor. Given the importance of these petroleum sector investments, the large investment requirements and the technical nature of these investments, it may be very beneficial to explore (i) ways in which joint ventures with foreign companies may be undertaken (particularly for gas development), and (ii) options for financing and technological upgrading of the other activities.

34. In the electric power sector the primary emphasis should be on policies and investment choices which reduce losses, improve efficiency, increase prices and efficiently supply power to meet demand at higher tariff levels. An analysis of the investment necessary to meet the rapidly increasing electricity demand scenario with continued low electricity prices indicates that SL 11 billion (excluding nuclear) would be required for investment. Since it is unlikely that such large investment resources solely for power are available, urgent measures are required to raise prices, cut losses, improve efficiency and reduce demand growth, if serious power shortages are to be avoided. Investment requirements to meet the resulting lower demand (Alternative 2) are estimated to be

SL 8.0 billion. Investment should focus on meeting immediate generation and transmission needs even if this entails less emphasis on investment in distribution in rural electrification. Details on investment in power and petroleum are given in Chapter IX.

35. In the petroleum sector certain technical inputs and new equipment are urgently required to improve the quality and efficiency of operations. Making foreign exchange available for these inputs would have a rapid payback in terms of improved operations.

Other Issues and Options

36. Renewable Energy. Among renewable sources, solar energy seems the most attractive. Solar energy for water heating is already cost effective and only needs suitable governmental policies to be more widely used. Solar energy for space heating requires more detailed studies and demonstration projects to assess the costs, risks and benefits more fully. Biomass and geothermal are likely to have little application in meeting energy needs of the domestic and commercial sector.

37. Institutional. There is a need to strengthen the institutional framework in overall energy planning, planning and coordination in refining, the capability to handle large integrated gas development projects, and planning in the power sector. Incentives for state enterprises which stress profitability as the target would lead to improved efficiency. Institutions in the energy sector have an immediate need for better training and more information on modern techniques and inputs.

Impact of Recent Lower International Oil Prices

38. This report was prepared in 1985 and its analysis is based on 1985 prices and price forecasts of crude oil and petroleum products. During the first two months of 1986 alone, spot prices of crude declined by almost 50%. Continued price volatility is expected over the short term. While some forecasters are projecting that oil prices in real terms will remain 50% below the 1985 level for a decade or longer, the majority of experts foresee oil prices rebounding over the next several years or even in the next year to around two-thirds of the 1985 level. The price projection the World Bank is currently using is a price of $13.50/bbl (average FOB) in 1986, increasing to $17/bbl in 1987 and up to $22/bbl in 1990 (which is equivalent to about a constant real price of $15/bbl, in 1985 prices).

39. Notwithstanding the precise future evolution of international oil prices, it is clear that the expectation is for a substantially lower price forecast for the immediate term. Therefore the validity and robustness of the Assessment Report's main recommendations need to be established in the light of lower oil prices and with a view to the increased degree of uncertainty of future oil price development. The approach adopted in this section is to briefly reassess the impact of lower oil prices on the report's key recommendations and, where possible,

to estimate the oil price switch-over point that would substantially alter the respective recommendation or set of recommendations.

Accelerated Gas Development

40. The principal energy supply-related recommendation of the report is to embark upon an accelerated program of natural gas development. This recommendation does not change even if oil prices remain at half the 1985 level. If one assumes oil prices drop to the new level currently being used by the Bank the rate of return on the overall gas and LPG development program drops to about 30% from the previous estimate of 43% and net present value is still over one-half billion dollars. In fact, the development of gas described in the report would be viable even if oil prices were to remain at $8.50/bbl (real 1985 prices) for the next two decades. It is at this price level that the overall rate of return drops to 15%. The pattern of gas substitution is not expected to change; the majority of the gas will substitute for fuel oil. Gas prices, as recommended. should still be pegged marginally below fuel oil, the principal alternative fuel.

Oil Production

41. There are two aspects to the problem: the impact of lower oil prices on the activities of foreign contractors and the impact on the recommendations for oil-related activities of SPC. Lower oil prices have already had a major impact on the budgets of major international oil companies who announced cuts of 20-30% in annual exploration and development expenditure plans. However, these reductions in activity do not appear to have affected activity in Syria. The new discoveries by Shell-Pecten seem to be highly profitable in view of the high well productivity and relatively shallow depth of the fields. In fact, Shell-Pecten has doubled the number of rigs and Marathon is negotiating an extension of its contract. Moreover, there are indications that other oil companies continue to be interested.

42. The recommendations outlined in the report on oil production are of course sensitive to oil price forecasts, but probably remain valid under the new lower oil price scenario currently used by the Bank. However, at even lower oil prices, the profitability of drilling plans would need to be carefully evaluated on a well by well and case by case basis. The nature of oil development is a series of small investments which cannot be evaluated in detail in this report. However, the sequencing and phasing of such drilling investments can be adjusted to fit variations in the profitability of oil development. Lower oil prices would not affect the need for urgently required technical inputs, studies and training.

Refining

43. Lower oil prices do not affect the report's recommendation to improve operational efficiency in the refining sector and to adopt a flexible operating policy for the refinery subsector so as to optimize

the country's crude and petroleum product trade balance. In fact, the expected increased volatility of fucure crude and product prices on the world market provides a stronger incentive to adopt a more flexible refining/product trade strategy, rather than operating on a predetermined policy of refining as much Syrian crude as technically possible and maximizing middle distillate output.

44. The report recommends that the benefits of installing some type of cracking facilities should be studied immediately since such an investment could have a rapid payback of a couple of years ($77 million annual benefit on an investment of $90-120 million). It is not clear yet how the drop in crude prices will affect the structure of product prices which influence the economics of cracking, but this investment is likely to remain profitable. For example, even assuming that the benefits are halved, this would only stretch out the payback period to four years, assuming little change in the structure of product/crude prices. In studying the economics of installing cracking facilities emphasis needs to be given to evaluating the risks involved. The report also identifies refinery efficiency improvements which would cost $25 million but have a payback time of less than one year. These improvements are still highly profitable at any oil price above $5/bbl.

Energy Pricing

45. Petroleum Products. The table below shows the ratios of retail to import/export parity prices — the latter indicatively based on international oil prices at 50% of their 1985 levels. The comparison is made at two exchange rates, and because of the divergence in these rates, the outcome is very different. However, using the tourist exchange rate as a guide to the shadow price of foreign exchange in the country, the table shows that the international price fall has eliminated the implicit price subsidy that petroleum products previously received in the country. Indeed, the resulting ratios of international to domestic prices are now much more in line with those prevailing in most other developing countries. Whether these new ratios should be maintained is a function of a number of factors including the fiscal requirements of the Government, the price structure for alternative fuels, and the expectation of the duration of the current international price levels. Although these questions are ultimately for the Government to resolve, in the view of the mission given the high degree of uncertainty about international price changes even in the short term and the fact that, at the shadow exchange rate, retail prices are not out of line with other countries, there does not appear to be a strong case for reducing domestic petroleum prices at this time.

RATIO OF RETAIL TO IMPORT/EXPORT PARITY PRICES OF PETROLEUM PRODUCT

Fuel	Parallel Exchange Rate (5.45 SL/$)		Tourist Exchange Rate (9.75 SL/$)	
	Nov. '85 int'l prices	one half of Nov. '85 int'l prices	Nov. '85 int'l prices	one half of Nov. '85 int'l prices
LPG	0.80	1.60	0.46	0.95
Gasoline	2.47	4.94	1.39	2.78
Kerosene/Jet	1.32	2.64	0.75	1.49
Gasoil	1.28	2.56	0.72	1.45
Fuel Oil	0.91	1.82	0.52	1.03

Note: Domestic prices are those in effect after September 20, 1985.
Tourist rate as of March 1986.

46. Electricity. The electricity price recommendations also do not change with lower oil prices. The proposed electricity price increase of 75% is to begin the process of the financial recovery of the power subsector. This is a minimum increase designed to cover operating costs and possibly also a portion of depreciation or interest costs which the tariff should eventually fully recover. Moreover, given the financial burden future investment requirements in the power sector are likely to pose on the Public Electricity Establishment, the report's recommendations concerning power tariff increases is considered valid.

Energy Conservation

47. Since oil prices directly determine the benefits of oil-related energy conservation, lower oil prices adversely affect conservation benefits. However, analyses show that even if petroleum and petroleum product prices remained for a long period at half of their respective 1985 levels, the specific energy efficiency improvement programs identified in the report would remain of high priority.

48. Improvement of Power System Efficiency. Lower international oil prices would affect the economic benefits of reducing technical power losses and improving the efficiency of power generation. However, even with oil prices 50% below their 1985 levels, the energy efficiency investments would result in favorable economic payback periods of about two years. Moreover, power system efficiency improvements are expected to yield additional indirect benefits by alleviating power supply shortfalls, and the financial benefits accruing to PEE from reduced losses would remain unaltered.

49. Industrial Energy Efficiency. Although some energy conservation measures that could have been proposed at 1985 oil price levels may not be justified at lower oil prices there appears to be scope for more than US$10 million in annual energy savings in the cement industry even at oil prices 50% below their 1985 levels. A similar quantitative assessment for the fertilizer industry cannot be derived at the present stage. However, there is evidence that even after successful conversion of the country's major ammonia plant to gas and with energy prices at half of the 1985 levels there would still be room for energy efficiency improvement that could be realized through measures with economic payback periods of less than 3-4 years.

50. Renewables. What seems to be obvious is that promoting the use of some renewable energy forms is less attractive as international prices of competing petroleum products get lower. In fact, the use of solar energy may prove to be uneconomic if international gas-oil prices remain at or below 55% of the 1985 price level.

Conclusion

51. In sum, the above outline shows that the assessment report's key recommendations appear in general robust to a 50% decline of international oil prices below 1985 price levels. In macroeconomic terms, the recent oil price drop is unlikely to have a major impact in the near future -- given Syria's present approximate balance in oil trade and assuming that lower international oil prices are not allowed to affect domestic petroleum product prices. However, to the extent that the country becomes a net oil exporter in the medium term, lower international oil prices will, of course, result in poorer terms of trade than would otherwise have prevailed.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
I. GAS UTILIZATION			
Rapid growth in the consumption of fuel oil (30% p.a.) and imported LPG (18% p.a.) while substantial gas resources remain undeveloped.	Accelerate the development of natural gas and extraction of LPG. Particular emphasis on gas from Palmyra Basin, primarily for electric power generation.	For Palmyra Gas: 1) Delineate and evaluate gas in Palmyra Basin. 2) Prepare least cost development plan for gas utilization in present power plants, in new power plants using combined cycle, and in fertilizer and cement factories. 3) Agreement should be expeditiously reached with foreign companies (who made some of the gas discoveries) on their role in development. For Jebisse Gas: 1) Utilize any surplus gas from the recently developed Jebisse field (which will be piped to Homs for fertilizer) in power generation. 2) Expand supply to Homs with additional gas from the northeast.	Approximate investment of US$650 million 1985-90 and US$320 million 1990-95. Internal rate of return over 40%, cumulative net cash flow of US$2 billion (US$ 1985) by 1995. LPG production would elimiate costly LPG imports. Improve efficiency of power generation through the use of combined cycle power plants.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
II. OIL PRODUCTION			
Declining well productivity may lead to reduced oil production if urgently needed technical inputs are not provided.	Maintain, or possibly increase, oil production from northeast oil fields. Improve quality of technical inputs and optimize field development.	1) Substantially increase development drilling with emphasis on increasing the amount of oil recoverable from the larger oil fields. 2) Provide new equipment for seismic data acquisition and processing, drilling, geochemical and reservoir engineering laboratories, and training of staff. 3) Studies on enhanced oil recovery.	Cost may be about US$850 million for next 5 years. Benefits include stable or possibly increasing production from the N.E. oil fields as opposed to declining production of 4-5% per year for investment at half that level. Present value of additions to proved oil reserves and additional production may be $2 billion or more.
III. HYDROCARBON EXPLORATION			
Information on hydrocarbon resource potential in SPC areas could be improved.	Improve information on overall hydrocarbon resource potential, on oil fields in N.E. and improve efficiency of drilling.	1) Increase seismic data acquisition in N.E. 2) Undertake resource appraisal, surveys and evaluation of Paleozoic prospects.	High potential for increasing oil and gas reserves in SPC areas.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
IV. REFINING			
Surplus of low value products and deficit of high value products.	Increase the output of high value products (primarily middle distillates, like diesel) from present refineries.	1) Postpone consideration of building a third refinery. 2) Undertake a detailed evaluation of the costs and benefits of installing cracking facilities at the Banias Refinery.	A third refinery would produce low, if not negative, returns and would be costly. Cracking facilities would cost around US$100 million and would have a rapid payback (2-3 years) in the context of the current world oil product market. Savings in the next 5 years could be US$200-300 million.
Refining system not operating in a flexible manner to maximize overall gains from crude and product exports.	Increase flexibility of crude input mix and product output pattern to ensure maximum economic gain to the economy.	1) The Banias Refinery should process only lighter crude (not heavy Souedie crude). 2) Restrict refinery throughput level when it is more profitable to export heavy crude than to export the product output. 3) Develop a refinery economic model for managers to take appropriate decisions to ensure maximum profitability of refinery operations.	Optimization of crude input and product output to maximize export earnings could result in savings from US$25 million to US$100 million in the next 5 years, depending on market price variations. Cost is minimal.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
The output of more valuable products could be increased and operating costs reduced.	Improve efficiency of operation of many units in the present refineries.	1) Undertake plans to improve the operation of the visbreaker. 2) Undertake a study to improve efficiency and debottleneck both refineries to improve yields and reduce losses.	Cost of improving visbreaker operation is US$0.2 million with benefits of US$28 million in next 5 years. Cost of US$25 to US$40 million for debottlenecking could result in benefits of US$200 million or more in the next five years.
V. ELECTRIC POWER			
Prices do not cover operating costs, much less capital expenditures. Demand increasing over 18% per year.	Reduce growth rate of demand, improve PEE financial position, improve load management.	1) Increase prices at least 75% to achieve short-term cost recovery. Eventually move to economically efficient pricing. 2) Introduce changes in peak pricing, particularily for certain industries.	Benefits over next 5 years are about SL 7 billion in increased revenues for PEE and reduced growth in demand with savings by 1990 of SL 1 billion in fuel and delayed investment saving SL 2.7 billion. Peak pricing may reduce investment requirements in peak capacity and save up to SL 300 million (100 MW). Total benefits for all sectors, industry and agriculture may be three times these savings.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
Losses are much too high (28% of gross generation in 1984).	Reduce losses, to around 10% of net generation, (or about 16% including station losses).	Expand present loss reduction efforts to a full scale program to reduce technical and non-technical losses.	Loss reduction could increase revenues up to SL 14 million and possibly more.
Poor quality of electricity supply.	Improve availability of electricity plants, reduce outage rates and improve reliability.	Commission a comprehensive maintenance program and training.	Increased utilization of existing plants and fewer disruptions to consumers.
Poor planning.	Immediately improve planning of least cost development, the utilization of gas in power and detailed demand forecasting.	1) Undertake detailed power demand forecast study. 2) Prepare least cost development study for power with primary emphasis on gas utilization. 3) Improve data collection and increase staff in PEE planning directorate.	Large benefits and cost savings through efficient planning.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
VI. OTHER			
Some distortions in petroleum product prices. These distortions are much smaller after the price increases on Sept. 20, 1985.	Set certain petroleum product prices to the equivalent border price.	Consider increasing LPG fuel oil prices about 10-20%.	Increased revenues and improved efficiency of fuel consumption.
Inefficient energy utilization in some sectors.	Improve energy conservation in industry and transport.	Undertake detailed energy rationalization programs with emphasis on fertilizers, cement, manufacturing and transport.	Potential savings of $10 to $20 million per year.
Consideration of shale oil development.	Reduce emphasis on shale oil development, gas and oil are much cheaper alternatives.	Postpone any consideration of shale oil development.	Savings on studies and pilot plants which can be much more profitably applied elsewhere.
Underutilized energy from solar radiation.	Promote solar hot water heating, which is cost effective but not widely used. Obtain more information on viability of solar space heating.	1) Promote manufacture of more solar hot water heating systems. 2) Study and provide demonstration plants for solar space heating.	Reduction in the high consumption of oil (mainly gas oil) in the household.

ISSUES	OBJECTIVES	RECOMMENDATIONS	COSTS/BENEFITS
Too little emphasis on quality of output from state-owned enterprises.	Improve profitability of enterprises.	1) Reduce emphasis on quantity targets. 2) Introduce more incentives based on profitability targets and quality of results.	Improve cost effectiveness.
Poor training.	Improve quality and speed of work completed.	1) Improve salaries of most highly qualified managers and technical staff. 2) Improve communication from other countries on latest technical developments with international seminars and training.	Improved quality of output and cost savings.

I. ENERGY AND THE ECONOMY OF SYRIA

The Economy and the Current Economic Situation

1.1 Syria is a medium-sized country (population 9.9 million) with a relatively well-balanced sectoral structure. Urban growth of about 4% slightly exceeds the rapid population growth of 3.4% p.a. GDP per capita is estimated at $US1,680 (at the official exchange rate) in 1983 and the social indicators compare favorably with those of other middle income countries. Employment is relatively evenly spread between agriculture, industry and services, and unemployment has been maintained at a very low 3.5% of the labor force. The relatively balanced structure of the economy reflects a diversified resource base, with 0.6 million hectares of irrigated land, stable oil production of about 8.5 million tons p.a., gas and phosphate reserves, and relatively developed manufacturing, construction, and trade sectors. In the past, the country has had a trade surplus in agriculture and oil, but with the rapid increase in domestic demand for energy and food, the oil surplus has all but disappeared and there is also now a deficit in food.

1.2 Under Syria's socialist system, the government directly owns and manages public enterprises in the mining, large manufacturing, energy and banking sectors. It also controls prices, credit, international trade, exchange, and all major investments. Public investments represent about two-thirds of total investments and over three-quarters of investments excluding dwellings. The dynamic private sector functions in a controlled environment in agriculture, small and medium scale industry, building and housing, and domestic trade. The social orientation of government policy is reflected in its near full employment policy (at relatively low wage levels), subsidized basic consumer goods and services, free or subsidized education and health services, and attention to rural and regional development.

1.3 The Syrian economy experienced rapid growth between 1970 to 1981, averaging almost 10% per year. The sources of this growth were revenues from oil, following the price rises of 1972/73 and 1979/80 and grants from several Arab oil-exporting countries, particularly following the 1978 Baghdad summit. After very rapid growth between 1970-1981, GDP growth fell to 3.2% in 1982 and 3.1% in 1983, or less than the rate of growth of population. This compares with the Fifth Plan (1981-85) objective of 7.2% p.a. growth. The slowdown in 1982 and 1983 was mainly due to a 2.5% drop in value added by agriculture in 1982 and to stagnation in petroleum and mining. The major growth sectors in 1982 and 1983 were manufacturing (where gross production grew at 17.9% and 9.4%, respectively), electricity (26% and 24%), construction (10% and 10%) and government services (9% and 7%). All these sectors are predominantly or wholly influenced by government investment and current expenditure policies.

1.4 A major factor in the economic slowdown is a worsening of the oil trade balance over the last few years. Oil exports declined gradually from $1.6 billion in 1981 to $1.3 billion in 1983, and were about the same level in 1984, as world prices declined and production continued to stagnate at about 8.5 million tons. In addition, oil imports soared in value in 1979-81 because of rapidly rising imports of light crude (which is mixed with heavy Syrian crude oil for domestic refining). Oil imports stabilized after 1981 at about 6.5 million tons and their value eased as international prices dropped. As a result, the oil trade balance turned from a positive $600 million in 1980 to negative $80 million in 1981 and negative $40 million in 1983 (Annex 1). In volume, the net trade balance in oil and oil products also dropped, from net exports of 3.4 million tons in 1980 to 0.9 million tons in 1983. The greater decline in value reflects the increasing share of higher priced imported light crude and exports of lower quality crude and fuel oil.

1.5 Another major factor behind the overall resource and budgetary constraints in 1982 and 1983 was the drop in the level of external grants to the public sector. These grants dropped from $1.8 billion in 1981 (10.8% of GDP) to $1.3 billion in 1983 (6.5% of GDP). They were expected to have remained at that level in 1984. On average, one-half of the overall budget deficit in 1980-83 has been financed by grants from neighboring oil exporting countries (mainly Saudi Arabia, but also Kuwait, United Arab Emirates (UAE), Qatar, Libya and Iran). The other half was financed largely by domestic borrowing, and to a lesser extent (except in 1981) by net borrowing from external sources. In attempting to contain the persistently large overall deficits since 1980, the Government has taken a series of measures to increase revenues and contain the rise in expenditures. A major action in 1981 was the freezing of nominal salaries and wage scales of government employees and those of public enterprises, though the cost of living rose by 54% between the end of 1980 and August 1984. Tax revenues also increased at an average of 20% p.a. compared with 18.5% p.a. growth of nominal GDP. Non-tax revenues have increased more rapidly than tax revenues, their growth averaging 26% p.a. during 1980-83.

1.6 The bulk of these revenues represented the "surpluses" of public enterprises. Most of these surpluses were transferred by the petroleum sector (which has, in effect, financed investment in the other sectors) and the banking and financial enterprises. The main measures taken by the government to achieve this result were the 1982 price adjustment of petroleum products, cement, unrationed rice and sugar. The sharp increases in the prices of petroleum products in August 1981 and in July 1982, together with the decline in international prices reduced the price subsidy on oil products accounts from SL 2.5 billion in 1980 to SL 0.8 billion in 1983. The remaining fuel subsidy applies mainly to LPG which is sold to households at 50% of cost. A major remaining subsidy is that on electricity, where tariffs, unchanged since 1981, cover only about two-thirds of electricity's operating costs. In early 1985 the government raised tariffs on larger household and commercial consumers, which is expected to raise revenues by 7%. Larger price increases are needed in all categories to slow consumption and cover costs. Economic subsidies to fertilizers, paper and some agricultural producers remain a heavy burden on the government and public enterprise accounts. An appropriate pricing policy in Syria is clearly needed to narrow the budget deficit and to narrow the current account deficit of the balance of payments by shifting demand for available tradeable resources from domestic consumption to exports. In particular, restraining the rate of growth in demand for energy (oil products and electricity) at a rate far above the rate of growth of GDP (9.4% p.a. for oil products and 15% for electricity compared with 5.5% p.a. for GDP during 1980-83) can be achieved by raising the price of certain energy products in relation to that of other domestic goods and services. Such restraint in domestic demand for energy could translate into increased net exports of oil and oil products.

Overview of the Energy Sector

1.7 Syria is reasonably well endowed with energy resources and has identified and developed these resources in a well planned manner in the last two decades. During this period, Syria has become a net exporter of energy, and also managed to meet the escalating domestic needs of commercial energy for a rapidly expanding economy. Exploitation of commercial energy resources began with petroleum production in 1967/68 at a modest level of about one million tons of crude; production peaked at 10 million tons in 1976, and gradually declined thereafter. Current production is 8.5 million tons. Two refineries have been built, the first at Homs, in 1959 and the second at Banias in 1980. Their total throughput capacity is 12 million tons. Syria imports annually 6.3 million tons of Iranian light crude (under concessional terms) and exports about 5.5 million tons of domestic heavy crude. Syria is also a net exporter of petroleum products, estimated at 2.15 million tonnes of oil equivalent (toe) in 1983. Recently there have been significant oil and gas discoveries which are likely to lead to not only higher levels of production but also to provide Syria with a number of options for meeting domestic energy requirements. With the commissioning of the hydro facilities on Euphrates (800 MW) at Thawra in 1974 and thermal plants at Mehardeh (300 MW) and Banias (340 MW), significant additions have been made to generating capacity. The medium term outlook for energy in Syria appears bright if appropriate decisions are taken to develop available resources and manage the growth of energy demand more effectively than in the past.

1.8 Net commercial energy consumption has risen from an estimated 2.7 million toe in 1974 to 5.9 million toe in 1983, at an average annual growth rate of 9.2%. Gross commercial energy consumption (including conversion and distribution losses) has risen from 3.0 million toe in 1974 to 7.8 million toe in 1983 at an annual growth rate of 10.9%. The difference between the two growth rates is due to the larger contribution of electricity and associated transformation losses. GDP has grown rapidly during this decade, averaging almost 10%, and the ratio of energy elasticity to GDP (at about 1.0) has been relatively low compared to most developing countries. In Syria this has been partially due to rapid growth in the service sector, which is not as energy intensive. The per capita commercial energy consumption at 629 kilograms oil equivalent compares favorably with other middle income developing countries. Petroleum product consumption has grown from 2.95 million toe in 1974 to 6.7 in 1983, at an annual growth rate of 9.6%. Petroleum product consumption (net of usage for electricity generation), has grown at a slower rate of 8.6% p.a. (from 2.60 million toe to 5.48 million toe) reflecting the higher growth rate of petroleum products for power generation of 15.4% p.a. (from 0.350 million toe to 1.270 million toe). Petroleum product consumption for power generation as a percentage of total consumption may grow as hydro potential has largely been exploited and most future power generation has to be hydrocarbon based. Electricity generation has grown from 1,133 GWh in 1974 to 6,128 GWh in 1983 at an annual growth rate of 21%, as shown in Table 1.1.

Table 1.1: HISTORICAL GROWTH OF ELECTRICITY DEMAND

Year	Sales	Losses		Generation	Maximum Demand
	(GWh)	(GWh)	(%)	(GWh)	(MW)
1974	935	198	17.5	1,133	214
1975	1,107	246	18.2	1,353	245
1976	1,320	308	18.9	1,626	340
1977	1,578	431	21.5	2,009	409
1978	1,792	647	26.5	2,439	511
1979	2,389	825	26.5	3,114	635
1980	2,739	898	24.7	3,637	768
1981	3,121	1,257	28.7	4,378	876
1982	3,649	1,651	31.2	5,300	1,070
1983	4,213	2,007	32.3	6,220	1,174
1984	4,678	2,168	31.7	6,847	1,324
Average Growth 1974-83	17.5	27.1		19.7	20.0

1.9 Petroleum product consumption for the period 1974 to 1983 is shown in Table 1.2.

Table 1.2: CONSUMPTION OF PETROLEUM PRODUCTS IN SYRIA
(Thousand Tons)

Year	LPG	Gasoline	Kerosene	Diesel	Fuel Oil
1974	34	332	407	1,563	561
1975	39	399	468	1,758	544
1976	51	456	515	1,944	487
1977	59	482	477	1,981	603
1978	76	534	529	2,097	710
1979	96	582	569	2,260	782
1980	119	527	558	2,526	924
1981	141	556	514	2,441	1,346
1982	172	599	469	2,592	1,587
1983	198	690	456	2,738	2,032
1984 (est.)	227	740	451	2,818	2,287

Source: Ministry of Mines and Energy (excludes naphtha for fertilizer).

II. ENERGY RESOURCES

Introduction

2.1 Syria is reasonably well endowed with energy resources, particularly hydrocarbons. The recoverable reserves of oil in the presently producing oil fields in the northeast is estimated at over 200 million tonnes. The discovery of a large field at Thayyem in central Syria in 1984 by Shell-Pecten, a foreign contractor, opens up an important new oil province and this discovery alone may add about 90 million tonnes to reserves. Official proved natural gas reserves are 104 billion m^3, largely in northeast Syria. However, in the Palmyra Basin in central Syria gas has been discovered, and this may increase reserves by a factor of two or three in the medium term. Natural gas is likely to be as important as oil. Exploration expenditures have been low compared to the potential and further discoveries are likely with an accelerated exploration program.

2.2 The hydropower resource is limited to the Euphrates, a large part of which already has been developed. The additional hydro potential that can be developed may be no more than 1,000-1,500 GWh per annum. There are large reserves of oil shale estimated at about 13 billion tonnes, but likely to be of use only in the distant future.

2.3 Among the renewable sources of energy, solar energy has great potential because insolation is high throughout the year. The wind regime is favorable in many parts of Syria and it could play a limited role in meeting energy demand. Biomass resources are negligible and could play an insignificant role in Syria's economy. There is some low temperature geothermal potential, which has not been adequately assessed but is likely to have only a limited application.

Petroleum and Gas Resources

2.4 Syria is located on the western edge of the Middle East oil province. The surface area of the country measures some 180,000 km^2, most of which is underlaid by sedimentary rocks which are favorable for the generation of oil and gas. There are wide variations in the prospectivity of the different areas, which can be explained by variations in the geological processes affecting the various regions. The eastern part of Syria is particularly favorable to the development of oil and gas, but an adequate appraisal of these resources has not been carried out. Also, the absence of consistent classification of known oil and gas reserves makes it difficult to accurately estimate reserves. Petroleum is found in two regions, the producing fields in northeastern Syria and the new discovery in central Syria near Der-el-Zor which will begin production in

1986/87. Gas resources are located in northeastern Syria and in several fields near Palmyra in central Syria.

Producing Fields in Northeastern Syria

2.5 Syria's known producing oil resources are located in seven major fields in the northeastern part of the country and are being exploited by the Syrian Petroleum Company. There is some uncertainty about the reserves of the old northeast oil fields. There are clearly at least 800 million barrels (115 million tonnes) of proved reserves. Official figures are 1,400 to 1,600 million barrels (200 to 230 million tonnes), but these official figures for proved reserves must also include some probable and possible reserves. This crude is of high viscosity and high in sulfur. Oil production from the seven fields peaked in 1976 and then declined, but the decline has been arrested in recent years. The Souedie field continues to provide two-thirds of all production since its discovery by a West German firm in 1959, as shown below:

Table 2.1: CRUDE OIL PRODUCTION BY FIELD

Field	Year of Discovery	Crude API	Percent of 1983 Production a/ (%)	Percent of Cumulative Production up to 6/82 b/ (%)
Souedie	1959	24-25	66	76
Karatchok	1968	22	16	16
Rumeilan	1962	23	4	5
Jebisse	1968	19	5	2
Others	--	-	9	1

a/ 1983 production was 8.49 million tons.
b/ Cumulative production was 110 million tons.

The two largest fields, Souedie and Karatchok, have produced about 12% of the original oil in place over the last 15 years. Since it is possible that the ultimate recovery factor could be as high as 30%, there may be large amounts of oil which still could be produced.

2.6 Many of Syria's oil fields are heavy oil deposits (see Annex 3). Besides Souedie and Rumeilan, most of the oil reserves are considered heavy oil deposits. Reserves in the Karatchok field alone account for 163 million m^3 (22%) of the total heavy oil reserves in the country. The rest of the heavy oil reserves are distributed among twelve other fields with oil in place, ranging in size from 2 million m^3 to 256 million m^3 for each field in the undeveloped Zouraba and Said structures. The oil gravity ranges from 12° to 20° API and the depth of the producing horizon ranges from 600 to 2,500 meters. The recovery factor for primary production is estimated to average about 11%. In some cases, the oil concentration per unit rock volume is too low (Tichrin field) or the oil zone is too deep for economic thermal recovery processes. In addition, many of the accumulations are small and scattered in isolated areas where little or no infrastructure is available. However, the volume of reserves, particularly in the large oil fields, would justify conducting an extensive study of possible enhanced oil recovery (EOR) processes. The prospects for improving the recovery efficiency from heavy oil accumulations is encouraging, but the lead time before field-wide applications could take place may extend to five years and the increase in production would not take effect until after seven years.

New Oil Discovery in Central Syria

2.7 The discovery of a new oil field (light oil) in 1984 at Thyayem near Der-el-Zor will increase the reserve and production level substantially. The discovery was made by a foreign contractor, Shell-Pecten. The oil is light and low in sulfur. Reserves are not yet proved but are roughly estimated to be around 90 million tonnes (greater than a 50% increase over present reserves).

Gas in Northeast and Central Syria

2.8 Official proved natural gas reserves are 104 billion m^3.1/ This represents a substantial increase from 1979 proved reserves of 36 billion m^3 (one-fourth of which were associated gas in the northeast oil fields and the rest non-associated). Official probable reserves in 1979 were 60 billion m^3 (primarily non-associated gas in the Jebisse region). Much of these have now been reclassified as proved reserves and some new reserves have been added from the Palmyra area. However, gas reserves in the country are larger than official figures indicate. In particular, gas in the Palmyra area in Central Syria comprises a fraction of the proved reserves, but a closer analysis of the records by mission members indicates that there is a good chance that there is 2 to 8 TCF (50 to 210 billion m^3). This is very important because this large quantity of gas could be used for power and industry and is located within about 100 km from Homs and Damascus compared to a distance of 400-500 km to the gas fields in the northeast, from where gas will be piped starting in 1986. Gas was discovered in the Palmyra area by SPC and by both foreign contractors, Marathon and Shell-Pecten. Additional associated gas has been recently discovered with oil by Shell-Pecten. All together, total proved and probable gas reserves are in the range of 200 to 300 billion m^3. This level of reserves implies that annual gas production could increase to a production level of 5 to 9 billion m^3 (4 to 8 million tonnes oil equivalent per annum) for over 25 years. This is equal to 50% to 90% of current oil production. Current gas production of 0.2 billion m^3 is insignificant compared to potential production.

1/ Cedigas, 1985.

2.9 Although the geological parameters of Syria are not as favorable as those in Iraq and the Gulf countries further south, there remains potential for important future discoveries of oil and gas. In the northeast there are good prospects for finding additional reserves which could well maintain the production of old oil fields at present levels for several years to come.

2.10 The Palmyra area may develop into an important gas province. Discoveries so far are of dry gas, but the oil potential cannot be disregarded with the information available at present. The Euphrates embayment may develop into an important oil province, and expectations could be a multiple of the preliminary reserve estimate established at Thayyem (600 million barrels or 90 million tonnes). The Aleppo uplift and the Jebel Arab area are in the early stages of exploration. Several geologic regions have been evaluated only in the most rudimentary fashion. Paleozoic rock sequences have been mapped over much of the country, but there has been no systematic exploration. The large amount of data from previous surveys has never been properly evaluated. Therefore, a regional resource evaluation is needed before formulating an exploration strategy.

Shale Oil

2.11 The Yarmouk Valley in the south of the country appears to have the largest reserves of oil shale, about 13 billion tonnes with an oil content of 7.4-11.7% and a caloric value of 1380-1810 kcal/kg. The average depth of the deposits is 150 meters below the surface. The surveys are the responsibility of the Ministry of Petroleum, which is expected to submit in due time a feasibility study showing whether or not the deposits could be economically exploited for power generation.

2.12 The Government should be aware that the implementation of a pilot program to determine the potential for commercially exploiting the shale involves substantial risks, both technical and financial. Shale oil has not proved economically viable anywhere in the world (including the U.S., Jordan, Morocco, etc.). The risks prevail irrespective of the strategy adopted and the technology selected. In view of the recent gas and oil discoveries, shale oil development should be regarded only as a future long-term proposition.

Petroleum and Gas Exploration Activities

2.13 The Syrian Petroleum Company abandoned its concession in 1951 after drilling several dry holes. In 1956 the Menhall Company discovered heavy sulfurous oil at Karachuk in northeast Syria but its license was withdrawn in 1958. The West German firm Concordia struck oil at Souedie in the same area in 1959. After protracted negotiations with several companies for joint exploitation of the fields, the Government prohibited by decree in December 1964 the grant of concessions and conferred a monopoly of oil operations on the General Petroleum Authority (GPA). Drilling on its own account with Soviet rigs, GPA found small quantities of oil at Rumeilan and Hamzah.

2.14 In 1975 Syria opened its territory to production sharing contracts. Since then a number of groups have conducted exploration under these contracts including Rompetrol, the Rumanian state agency, Shell-Pecten group, Challenger Oil of Canada in association with Chevron, a consortium (Samoco) headed by Coastal States and, most recently, Marathon.

2.15 Hydrocarbon exploration is carried out by both the SPC and by foreign contractors. SPC operates ten exploration and eight production rigs. In 1983 the SPC drilled 28 exploratory wells, totaling about 50,000 meters. As the cost of drilling is about US$1,000/meter, this is an annual expenditure of US$50 million per year. Geophysical operations include two seismic parties. Progress over the last six years (1979-1984) averaged 1,100 km/year or (90 km/month). Over 80% of SPC's exploration drilling activity is carried out in the northeast. Work focuses on field extensions and drilling/testing of structures on or near producing trends. SPC also continues exploring in the western and southwestern part of the country.

2.16 The Government's attitude towards oil and gas operations has been pragmatic. It has adopted an open door policy towards exploration by international oil companies. While SPC continues exploration in its reserved areas in the northeast, practically all of the remainder of the country is open to foreign oil companies under production sharing contracts. At present the only active foreign operators are Shell-Pecten and Marathon. The Pecten Syria Petroleum Company is owned by Pecten International which is a wholly owned subsidiary of Shell USA, which has a 50/50 share with Royal Dutch Shell in Syrian exploration. Arrangements with foreign oil companies are governed by production sharing contracts basically tailored after the Egyptian model, as described in Chapter IV.

2.17 Marathon's contract area is located northeast of Homs. A second gas discovery was made in 1985. Two previous wells discovered gas and condensate. Shell-Pecten has drilled five wells in the Rasafa block in central Syria where some heavy oil and gas was discovered. Recently the consortium joined Deminex in the Der-el-Zor service contract area. The discovery in 1984 of a large oil field at Thayyem in the area is a major discovery and will lead to a sharp increase in the consortium's exploration program in its contract area. It is believed that the Thayyem structure may contain as much as 600 million barrels of reserves (90 million tonnes). The total potential in the area may be many times this figure. This recent discovery has opened up an important new oil province. Eventual production from the Thayyem structure could be three to six million tonnes per year. The crude is light and low in sulfur.

Petroleum Production

2.18 Oil production reached a peak of 10.04 million tonnes in 1976, which declined at over 4% per year to 8.32 million tonnes in 1980 in spite of a substantial increase in production drilling activity, as shown below.

Table 2.2: OIL PRODUCTION AND DEVELOPMENT DRILLING

Year	Oil Production	Productive Drilling	Productive Drilling
	(thousand tonnes)	(no. of wells)	(meters)
1975	9,572	31	79,166
1976	10,039	29	53,556
1977	9,117	23	39,005
1978	8,932	48	69,421
1979	8,760	44	62,235
1980	8,324	37	60,588
1981	8,592	63	89,530
1982	8,191	74	105,775
1983	8,489	101	172,256
1984	8,489 a/		

a/ Preliminary figure.

2.19 The natural decline of oil production during 1980-1984 has been stabilized, at least temporarily, by drilling an increasing number of production wells (up to 101 wells in 1983 compared to 37 in 1980. This indicates that the marginal cost of oil production has at least doubled from 1981 to 1983. SPC engineers stated that the current level of stabilized production can be held only until 1986, at which point production could fall off at a rate of 3.5% per year or faster. With additional effort and badly needed technical inputs, the production from these oil fields could be maintained at 8.5 million tonnes per year. Thus, old and new oil production together is likely to be in excess of 11.5 million tonnes by 1990 and 13.5 million tonnes by 1995.

2.20 Based on current plans, gas production is expected to increase from 0.2 BCM per year in 1984 to 0.7 BCM per year in 1986. However, the mission believes that a substantial increase in gas production to 2.77 BCM (2.2 million toe) by 1990 and 5.31 BCM (4.3 million toe) by 1995 is feasible. This increase would come primarily from the Palmyra Basin but also from additional associated gas from the new Der-el-Zor oil discovery and from the Jebisse and Souedie areas. LPG production from the gas would be approximately 250,000 tonnes in 1990 and near 400,000 tonnes in 1995. This surge in available LPG would be enough to satisfy the rapidly growing demand and possibly allow for exports.

Hydroelectricity

2.21 The Euphrates is Syria's most important resource for hydropower and irrigation, accounting for 88% of the country's water resources. The Thawra hydro plant and Assad reservoir started operating in 1974. Its installed capacity is 800 MW, with an average annual energy capability of about 2,360 GWh. The reservoir has a live storage capacity of 7.4 Gm^3 compared with an annual river flow of 28 Gm^3 (890 m^3/s). The dam height (60 m) is being increased by 4m, which would increase average generation by about 10%. A regulating dam at Baath with a generating plant of 3 x 25.5 MW will increase generating capability by another 12%. Both works are expected to be completed in early 1986. Three small hydro stations, aggregating about 15 MW, operate largely as run of the river stations, and the total energy capability does not exceed 50 GWh/year.

2.22 Turkey completed the Keban hydro plant and reservoir (31 Gm^3) on the Euphrates at about the same time as Syria completed its Thawra plant. A further reservoir of about 10 Gm^3 at Karakaya is expected to be closed at the end of 1986, which may temporarily decrease inflow to Syria by 3 to 5 Gm^3 per year, depending on the time required for gradual filling. Except for the dead volume (some 4 Gm^3), however, the retained water would become available again after the commissionning of Karakaya in 1987/88. A further large hydro scheme (Ataturk) with a reservoir of 48 Gm^3 would be completed in Turkey in the first half of the next decade, at the time Syria expects to complete a 4 x 100 MW plant downstream from Thawra at Tichreen (the size of the reservoir is not known yet). The total live volume of the Euphrates reservoirs would then be in the order of some 55 Gm^3 or about double average flow (at Thawra) assuring more than full regulation of the Euphrates.

2.23 Syria's irrigation projects were seriously delayed and the amounts of water used for this purpose upstream from Thawra (as well as the use of electricity for irrigation pumping of Euphrates waters) has been small until now. However, as of 1985 the Public Establishment for Electricity (PEE) expects that Thawra generation will decrease at an average of 40-50 GWh annually due to irrigation tapping of Euphrates waters and that some 100-150 MW of capacity would be required for pumping. No water is diverted in Turkey for irrigation, and irrigation projects associated with the Ataturk project are not expected to require substantial amounts of water before the next century, when for Syria hydro generation would constitute less than 10% of requirements.

2.24 A recent Romanian study identified a large number of multipurpose hydroresources (irrigation, potable water, and power), aggregating some 250 MW in small units (10-30 MW). Some development scheme has been prepared by the Irrigation Ministry and details are being studied, but execution is expected to be slow in view of the high cost of various individual projects.

2.25 In summary, except for the construction of a further plant on the Euphrates at Tichreen, which would generate between 1,000-1,500 GWh/a, no further hydro sources of reasonable substance can be developed in Syria. Numerous small sites may be developed in the longer term from which secondary energy can be obtained, but the quantities generated are expected to be neither large nor cheap.

Renewable Energy Resources

2.26 The most important renewable source of energy available to Syria is solar energy. The country enjoys high solar insolation with yearly averages of 4,500 $kcal/m^2$ per day or nearly 1,350 kcal x $10^3/m^2$ per year. The second most important renewable source is wind energy. The wind regime in Syria is moderately high and shows steady flow characteristics with average speeds ranging from 3 to 5 meters/second. The biomass resource of Syria is negligible except for possible use of agricultural wastes. Official estimates of charcoal and fuelwood are 0.2% of energy use. The potential role of these renewable energy sources is discussed in Chapter VII.

III. SUPPLY AND DEMAND FORECASTS

Introduction

3.1 This chapter describes the evolution of past demand for petroleum products and electricity as well as the energy balance for 1983. Demand for oil products and for electricity is projected for 1990 and 1995. These projections are combined with projections of supply (oil, gas, and refinery output assumptions) to give the overall energy balances for 1990 and 1995. Since the pricing policies regarding these fuels have had a major impact on demand, issues relating to the level and structure of prices are also discussed.

1983 Energy Balance

3.2 Based on available data, the mission has prepared an energy balance for 1983 (Table 3.12). (The mission has also prepared an energy balance for 1981 which is given in Annex 2.) As indicated earlier, almost all of the primary energy supply was provided by oil, with hydro accounting for a mere 5.5%. The contribution of biomass is negligible and has not been taken into account. There is a net import of crude of about 0.8 million toe, which is offset by product export of 2.073 million toe (with a net deficit of US$40 million in terms of foreign exchange due to lower value realized for product export). The gross primary energy supply less product exports is estimated at 7.766 million toe. The conversion losses are estimated at 1.557 million toe and include refinery losses and transformation losses in electricity generation. In addition transmission and distribution losses in the electricity sector are estimated at 0.164 million toe. These losses amount to 17.5% of primary energy input to the economy. The net energy available for domestic consumption is 6.045 million toe. The consumption of energy by sectors is 30.4% for domestic and commercial, 34.4% for transportation, 27.5% for industry and 7.7% for agriculture. The consumption of energy in the domestic and commercial sector appears high but this is partly because nearly 1.2 million toe of gasoil is used for water and space heating. Most of the electricity consumption is in the domestic and industrial sectors. Agriculture accounts for only a little over 1.0% of electricity consumption but about 8.0% of petroleum products.

3.3 Energy consumption in the domestic sector is likely to grow somewhat faster than the overall population, similar to the growth in energy usage by middle income country standards. Energy demand by the agriculture sector is likely to grow faster because of increased lift irrigation and farm mechanization over the next decade. Energy consumption in industry is likely to grow at a slower rate than in the past as the energy intensive industries like cement, fertilizer and refining have already been established. Energy consumption in the transport sector is expected to grow faster than GDP with an elasticity of 1.70, somewhat lower than past trends.

Petroleum Product Demand

3.4 The rate of growth in demand for the different petroleum products depends on their use in the different sectors of the economy and the sectoral growth rates. Between 1974 and 1984 fuel oil used in the industrial and power sectors grew an average of 24% p.a. while LPG used largely in the domestic sector has grown at 21% p.a. Other products have been growing at a more modest rate, such as gasoil, used in the domestic and transport sectors, at 6% p.a. and gasoline at 8% p.a. Household kerosene grew at 7% p.a. until 1979, but declined (-5% p.a.) from 1979 to 1984 as LPG was substituted for kerosene in the household sector. In order to understand the evolution of demand it is important to analyse the growth of GDP, sectoral growth rates and effect of petroleum product prices on interfuel substitution. The following section outlines the structure and level of petroleum product prices. This is followed by an analysis of how demand has been affected by prices and by economic sector growth rates. Based on anticipated GDP growth and sectoral growth rates, the mission has prepared demand forecasts for the years 1990 and 1995 and suggests a supply scenario.

Level and Structure of Petroleum Product Prices

3.5 The current level of petroleum product prices in Syria, compared to international border prices, depends on which exchange rate is used, either the official rate of 3.95 SL/$, the parallel rate 5.45 SL/$ or the tourist rate of 8 SL/$. Price comparisons were made using both the official rate and the parallel rate. (It is assumed here that the parallel rate represents a closer guide to the average cost of foreign exchange than the official rate).

3.6 Note that since the green cover version of this report was prepared in August 1985 the Syrian Government has taken very positive steps with major increases in prices of most petroleum products on September 20, 1985. The price increases announced in September were a 27% increase for super gasoline (SL 2.8/l), a 30% increase for regular gasoline (SL 2.65/l), a 47% increase for kerosene (SL 1.55/l), a 50% increase for gas oil (SL 1.5/l) and a 63% increase for LPG (SL 18/12 kg bottle). At these new prices only LPG and fuel oil are about 20% below international prices when comparisons are made at the parallel exchange rate. These new prices and price ratios are given in Table 3.1 along with the previous prices. Note that the sections in the rest of this chapter on petroleum product pricing, sectoral demand, and energy conservation refer to the prices prevailing before the increase on September 20, 1985.

3.7 The structure of domestic prices is compared to that of international prices in Table 3.2. As can be seen the price of LPG is much lower than the price of kerosene in Syria compared with the international price ratio. The gasoline diesel ratio is about twice that in the international market. This structure of prices encourages the consumption of LPG at the expense of kerosene and encourages the use of diesel in transport compared to gasoline.

Table 3.1: COMPARISON OF DOMESTIC AND IMPORT/EXPORT PARITY PRICES OF PETROLEUM PRODUCTS d/

	$/ton			SL/ton				Ratio of Domestic to Import/Export Parity Prices		
	Average Spot	Trans-		Approximate	Economic Cost of Supply		Domestic			
	Product Prices	port	Border	Distribution			Retail	at 3.95	at 5.45	at 8
Product	in Italy (FOB) a/	Cost	Price	Cost	3.95 SL/$	5.45 SL/$	Price b/	SL/$	SL/$ c/	SL/$
LPG	262	62	324	100	1,380	1,866	916 (1,500)	0.66	0.49 (0.80)	0.34 (0.56)
Gasoline	277	9	268	28	1,087	1,489	2,849 (3,675)	2.62	1.91 (2.47)	1.31 (1.69)
Kerosene/Jet	265	9	274	31	1,113	1,524	1,371 (2,015)	1.23	0.90 (1.32)	0.62 (0.91)
Gasoil	245	9	254	33	1,036	1,417	1,212 (1,818)	1.17	0.86 (1.28)	0.59 (0.88)
Fuel Oil (3.5%)	163	9	154	21	629	860	785 (785)	1.29	0.91 (0.91)	0.63 (0.63)

a/ Product prices are average for the first half of 1985.

b/ Domestic prices which are not in parenthesis are those prevailing up to September 20, 1985. Those prices in parenthesis are those prevailing after the increase on September 20, 1985.

c/ Price ratios in parenthesis reflect those prevailing after the increase of Spetember 20, 1985.

d/ Net exporter for gasoline and LPG, while for other petroleum products net importer.

Table 3.2: PETROLEUM PRODUCT PRICE RATIOS

Fuel	Domestic Price Ratios a/	International Price Ratios b/
Gasoline/Gasoil	2.05	1.13
Kerosene/Gasoil	1.05	1.08
Gasoline/Kerosene	1.95	1.04
Kerosene/LPG	1.50	1.00 c/
Gasoil/LPG	1.30	0.94

a/ Based on prices for the first half of the year.
b/ International prices are average Italian product prices in US$/ton (F.O.B.), from Table 3.1
c/ Since LPG has high transport costs, the ratio varies from 0.81 for imported LPG to 1.3 for exported LPG.

3.8 Between 1979 and 1982 petroleum product prices increased substantially. The nominal prices of diesel and kerosene increased fourfold while fuel oil and gasoline prices were tripled. All these fuel prices have increased in real terms at several percent per year during the past decade. LPG prices, however, have increased only slightly in nominal terms and have fallen in real terms by about 50% in the last decade.

Petroleum Product Demand by Sector

3.9 Detailed data on the consumption of petroleum products by sector are not available, except for 1981 and 1983, which makes analysis of past consumption difficult but some simple equations for projecting the demand for individual petroleum products were developed using time series regressions which explain consumption using real income (GDP) and real prices. (The data series was for 1970 to 1984). For those sectors which have a large number of consumers, such as transport and household, statistically significant price and income elasticities were estimated.

3.10 These elasticities are important because the income effect is separated out from the price effect so that future demand projections can be made for different GDP growth rate scenarios and different price scenarios. Many projections are based only on energy/GDP ratios and the future demand forecasts are overstated because the increase in consumption caused by past declines in real prices are left out. For those sectors such as industry, price elasticities were not significant or sufficiently detailed data was not available to make an accurate analysis. The mission's forecast of consumption uses the simple regression equations where they are appropriate and in the other sectors simple relationships between sectoral growth rate and consumption were developed and used for projection.

3.11 For projection purposes future GDP is expected to grow by 4.7% p.a. from 1983 to 1990 and 5.1% p.a. from 1990 to 1995 (this projection is based on the 1985 World Bank Country Economic Memoranda).

Transport Sector

3.12 The transport and communications sector has been growing at 12.5% per year from 1979 to 1983 (transportation consists of 90% of this category). This growth rate is about twice that of GDP over the same period. Transport fuel consumption in 1983 is as follows:

FUEL	UNIT	
	('000 TOE)	%
Gasoline	714	(43%)
Aviation Kerosene	274	(16%)
Diesel	669	(40%)
Fuel Oil	6	(1%)
Total	1,663	(100%)

3.13 Overall, the consumption of transport fuel is projected to grow at 6% per year between 1983 and 1995. 43% of transport sector consumption is provided by gasoline. Using a regression equation, the income elasticity of gasoline was calculated to be 1.26 (percent change in gasoline consumption/percent change in GDP) and the price elasticity -0.33. Assuming no change in real gasoline prices, consumption is expected to grow at about 6% in the future. Aviation fuel is expected to continue to follow the growth at 6%.

3.14 The income elasticity for total gasoil demand was estimated at 1.0 with a price elasticity of -0.06. This low price elasticity for gasoil is consistent with other countries. However, gasoil use, specifically in transport, most likely has an elasticity greater than 1.0. Future demand has been estimated to grow at the forecasted rate for the road transport sector (8% as stated by the State Planning Commission) which is consistent with an elasticity of 1.5. Annex 5 gives the elasticity results from the energy demand regression equations.

Domestic and Commercial Sector

3.15 Energy use in the domestic and commercial sectors consists primarily of gasoil (for water and space heating) and roughly equal amounts of LPG and kerosene used for cooking. The consumption for 1983 was:

FUEL	UNIT	
	('000 TOE)	%
Gasoil	1,205	(67%)
LPG	211	(12%)
Kerosene	239	(13%)
Electricity	152	(8%)
Total	1,807	(100%)

Data is not available to show detailed breakdown of consumption over time. What data is available shows inconsistencies, particularly with regard to gasoil. Gasoil consumption (from BIECIP LPG report) was 490,000 toe in 1981 for space heating but the report states this as low since it was a warm year. The mission estimates the gasoil consumption in the domestic sector at 0.737 million toe for 1983, the balance of 0.428 million toe being consumed in the commercial sector. Base case assumptions on the growth of domestic and commercial gasoil use are 4% p.a. or about equal to the anticipated household growth rate. This assumes that there is no major fuel substitution effort and no major change in structure of petroleum prices. The impact of solar energy use and price changes on the base case demand are discussed in Chapter VII.

3.16 LPG use for domestic cooking is increasing rapidly at the expense of kerosene, which is declining at about 5% per year. The decline in consumption of kerosene started when the real price of kerosene increased sharply to a price above the LPG price (as shown in the following table). The relative costs of fuel for cooking indicate that LPG is cheaper than kerosene or electricity as shown below:

Table 3.3: COOKING FUEL END USE PRICES

	$SL/10^3$ kcals		
	Current Price	Efficiency	End Use Price
Electricity	0.41	60% to 80%	.68
Kerosene	0.13	40%	.32
LPG	0.09	50%	.18

The wholesale price of LPG is 11.45 SL/12.5 kg. The official retail price is slightly higher but shortages of LPG, particularly in winter, have driven the actual retail price that consumers pay up to 20 SL. The elasticity of total LPG plus household kerosene consumption to GDP was estimated to be 0.75. Several equations were used to estimate LPG demand and the best fit was found when only the price ratio of kerosene to LPG was used (1.0 was the elasticity of demand with respect to this ratio of fuel prices). This indicates that LPG is a pure substitute for kerosene and most all consumers would switch from kerosene to LPG, if it were made available, until the market is totally saturated with LPG. The demand for total LPG plus kerosene is expected to grow at about 4% p.a. (.75 elasticity times GDP) and LPG is expected to constitute most of the market by the early 1990s. If the LPG price continues to be subsidized LPG could penetrate into uneconomic use in space heating and transport.

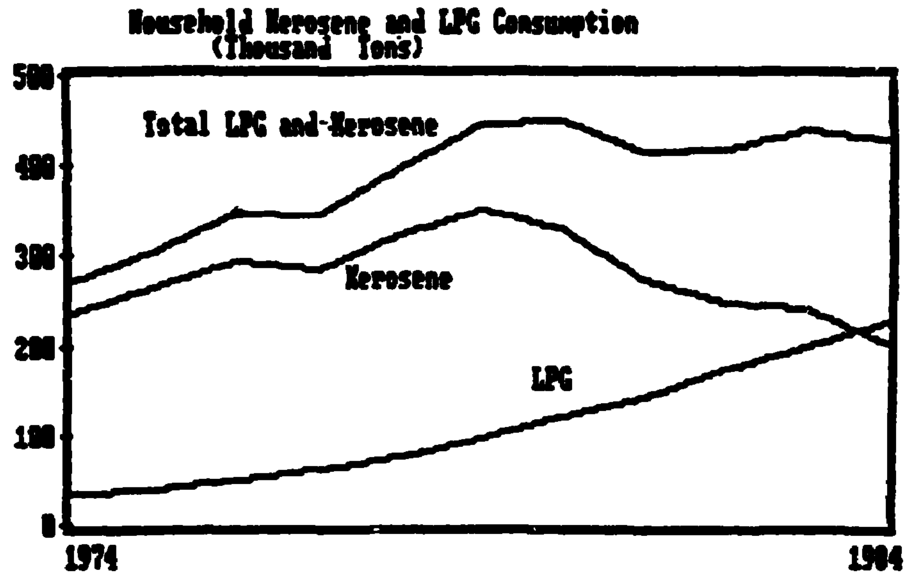
Agriculture

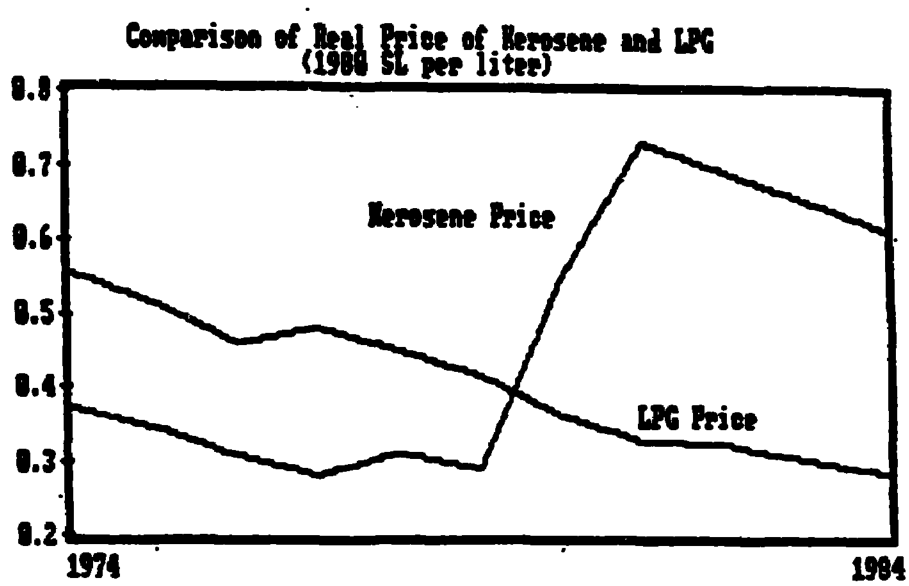
3.17 At present an estimated 0.454 million toe of gasoil is used in agriculture for pumping and farm mechanization. The number of pumpsets in use for irrigation in 1983 is estimated to be about 65,000; only a small portion are electrically operated (approximately 4,000) and the balance are gasoil operated (approximately 60,000). As electricity is extended to rural areas, substitution of gasoil sets by electric sets will take place and over time gasoil consumption for pumping may decrease. In addition, several large pumping schemes are being planned in the Euphrates and Tigris, but they are likely to be electrically operated and will not result in any increase in gasoil consumption for pumping. On the other hand, electricity consumption in the agricultural sector is likely to increase substantially. Currently there are 38,000 tractors in Syria. There is a tractor plant producing 4,000 tractors per year, all of which are sold in the domestic market. This 10% growth is expected to continue and gasoil consumption for farm operations may be expected to increase. Overall energy consumption in agriculture is estimated to grow at about 5% p.a.

Industry

3.18 Gross industrial sales from 1979 to 1983 grew 29% p.a. at current prices. Industry is expected to grow at 6% during the 6th and 7th plan periods, with major emphasis on higher productivity and profitability and less on energy intensive industry. The consumption of petroleum products by industry in 1983 is estimated to consist of 1.069 million toe of fuel oil, 0.212 million toe of naphtha and 0.146 million toe of gas oil, presumably for captive power generation. Energy consumption by industry is expected to grow at a lower elasticity. A major interfuel substitution is anticipated in industry as gas becomes available at Homs as feedstock for the fertilizer plant and subsequently at other locations as fuel for cement and other industries. In fact, petroleum product consumption in industry is expected to increase only marginally from 1.32 million toe in 1983 to 1.515 million toe in 1990 as 0.69 million toe of gas is expected to be used in industry by 1990 both as feedstock and as fuel. For the year 1995, petroleum product consumption in industry is estimated at 1.818 million toe, out of a total of 3.484 million toe (balance 1.666 toe being gas), or about 52% of industry's requirement of feedstock and energy.

Graph 3.1


Household Kerosene and LPG Consumption
(Thousand Tons)
500
400
300
200
100
0
1974
1984
Total LPG and Kerosene
Kerosene
LPG


Comparison of Real Price of Kerosene and LPG
(1980 SL per liter)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1974
1984
Kerosene Price
LPG Price

3.19 The anticipated sectoral consumption of gas/petroleum products for the years 1990 to 1995 is given in Table 3.4.

Table 3.4: PETROLEUM CONSUMPTION
(Thousand toe, annual percentage growth in parenthesis)

Sector	1983		1990		1995
Domestic and Commercial	1,655	(4.1)	2,207	(4.0)	2,693
Industrial	1,321	(7.6)	2,201	(9.6)	3,596
Agricultural	454	(3.8)	590	(4.9)	749
Transportation	2,049	(6.0)	3,080	(6.0)	4,118
	5,479	(5.7)	8,078	(6.6)	11,156

Petroleum Product Pricing and Energy Conservation

3.20 This is a summary of petroleum product pricing recommendations which discusses prices prevailing before the increase on September 20, 1985. Table 3.1 provides the prices prevailing after September 20, 1985. Electricity prices are discussed in the power chapter (VI) and gas pricing recommendations are presented in the oil and gas chapter (IV).

3.21 The prices of petroleum products in the first half of 1985 were above border prices at the official exchange rate except for LPG. At the parallel exchange rate, kerosene, gasoil and fuel oil prices are 10%, 14% and 9% below border prices respectively. At the tourist rate (8 SL/$) gasoil, kerosene and fuel oil are all about 40% below the border price.

Table 3.5: RATIO OF DOMESTIC TO IMPORT/EXPORT PARITY PRICES AT VARIOUS EXCHANGE RATES

Product	Official (3.95 SL/$)	Parallel (5.45 SL/$)	Tourist (8 SL/$)
LPG	0.66	0.49	0.34
Gasoline	2.62	1.91	1.31
Kerosene	1.23	0.90	0.62
Gas Oil	1.17	0.86	0.59
Fuel Oil	1.25	0.91	0.63

Product prices are those prevailing the first half of 1985.

3.22 Prices which reflect parity with border prices depend on the exchange rate and on the international average spot prices for petroleum products. If the relevant exchange rate is between the parallel rate and the tourist rate, the prices of kerosene, gas oil and fuel oil need to be raised to achieve parity with current border prices. For every 10% real increase in specific fuel prices (i.e. above inflation), the impact on future demand can be estimated from price elasticities calculated in Chapter III. The results are as follows:

Table 3.6: IMPACT OF PRICE CHANGES OF GASOLINE, KEROSENE AND GAS OIL

Product	Percent Real Increase in Price	Approximate Reduction in Demand	Foreign Exchange Savings
		(tonnes)	(million $)
Gasoline	10%	16,000	4.6
Kerosene	10%	24,000	6.5
Gasoil	10%	17,000	4.4

3.23 About $12 million per year in foreign exchange savings would be achieved by reductions in demand from bringing prices of kerosene and diesel prices up to equivalence with border prices at the parallel rate. These savings would increase to about $50 million at the tourist rate.

3.24 The price of LPG should be increased in any case because the LPG price is too low at any of the three exchange rates compared to border prices. LPG is currently imported with a CIF price of $324/tonne. LPG prices need to be increased at least 50% to match the current import cost. If gas development proceeds rapidly Syria may even become a marginal LPG exporter. Given the high transport cost of LPG, the relevant F.O.B. price is then $200/tonne. Even with this situation, LPG prices would need to be increased 50% to reach the F.O.B. price, at an exchange rate between the parallel and tourist rate.

3.25 The current wholesale price of LPG is 11.45 SL/12.5 kg container and the retail price should be about SL 13. However, due to shortages, actual retail prices paid by consumers are frequently near SL 20. In addition, LPG bottles are hoarded by consumers which creates uneconomically large stocks of containers. In addition, LPG bottles are hoarded which creates uneconomically large stocks of LPG bottles. If customers are frequently paying a price 50% or more than the official retail price, then increasing the price would have little affect on consumers or on demand but would transfer the high profit margin from LPG retailers to the government.

3.26 In summary, the overall structure of Syrian petroleum product prices are superior to many developing countries. It is clear, however that wholesale LPG prices should be increased at least 50% and possibly up to 100%. Smaller increases in the prices of kerosene and gasoil (imported) to bring these prices up to the level of border prices (at the parallel exchange rate) would slow demand growth. These changes would improve the overall structure of prices by reducing the gasoline/gasoil price ratio and reducing the kerosene/LPG price ratio and make them closer to the international price structure. This would encourage more efficient use of LPG and diesel in the domestic sector and more efficient use of diesel in the transport sector.

Energy Conservation

3.27 A lesson drawn from experience in many countries is that substantial benefits can be achieved by energy conservation programs in industry and that the rate of return on investment for energy efficiency improvements is very high. Depending on the subsector, scope for energy savings of 10-25% could be identified. In order to evaluate these savings, many countries have found it useful to energy audits and to implement vigorous and comprehensive energy conservation programs supported by specific policy measures. In Syria, potential areas for energy conservation include the industrial, transport and household sectors. A detailed study of energy conservation was not in the terms of reference of the mission. This mission, however, visited the fertilizer plant at Homs and the cement plant at Tartous.

3.28 Industrial Sector. The total use of energy in the industrial sector in 1983 was 1,597 toe, with 34% in cement industry, 19% in fertilizer and 44% in manufacturing.

3.29 Cement. Between 1979 and 1983, cement production increased from 1.8 million tons to 3.7 million tons and is presently over 5 million tons. Capacity utilization in this subsector ranges from 70% to 100%. The new plants use the dry process, while the older factories use the wet process. Consequently, energy requirements vary greatly, ranging from 0.10 toe per ton of cement in the new Tartous factory to 0.18 toe per ton of output in the older Latakia factory -- a difference of 80%. This compares to .095 toe per ton of cement achieved in other countries in plants using the dry-process, and 0.14 toe per ton of cement in plants using the wet process. This indicates that the Syrian cement industry has significant scope for rationalizing output and conserving energy primarily in the older-wet process plants with savings of up to US$25 million per year. Experience shows that savings of 10-15% in energy consumption in the cement industry in developing countries can be achieved through improvements in operating procedures attainable in the short-term without major investments. Further savings usually require substantial investments involving plant modifications or replacement of specific operational units. It is recommended that the options for improving the energy efficiency as well as an eventual substitution of fuel oil with gas and possibly coke (in the Kiln charge) in the cement industry be studied.

3.30 Fertilizer. The fertilizer industry is another area with scope for substantial energy savings. Savings of up to 25% can be achieved through improved housekeeping and maintenance systems and retrofitting investments. However, with the fertilizer industry in Syria which is reported to operate at about 31% of its technical capacity, efforts should be made to improve the economics of energy utilization by realizing substantially higher production levels. The details and economics of converting the Homs Fertilizer Plant to natural gas have been discussed in Chapter IV. Based on full capacity utilization the value of fuel savings by switching to gas are estimated at about US$19 million per year. It is recommended that in the context of studying in detail the possibility of using gas in the fertilizer industry, thorough plant audits be conducted focusing on improving the plant's capacity utilization and on the potential for energy efficiency through co-generation and energy conservation measures.

3.31 Manufacturing. The manufacturing sector in Syria comprises over 100 major public enterprises and about 55,000 small private firms. Major energy consumers are the sugar, food processing, textile, glass, brick and pottery industries. Generally, as the manufacturing sector accounts for a high proportion of the country's total energy consumption, energy audits should be conducted in all major public enterprises in order to determine the scope and means for implementing energy efficiency improvement measures. At the present stage, plant operators should be made aware of available technologies to improve energy efficiency, while also undertaking an energy audit program for those industries with the highest energy consumption.

3.32 Transport. With an estimated 2.049 million toe energy consumption in 1983, the transport sector in Syria accounted for about 34% of the country's total energy consumption. However, to date, only very limited data is available that could be used to determine how efficiently fuel is used in this sector. Drawing upon the experience of other countries, where improvement of energy efficiency of 5-10% in the transport sector could be identified, it is reasonable to assume that similar scope for improvement exists in Syria. Even marginal improvements would yield substantial savings, on the order of roughly US$10 million per year. The large magnitude of these savings indicate that detailed investigation of energy conservation options and interfuel substitution are warranted.

3.33 Household Sector. The household sector accounts for nearly 30% of all commercial energy consumption in 1983. Electricity accounts for only 8.4% of this total, the balance (91.6%) being accounted for by LPG, kerosene for cooking, and gas oil for space/water heating. Demand is expected to grow at about 5% per year (a higher rate than population growth). The share of household consumption will decline only marginally to 28% by 1980 and to 26% by 1995.

3.34 Detailed household surveys in rural and urban areas and at different income levels would help to develop basic data that can be used for energy planning and conservation. These surveys should study current energy consumption patterns and also establish the efficiency of energy use for cooking and heating. If the growth of energy consumption with household sector could be limited to the rate of growth of the population, the savings would be substantial.

3.35 Recommendations on Energy Conservation

(a) A detailed energy audit should be undertaken for the fertilizer industry. The inter-relationship of improved capacity utilization, switch to natural gas, cogeneration opportunities and efficiency improvements needs to be analyzed. This activity should proceed as soon as possible since gas is expected to arrive in 1986.

(b) Detailed energy audits and energy rationalization activities should be undertaken for the cement industry and other energy intensive manufacturing industries. This should be done in the broader context of improving capacity utilization and efficiency. In the cement sector, particular emphasis should be placed on options for using gas and cooking fuel.

(c) Given the large share of energy used in transport, a detailed study of energy conservation options in this sector should be undertaken.

(d) Surveys of the household sector should be carried out to determine energy consumption patterns and the efficiency of appliances used.

Electric Power Demand

3.36 Electricity generation increased from 1133 GWh in 1974 to 6887 GWh in 1984 at an annual growth rate of 19.8%. Per capita generation increased from 157 kWh in 1974 to 696 kWh in 1984 while per capita consumption increased from 130 kWh to 501 kWh in 1984, reflecting a higher percentage of generation and distribution losses.

Table 3.7: ELECTRICITY SALES

	Domestic & Commercial		Small Industry		Large Industry		Government b/	
	GWh	% p.a.	GWh	% p.a.	GWh	% p.a.	GWh	% p.a.
1974	352		270		238		75	
1980	1,078	20.5	703	17.3	722	20.3	236	21.1
1984 a/	1,995	16.6	1,059	10.8	1,321	16.3	586	25.5

a/ Preliminary.
b/ Includes street lighting.

3.37 Several factors explain this extraordinary rate of growth. During the 1970s, GDP grew at an annual rate of about 10% and an elasticity of 2.0, which is normal for most developing countries. There has been rapid growth in the number of domestic consumers connected to the grid though real prices of electricity declined, which lead to very high growth rates.

Previous Forecasts of Electricity

3.38 Various electricity forecasts have been prepared in the past, including one prepared in 1978 by consultants. 2/ The consultants investigated trends using an analytical method and tried to match electrical consumption with economic factors such as industrial production and GDP. However, previous forecasts were based on a simple exponential model that was somewhat modified to account for large industrial loads. Its minimum forecast of generation was close to actual generation (Annex 6). However, early econometric models all showed a slower growth which gave a generation requirement that was about half of what actually was generated in 1984.

3.39 In early 1984, the Ministry of Electricity and PEE prepared a new forecast using the exponential model. The forecasts used average growth rates, which in 1983 were still high and considered generation only, which was distorted by the high growth rate of losses. The forecasts assumed (1) a continued growth rate of 19% for its "high forecast"; (2) a decrease by 1% annually, starting in 1983, under its "medium" assumption until it reached 9% in 1993; and (3) a decrease by 2% annually under its "minimum" assumption until 7% is reached in 1989. The study then concentrated on the medium forecast for defining a development scheme in generation. This forecast is shown in Annex 6 for the period until 1990. PEE has prepared a revised forecast in 1985 with lower figures for 1990 (shown in Table 3.10).

Analysis of Electricity Demand

3.40 Two electricity demand alternative forecasts will be developed and analyzed in this section. Both take saturation effects into consideration, which exponential models do not. Alternative 1, or the "high" forecast, is based on a moderate reduction of losses, no significant price increases and steady growth in consumption per consumer and significant additions to demand from large pumping schemes. Alternative 2, the "low" forecast, assumes slower growth in the household, commercial and industrial sectors due to major price increases. The forecasts are discussed and analyzed by consumer category.

2/ Etude Générale du développement de la puissance électrique et de l'interconnexion avec les pays voisin; Sofrelec Janvier 1978. The study, which also comprises a gas study, constitutes a combination of various studies financed under IBRD Loan 1194-SYR.

3.41 Access to electricity in Syria, according to PEE, has grown rapidly from 58% to 88% in the last 10 years, as shown in Table 3.6. These figures indicate both those who have connections and those who could connect but the actual percent of the population that is connected is somewhat lower (possibly 10-15%).

Table 3.8: ACCESS TO ELECTRICITY
(% of population which has connected
or which could be connected)

Year	Urban	Rural	Total
1970	100	6	53
1975	100	16	58
1980	100	50	75
1985	100	76	88

3.42 PEE has about 1.6 million connections in 1984 compared with 0.56 million in 1974. The average growth rate of consumers of 11.1% is impressive and must be due in part to the rural electrification program. No statistics, however, are available to assess the contribution of the rural areas to the increase. Unfortunately, because domestic and commercial consumers form one tariff class, no information is available on their separate levels of consumption.

3.43 The number of domestic and commercial consumers has also been growing rapidly, at a rate of 6% between 1980 and 1984. This means that out of the 16.6% growth rate in consumption, a large fraction was due to the addition of new consumers. The remaining growth of about 5.6% has come from increases in consumption per consumer due to rising incomes and falling real electricity prices.

3.44 The trend in consumption per consumer is likely to continue in the absence of major changes in electricity prices. Since fewer small consumers are expected to be added in the future, compared with the past, this growth rate may be higher in the future. On the other hand, income growth in the future may be lower. The growth of electricity consumption per consumer is estimated to be around 5-7% (similar to PEE projections). Income elasticities of consumption per consumer with respect to GDP per capita are estimated to be greater than one (see Annex 5). If electricity prices are increased significantly in real terms (e.g. a 75% increase above the rate of inflation), consumption per consumer is expected to reduce growth 1-3% per year. This is based on price elasticities of between -0.1 to -0.3. Thus, the overall growth in consumption per consumer, combining income and price effects, indicates a growth of 4% per year if prices are increased. The income and price relationships discussed here illustrate the approximate impact of price and income changes. Clearly, more detailed investigation of these relationships is warranted.

3.45 To project consumption in GWh for the country, the next step is to forecast the growth in the number of consumers. Lack of detailed data makes this difficult, but the rate of electrification has been high and it must slow down in the next decade. The rate of growth in number of consumers is estimated by assuming that about three-fourths of the 1.413 million consumers within the class are domestic (as stated by PEE), or about 1.06 million out of a total of about 1.53 million occupied households in 1983. The number of domestic consumers presumably refers to registered consumers. Since losses are partly due to unregistered consumers the number of registered consumers may rise significantly in the next few years as the number of unregistered consumers are reduced.

3.46 By combining the forecasts of growth in consumption per consumer with the forecasts in the growth in the number of consumers the total demand for Alternative 1 (high) forecast and Alternative 2 (low) forecast for the domestic and commercial category is obtained. The results are shown in Table 3.7. Both forecasts assume 95% electrification of households by 1995. Alternative 1 assumes that consumption per consumer will grow at 6% p.a., households will grow at 4% p.a., commercial consumers will grow at 6% p.a., and has a rapid growth in the number of registered consumers as losses are reduced. Alternative 2 assumes that higher prices and possibly slower income growth will lead to a 4% p.a. growth in consumption per consumer, while the number of household and commercial consumers will grow at the same rate as in Alternative 1. Alternative 2 demand is lower only due to assumed affect of price increases and doesn't take into account policy factors such as lower household or lower income growth. These forecasts provide a range of uncertainty regarding demand growth. Alternative 1 (high scenario) has an average growth of about 13% and the Alternative 2 (low scenario) has a growth of about 10% between 1983 and 1995.

3.47 Analysis of the growth of electricity demand in the large industrial sector indicates that there is low price elasticity, at least when relatively small electricity price changes, such as those in the past, are considered. There are very few large industry consumers (the total number for 1984 is low, only 28), but they account for nearly 27% of all electricity sales. Consumption by larger industries has grown at an average rate of 18.7% for the period 1974-84, although its contribution to GDP over this period has declined from 23.6% to 16.5%. The elasticity of GDP to manufacturing is estimated at 2.4 and electricity consumption to manufacturing at 4.0, indicating the power intensity of present manufacturing activity. Plans for large industrial projects in the future indicate a slower growth than the past but an increase is projected in the growth of smaller manufacturing industries. Assuming some improvements in efficiency of electricity use by existing industry and a slower elasticity of large industrial consumption to GDP, the growth rate of electricity consumption by the industrial sector is expected to decline.

Table 3.9: DOMESTIC AND COMMERCIAL ELECTRICITY DEMAND GROWTH

	1983	1990	1995
I. Alternative 1 - High Demand			
A. Number of Households, 4% p.a. (million)	1.525	2.0	2.43
B. % Households with Electricity	69%	90%	95%
C. Number of Dom + Comm Consumers (million)	1.413	2.34	3.03
D. Consumption per Consumer, 6-6.5% p.a. growth (kWh/yr)	1,155	1,736	2,324
E. Total Consumption (GWh)	1,632	4,491	7,809
II. Alternative 2 - Low Demand			
A. Number of Households, 4% p.a. (million)	1.525	2.0	2.43
B. % Households with Electricity	69%	89%	95%
C. Number of Dom + Comm Consumers (million)	1.413	2.34	3.03
D. Consumption per Consumer, 4% p.a. growth (kWh/yr)	1,155	1,520	1,850
E. Total Consumption (GWh)	1,632	3,930	5,977

3.48 Consumption of electricity in the agriculture sector is very low as most of the lift irrigation pumps are diesel operated. As rural electrification programs cover wider areas, there will be a shift from diesel engines to electric motors. In addition, if the large pumping schemes being planned are carried out on the Euphrates and Tigris (for irrigation of nearly 640,000 hectares) then the agricultural pumping load may be as high as 300 MW (about 1,000 GWh) over the next five years. This load is combined in the industrial consumption category. This industrial and agriculture growth is estimated to be 13.6% to 1990 and 9% between 1990 and 1995. Government electricity consumption is assumed to grow at a rate of 9.3% p.a.

3.49 When the projections of the four categories are combined the forecasts are obtained. Both forecasts assume GDP will grow at 4.7% p.a. from 1983 until 1990 and 5.1% p.a. until 1995. Alternative 1 (high forecast) assumes that there will be no change in real electricity prices, i.e., that prices will only be increased with inflation. Because of the distortions that have been caused by the losses, sales trends were established instead of generation trends and a gradual decline in the growth rate was assumed; until 1991, an average total growth rate of 9.5% is projected. Losses were assumed to decrease moderately from the present 29% to 23% by 1990 and 20% by 1995. Alternative 1 assumes some of these "losses" are unregistered consumers who became registered consumers; it also assumes a steady growth in consumption per consumer, industrial consumption and electricity for large pumping schemes. This forecast was designated the base case (shown in Annex 7). The Alternative 2 Forecast assumes losses (non-technical) are further reduced to 22% by 1990, that prices are increased substantially (75% in real terms) resulting in lower consumption per consumer. It also assumes that due to energy conservation measures and higher tariffs, specific energy consumption in the industrial sector would be lower. The forecasts in GWh are:

Table 3.10: ELECTRICITY FORECASTS
(GWh)

	Sales					
	Dom & Com	Industry	Govt.	Total	Losses	Generation
1983	1,632	2,211	432	4,275	1,943	6,218
Alternative 1 - High						
1990	4,491	5,523	793	10,807	3,228	14,035
1995	7,809	8,350	1,249	17,408	4,461	21,869
Alternative 2 - Low						
1990	3,930	4,789	793	9,413	2,781	12,194
1995	6,213	7,036	1,249	14,495	3,623	18,118
PEE Forecast						
1990	5,017	6,485	913	12,415	3,502	15,917
1995	9,914	11,257	1,804	21,975	5,494	27,469

3.50 Much work remains to be done on power demand forecasting in Syria. PEE should have consultants to overcome its present lack of in-depth forecasting efforts and improve statistical data collection. It is extremely important to improve forecasting accuracy since the power sector requires substantial financial resources. Policies and options in the power sector are discussed in Chapter VI.

Energy Supply and Demand Forecasts for 1990 and 1995

3.51 Based on the sectoral growth rates and elasticities as discussed above, energy balances have been prepared for the years 1990 and 1995. For both these forecasts, it has been assumed that Syria will undertake an accelerated program to develop gas reserves, that gas will play an important role in meeting Syria's energy needs and that gas production will be at a rate of 2.0 to 2.525 million toe by 1990 and 4.4 to 4.7 million toe by 1995 (discussed in Chapter IV). In addition, oil production is expected to go up to 12.00 million tonnes by 1990 and to 13.5 million tonnes by 1995 as a result of steps taken to sustain production in the Northeast oil fields, the new discoveries at Thayyem and a larger exploration effort. Net crude exports are estimated at 1.7 million toe in 1990 and 2.2 million toe in 1995. Refinery throughputs have been restricted to 10.3 million toe in 1990 and 11.3 million toe in 1995 for optimization of foreign exchange earnings from crude import/export and product import/export. It is also assumed that cracking facilities are installed at Banias to optimize middle distillate output. This is discussed in detail in Chapter V.

3.52 On the demand side, Table 3.10 summarizes the consumption of commercial energy on a sectoral basis for the years 1983, 1990 and 1995 and the anticipated growth rates.

Table 3.11: COMMERCIAL ENERGY CONSUMPTION
('000 toe)

	1983		1990		1995
Domestic Sector	1,807	(4.8)	2,541	(5.4)	3,304
Industry	1,597	(7.1)	2,595	(9.9)	4,214
Agriculture	514	(4.0)	675	(4.8)	855
Transport	2,049	(6.0)	3,080	(6.0)	4,118
Total	5,967	(5.9)	8,891	(7.0)	12,491

3.53 The net domestic consumption of energy is expected to increase from 6.0 million toe in 1983 to 8.9 million toe in 1990 and 12.6 million toe in 1995 (an average growth rate of 5.9% for the period 1983-90 and 7.0% for the period 1990-95). The reason for the anticipated higher growth rate for the period 1990-95 compared to 1983-90 is mainly explained by (1) energy conservation measures and price increases having strong impact over the next five years; (2) operating present plants at higher capacity; 3) higher GDP growth due to improved oil production; and (4) less energy-intensive industry for the sixth plan as compared to the seventh plan.

3.54 The combined supply and demand scenarios described above are combined in the energy balance for 1990 (Table 3.11) and for 1995 (Table 3.12). It is important to note that the assumed accelerated development of gas, combined with modifications to the Banias refinery, produce a situation where the massive and uneconomic surpluses of fuel oil in 1983 are reduced substantially in both 1990 and 1995. Electricity demand projections follow the Alternative 2 scenario, which assumes major increases in electricity prices.

Table 3.12: ENERGY BALANCE FOR 1983
(Thousand TOE)

Year-1983	Primary Energy					Elect-	Petroleum Products							Line
	Crude Oil	Gas	Coal	Hydro	Nuclear	ricity	L.P.G.	Naph/Gaso	Jet/Kero	Diesel	Fuel Oil	Other	Total	Totals
Gross Supply														
Production	8489	0		540										9029
Production, Sy Light														0
Imports	6307		4											6311
Primary Exports	5487													5487
Stock Changes	-14													-14
Total Available	9295	0	4	540	0									9839
Conversion:														
Petroleum Refining	-8908					0	113	1344	426	2434	4007	584	8908	0
Power Generation		0		-540		1810				-314	-956		-1270	0
Conversion Losses	-387					-1170							0	-1557
Trans/Dist Losses						-164							0	-164
Available for Consumption	0	0	4	0	0	476	113	1344	426	2120	3051	584	7638	8118
Secondary Supply:														
Secondary Exports						-8	-98	-435	-62	-398	2116	88	2081	2073
Bunkers											0		0	0
Total Domestic Supply		0	4			484	211	909	488	2518	935	496	5557	6045
Consumption by Sector														
Domestic and Commercial						152	211		239	1205			1655	1807
Agriculture						60				454			454	514
Industrial														0
Cement						51				18	476		494	545
Fertilizer						35		195		3	65		263	298
Manufacturing			4			174				110	389	30	529	707
Extraction						12				35			35	47
Transport								714	274	669	6	386	2049	2049
Total Domestic Consumption		0	4			484	211	909	513	2494	936	416	5479	5967
Increase in Stock			0				0	0	-25	24	-1	80	78	78

Table 3.13: ENERGY BALANCE FOR 1990
(Thousand TOE)

Year - 1990	Primary Energy					Elec-	Petroleum Products							Line
	Crude Oil	Gas	Coal	Hydro	Nuclear	tricity	L.P.G.	Naph/Gaso	Jet/Kero	Diesel	Fuel Oil	Other	Total	Totals
Gross Supply														
Production	8,000	2,050		702										10,752
Production, Sy Light	4,000													4,000
Imports	6,300		5											6,305
Primary Exports	8,000													8,000
Stock Changes														0
Total Available	10,300	2,050	5	702										13,057
Conversion:														
Petroleum Refining	-9740	-270				0	541	2,059	1,118	2,707	2,902	683	10,010	0
Power Generation		-1,089		-702		3,363				-100	-1,472		-1,572	0
Conversion Losses	-560					-2,327							0	-2,887
Trans/Dist, Losses						-228							0	-228
Available for Consumption	0	691	5	0	0	808	541	2,059	1,118	2,607	1,430	683	8,438	9,942
Secondary Supply:														
Secondary Exports						0	0	986	606	-1,005	264	200	1,051	1,051
Bunkers											0		0	0
Total Domestic Supply		691	5			808	541	1,073	512	3,612	1,166	483	7,387	8,891
Consumption by Sector														
Domestic and Commercial						334	541		100	1,566			2,207	2,541
Agriculture						85				590			590	675
Industrial														0
Cement		325				66				39	369	35	434	825
Fertilizer		366				45		0		0	62		62	473
Manufacturing			5			260				200	726	40	966	1,231
Extraction						18				48			48	66
Transport								1,073	412	1,178	9	408	3,080	3,080
Total Domestic Consumption		691	5			808	541	1,073	512	3,612	1,166	483	7,387	8,891
Increase in Stock		0	0				0	0	0	0	0	0	0	0

Table 3.14: ENERGY BALANCE FOR 1995
(Thousand TOE)

Year - 1990	Primary Energy					Elec-	Petroleum Products							Line
	Crude Oil	Gas	Coal	Hydro	Nuclear	tricity	L.P.G.	Naph/Gaso	Jet/Ker.	Diesel	Fuel Oil	Other	Total	Totals
Gross Supply														
Production	8,000	4,363		945										13,380
Production, Sy Light	5,500													5,500
Imports	6,300		20											6,320
Primary Exports	8,500													8,500
Stock Changes														0
Total Available	11,300	4,363	20	945										16,628
Conversion:														
Petroleum Refining	-10,692	-418				0	705	2,241	1,225	2,883	3,304	752	11,110	0
Power Generation		-2,084		-945		4,542				0	-1,513		-1,513	0
Conversion Losses	-608					-3,002							0	-3,610
Trans/Dist, Losses						-308							0	-308
Available for Consumption	0	1,861	20	0	0	1,232	705	2,241	1,225	2,883	1,791	752	9,597	12,710
Secondary Supply:														
Secondary Exports						0	0	812	632	-1,714	416	73	219	219
Bunkers											0		0	0
Total Domestic Supply		1,861	20			1,232	705	1,429	593	4,597	1,375	679	9,378	12,491
Consumption by Sector														
Domestic and Commercial		83				528	705		0	1,988			2,693	3,304
Agriculture						106				749			749	855
Industrial														0
Cement		650				66				33	380		413	1,129
Fertilizer		732				90		0		0	120		120	942
Manufacturing		396	20			412				322	654	49	1,225	2,053
Extraction						30				60			60	90
Transport								1,429	593	1,445	21	630	4,118	4,118
Total Domestic Consumption		1,861	20			1,232	705	1,429	593	4,597	1,375	679	9,378	12,491
Increase in Stock		0	0				0	0	0	0	0	0	0	0

Notes on 1983 Energy Balance

- Source is Ministry of Petroleum and Mineral Resources (MPMR), units are thousand tonnes oil equivalent.

- Refinery fuel is considered as fuel oil consumption in conversion losses (this figure is about 133. Fuel figures are much higher, near 400, according to data from refineries).

- Transmission and distribution losses for electricity in the balance are from PEE and are 35,000 toe higher than MPMR figures.

- Naphtha exports in the balance are 435,000 tonnes, which matches CBS statistics, whereas MPMR figures show 220,000 tonnes of this as stock increase.

- The implied conversion efficiency in electricity is 35.4%; this appears high. The reason for this is unknown.

- Hydroelectricity is converted at a rate of 4000 kWh = 1 toe.

Notes on 1990 Balance

- Gas production is up to 2.050 million toe with 0.27 million toe of this as LPG.

- Transmission and distribution losses are assumed to drop to 23%. Conversion efficiency in electricity is 30.8%.

- Output of refined products assumes that the Homs refinery is running on 50% Souedie crude/50% light crude at a throughput of 5.4 million tonnes/yr. Banias refinery is assumed to have a throughput of 4.73 million tonnes/yr of light crude (such as Kirkuk) and a new FCCU (1.1 million tonnes of fuel oil feed).

- GDP growth is assumed to be 4.7%/yr from 1983 to 1990.

- Figures are based on Alternative 2 electricity demand (which assumes higher electricity prices and lower demand). The changes in the balance, in thousand toe, using the higher Alternative 1 electricity demand figures are: gas production (2,525), gas in power generation (-1,564), electricity generation (3,838), electricity losses (-2,655 for conversion, -272 for transmission and distribution, electricity consumption and supply [911 total, with changes in domestic and commercial (321), agriculture (135), manufacturing (326)]. Total domestic consumption changes to 8,994.

Notes on 1995 Energy Balance

- GDP is assumed to increase 5.1%/yr from 1990 to 1995.
- Gas production is assumed to go up to 4.738 million toe of which 0.418 toe is LPG.
- Refinery output assumptions are the same as for 1990 except that an additional one million tonnes of light crude will be run at the Banias refinery.
- Overall efficiency in the power sector is assumed to be 33.9%.
- Figures based on Alternative 2 electricity demand. The changes in the balance, in thousand toe, using the higher Alternative 1 figures are: gas production (4,738), nuclear supply (550), gas in power generation (-2,459), electricity generation (5,467), electricity losses (-3,624 for conversion, -405 for transmission and distribution, electricity consumption and supply [1,438 total, with changes in domestic and commercial (663), agriculture (212), manufacturing (377)]. Total domestic consumption changes to 12,697.

IV. PETROLEUM AND GAS SECTOR — ISSUES AND OPTIONS

Oil Production Strategy

4.1 The major oil fields operated by the Syrian Petroleum Company (SPC) have been producing for about fifteen years, and many are well past their peak. Production from the major producing horizon of the Souedie field declined from about 8.3 million tonnes in 1976 to 6.2 million tonnes in 1984, and could drop to 5.8 million tonnes in 1985. In addition, the water cut increased to more than 43% in 1984. The condition of the Karatchok field is similar but not as dramatic.

4.2 Despite these trends, the fields are not yet approaching depletion. On the contrary, considerable reserves could be extracted from Souedie, Karatchok and the small but numerous oil accumulations in the Rumeilan and Jebisse regions. The oil produced so far from the two main reservoirs in Souedie and Karatchok is about 12% of the estimated original oil in place. With proper equipment and techniques, supported by laboratories and computer facilities for detailed studies, such reservoirs could yield more than twice what they have produced so far. Hence, with additional technical inputs, it is possible to arrest the production decline and reverse it within the next four years.

4.3 SPC is operating very complex fields in a very remote and inhospitable environment. The company has operated well, particularly considering the limited access to foreign exchange and the use of old equipment and services. However, the technical staff of SPC has been isolated from the advancements attained in the international petroleum industry over the past fifteen years, and many of the practices and most of the equipment is obsolete. The challenge which faces SPC is to take bold steps within the next few years to modernize the oil field equipment, rehabilitate surface facilities, improve drilling and completion efficiencies and launch initial reservoir studies.

4.4 Considering the complexity, varied lithology and large area of the main reservoirs in Souedie, Karatchok and Jebisse, the well spacing is too wide (averaging more than 30 hectares per well). This condition is compounded by water breakthrough in many producing wells. Such massive reservoirs should be considered as different, often disconnected vertical and lateral units. Hence, their development schemes and well spacing should correspond to the reservoir characteristics. The present wide spacing, while allowing low unit production costs in the short term, may actually result in the bypassing of some oil and reducing of the ultimate recovery from the oil reservoirs in the long term.

4.5 Field surface facilities are old, and equipment and methods to measure the flow of oil, gas and water are in many cases outdated and inaccurate. Flow lines between wells and gathering stations are often too long, imposing back pressure on the wells (particularly in the winter season, when oil viscosity increases). In Souedie, some 55 wells are reported to have collapsed casings. Many wells in Karatchok have no proper cementing behind casings. A major campaign is needed to rehabilitate the fields (surface and subsurface). For this SPC may need to mobilize service contractors and purchase the necessary equipment.

Heavy Oil and Enhanced Recovery

4.6 Many of Syria's oil fields are heavy oil deposits (see Annex 3). Reserves in the large Karatchok field alone account for 163 million m^3 (22%) of the total heavy oil reserves in the country. The rest of these heavy oil reserves are distributed among twelve other fields with oil in place, ranging in size from 2 million m^3 to 256 million m^3 for each field in the undeveloped Zouraba and Said structures. The oil gravity ranges from 12° to 20° API and the depth of the producing horizon ranges from 600 to 2,500 meters. The recovery factor for primary production is estimated to be about 11% on average. In some cases, the oil concentration per unit of rock volume is too low (Tichrin field) or the oil zone is too deep for economic thermal recovery processes. In addition, many of the accumulations are small and scattered over many isolated areas where little or no infrastructure is available. However, the volume of reserves, particularly in the large oil fields, would justify conducting an extensive study of possible Enhanced Oil Recovery (EOR) processes. The prospects for improving the recovery efficiency from heavy oil accumulations are very encouraging, but field-wide applications could take up to five years to complete so that appreciable increases in production would not occur before seven years.

Unit Costs and Investment

4.7 SPC has managed to keep the cost of its operations remarkably low. In particular, the exploration, drilling and production costs are far below comparable international standards. This in itself is an indication of the efficient management at the headquarters and districts and shows a commitment of SPC staff towards cost effective operations. On the other hand, low costs reflect some of the following:

(a) Inadequate investment in renovations, rehabilitation, supporting services, studies and research;

(b) Continual use of equipment beyond its useful economic life, resulting in slow drilling times; and

(c) Low level of investments in exploration work, and in developing the producing oil fields, particularly Souedie and Karatchok.

4.8 Most of the equipment and surface facilities in the SPC fields is outdated, and many of the drilling rigs are more than fifteen years old (many are 1950s and 1960s vintage). Drilling costs are quite low (less than SL 1,000 and 3,000 for development and exploration drilling, respectively), but the time needed to drill a 700 meter development well is 15 days and for a 2,000 meter well average time is 22 days. The time needed to drill increases to as much as 45 days for complicated wells and for some difficult 4,000 meter wells, the drilling time could be almost one year. These time frames are longer than industry standards. Improvements of 20% to 30% can be achieved with new equipment. Most of the drilling rigs lack mud logging services, power tools, automatic drillers and monitoring devices. Formation logging tools and evaluation tools are outdated and modern logging and computer evaluation is seldom used. Surface facilities need considerable redesign and renovation. Supporting services such as laboratories (mud, cement, core, etc.), reference and periodical libraries, and computer centers need to be established or enlarged to support the SPC's expanding activities. Such additional investment in equipment and support services will improve efficiency and further reduce costs in the long run. SPC management is well aware of these prospects; however, the limited availability of foreign exchange and limits on new investments prevent SPC from taking full advantage of them. (Detailed investment plans are given in Table 9.1.)

Recommendations on Oil Production

4.9 Maintaining production in the old oil fields should be a top priority. The complexity of the major reservoirs in Souedie and Karatchok and those in the small fields of the northeast cannot be overemphasized. The density of the producing wells has been rather low. Several urgent steps are required to increase ultimate oil recovery and prevent production declines. Investments on the order of $80C-900 million are expected to contribute to oil reserves and production worth a discounted present value of $2 billion or more, assuming constant real oil prices.

4.10 Recommendations are outlined below:

(a) SPC has launched a program of development drilling during the last four years. The sixth five-year plan calls for drilling some 350 development wells. Considering the wide spacing of the wells, (particularly in Souedie and Karatchok, Masif and Jbeseh Jeribe) this development effort is not sufficient to address reservoir complexities. The planned development effort should be doubled if the SPC objective is to arrest the decline in production or increase the production and improve recovery from the old fields.

(b) In order to adequately support this development effort numerous studies are required on: the performance of various reservoirs, the optimization of recovery, enhanced recovery for heavy oil, surface facilities design, and restructuring, etc. (SPC has included all the studies in its plan.) Priorities need to be clarified, focusing on production from large accumulations rather than smaller fields.

(c) An intensive training program and supporting laboratories and services are required.

Hydrocarbon Exploration

4.11 Since its formation in 1958, SPC has grown in size and maturity and has developed capabilities for carrying out all exploration activities by itself, including service data required, data processing and drilling. While some use has been made of Western equipment and technology, most of the technical advice and equipment has been provided by the USSR. In the mid-1970s SPC realized it could not explore for new prospective areas and simultaneously handle increasingly complex production operations. Consequently, international oil companies were invited to enter into production sharing contracts in the central and southeastern part of the country. Contracts were concluded in rapid succession with Shell-Pecten, Tripco, Marathon, Samoco, and Chevron (all USA). Exploration contracts are based on the Egyptian model, in which oil production contractors receive 25% of profit oil, after cost recovery. For gas, the contractor must consider all gas utilization options and decide on the best alternative for the contractor and SPC jointly. If gas is sold for export the contractor receives the same terms as for oil. If the gas is not exported it becomes entirely owned and utilized by SPC.

4.12 At present, about 50% of the total land area is covered by production sharing contracts. A recent discovery by Shell-Pecten will probably heighten interest in other parts of Syria. Marathon Oil has discovered two gas fields and their contract is due to expire in 1987. Given the pragmatic attitude of the Government of Syria, additional production sharing contracts may well be concluded in the near future.

4.13 SPC explores in almost all areas not covered by service contracts. Its operations include two seismic parties which, over the last six years (1979-1984), averaged 1,100 km/year or 90 km/month. Operations are made difficult by the lack of spare parts. SPC urgently needs modern equipment as work is now directed towards smaller and more complex prospects.

4.14 The company operates ten exploration drilling units which are completing about 40 wells per year. Again, this slow progress is due to lack of modern equipment and spare parts. Drilling remains concentrated in the northeast, although intermittent operations take place in the Aleppo/Palmyra areas. To date SPC has profiled in excess of 32,000 line kilometers of seismic which supported the drilling of about 100 pure exploration wells.

4.15 SPC's planned exploration investment for 1985 is SL 222 million ($55 million), although 40 exploration and delineation wells are expected to be drilled in 1985. Seismic effort for 1985 is anticipated to reach 3,600 line-kilometers, in addition to lines shot by foreign companies (foreign companies shot less than 2,000 line-kilometers in 1984).

4.16 The extent of several large fields in the northeast is not yet known although there is evidence that Souedie and perhaps Karatchok are combination structural/stratigraphic traps. There appear to be many indications of satellite structures between the major fields, but none of these have been explored systematically. A regional geochemical/geological/geophysical compilation is needed. SPC should embark on a comprehensive geological assessment of the entire producing areas incorporating all available seismic/sub-surface data.

SPC Exploration Plans, 1986-1990

4.17 SPC has relatively ambitious plans for the coming five years. Seismic acquisition will increase to three parties; a total of 17,000 line kilometers will be profiled. The company will acquire new equipment and expand its processing facilities. Of the total acquisition only about 800 km, or 4%, will be acquired in the northeast. The bulk of the acquisition will be in the Jebel Arab area (6,700 km or 39%), in the Aleppo/Palmyra area (5,800 km or 34%) and in the western/northern part of the country (3,700 km or 22%). Of this effort, about 8,000 km will be of a regional nature while the balance will be more detailed.

4.18 The 1986-1990 plan calls for the drilling of 100 exploration wells, 80 of which will be located in the northeast and the rest distributed over the Aleppo area, the Palmyrian, and perhaps the Jebel Arab area.

4.19 According to historical costs provided by SPC, exploration expenditures for the above five-year program would be around $220 million, or $40-50 million/year. A more realistic figure would probably be $50-60 million/year. SPC expects to find sufficient oil reserves in the northeast to maintain production at its present level for some years to come. Exploration drilling will concentrate on evaluating extensions to existing fields and testing small satellite structures. In addition, exploration will be directed towards small subtle structures between producing trends for which there are many indications.

4.20 In the Palmyra area efforts should focus on structural trends where gas accumulations have been discovered. Determination of drillable prospects will be made on the basis of available seismic and surface geology; only 400 km of additional seismic acquisition is planned here.

4.21 Activities in the Jebel Arab area and on the Aleppo high are mainly limited to inventory prospects. In the Aleppo area expectations may be low, while the Jebel Arab area could be described as having high risk and medium potential.

Recommendations on Hydrocarbon Exploration

4.22 SPC's present five-year exploration program could be better balanced. Recommendations on how to improve this balance are given below:

(a) There is insufficient seismic data in the areas where the bulk of exploration/delineation drilling will be carried out. Seismic operations should include at least 4,000 kilometers over the next five years in the northeast instead of the original planned level of 800 kilometers. There should also be a corresponding decrease in the Jebel Arab/Aleppo areas. Consideration should be given to acquiring some 3-D seismic data.

(b) SPC's study/evaluation effort should be increased to include regional geochemical studies, evaluation of Paleozoic prospects, etc. These studies should be assisted by consultants/contractors where feasible.

(c) SPC needs to update its seismic and drilling equipment. Updated equipment will result in faster drilling progress; the time gained should be deployed for additional exploration and delineation drilling in the producing areas and drilling for key tests in new geologic plays, particularly the Paleozoic. The size and scope of these programs is the maximum SPC can undertake efficiently.

(d) Additional exploration/operations in Syria could be achieved with contract drilling and contract seismic in certain selected areas.

(e) A regional resource appraisal should be undertaken for optimum planning of seismic operations. The results would assist in realigning the seismic acquisition programs. Resource appraisals should be carried out on a continuous basis. Given a prospective ranking of the various geological plays, an efficient country-wide drilling program could then be developed.

4.23 With the above points in mind, the following is proposed for SPC:

(a) Geological studies (1986-1987): to include a regional evaluation of the Paleozoic source rocks including stratigraphic development and geochemical analyses.

(b) Describe geological play areas operated by SPC and carry out a resource appraisal using the RASP or expanded Nature model (used by the World Bank and the InterAmerican Development Bank).

(c) Geophysical operations: during 1986 and 1987 concentrate geophysical (seismic) acquisition in the producing areas of the northeast (two parties). Acquire experimental lines in unexplored Jebel Arab (one party).

(d) Based on the results of the resource appraisal, determine a seismic program for the remainder of the period.

(e) During 1988-1990 one party should remain in the northeast and two parties should operate in selected SPC areas as determined from the geological ranking.

(f) Exploration drilling: provisions are made for ten drilling units to drill 100 exploration wells under the five-year plan. With the provision of new equipment, drilling time could be reduced and at least half of the additional capacity should be used for additional exploration/delineation drilling in the producing areas and drilling of key wells for Paleozoic prospects.

4.24 The following consultants and expert services should be obtained for executing the alternative exploration program.

(a) Foreign specialists in seismic acquisition should be contracted for geophysical operations when operating in difficult areas.

(b) Geochemical consultants will be required to install new equipment and train SPC geologists in the latest developments for identifying source rocks and matching crude oils with source rock extracts.

(c) Consultant services will be required to introduce the latest processing and interpretation techniques. Seismic processing should make increasing use of synthetic seismograms and detailed interval velocity studies.

(d) Consultant services will be needed to evaluate the hydrodynamic effects on a regional basis, close cooperation with geochemical consultants is required.

(e) In order to cope with the geophysical interpretational requirements, SPC should go ahead with plans to upgrade its field equipment and therefore acquire a third seismic crew (vibroseis). In order to deal with the complex processing requirements, SPC needs to expand its seismic processing facilities.

The investments required to fulfill these recommendations are discussed in Chapter IX.

Gas Production Strategy

Present Natural Gas Production Projects

4.25 During the last seven years, Syria has begun to focus attention on natural gas development and utilization. In 1983 no gas was utilized, but at present there are two firm gas projects. The first is a $60 million project for collecting associated gas from Rumeilan oil fields to recover LPG and condensate and to use the dry gas for power generation. The plant, which was commissioned recently, handles 0.241 BCM/Y (20 MMCF/D) of raw gas and produces 0.182 BCM/y (19 MMCF/d) of dry gas for electricity generation and 130 tonnes/d LPG plus 22.2 tonnes/d sulfur. At present, some of the dry gas is flared, but by the end of 1985, new power generating units will be installed and little gas will be flared. Additional project details are given in Annex 8.

4.26 The second project, planned to begin in 1986, is designed to pipe gas from the Jebisse field in northeast Syria to Homs in the west. In an effort to expedite exploration and development of the gas reserves in the Jebisse region, the government of Syria signed an agreement with Bulgar Geomin Company of Bulgaria in November 1982 to complete delineation of the gas structures, develop them and pipe the gas to the treating plant in Jebisse. The duration of the agreement is 36 months from its effectiveness date of April 25, 1985. The contract with Geomin is a turnkey contract for $185 million and the expected gas production rate is 1,700,000 m^3/d (±50 MMCF/D). In addition, a separate contract was signed with a Czechoslovakian firm for $135 million to construct an LPG and sulfur extraction plant and a 16"-350 kilometer pipeline to Homs (see Annex 8 for details). Repayment terms under the contract are complex, and it involves a barter agreement with exports of phosphates, textiles and cotton from Syria to Bulgaria and Czechoslovakia. Based on these cost figures provided to the mission (for production wells, gas processing and pipelines), the approximate cost of this gas delivered to Homs is high at over $3/MCF.

4.27 The planned utilization of the gas is to replace the naphtha used in the fertilizer plant in Homs. The substitution value of the naphtha to be replaced by gas is estimated to be $4.84/MCF. The input of naphtha for the design capacity of the fertilizer plant is 306,000 tonnes per year. Plans are to use 0.45 BCM/Y (about 50 MMCF/D) of gas to replace this naphtha feedstock and a small amount of fuel oil. However, the fertilizer plant has been operating at only about 50% capacity in recent years, probably due to operational problems.

4.28 Total gas utilization from the two ongoing gas projects is expected to be 0.63 BCMY (66 MMCFD) in 1987.

Potential Additional Gas Supply

4.29 Gas supplies are not limited to the Souedie and Jebisse areas. The appraisal of gas finds and exploration for gas in the Palmyra region should be a first priority, particularly if the volume of reserves foreseen and the prolific nature of the structures can be established. There is tremendous scope for increasing gas production from these fields in the Palmyra Basin, the potential of which has not been adequately accessed so far. There also is scope for expanding the production from the Jebisse area by about 0.5 BCM/Y. Associated gas produced from the new oil discovery at Der-el-Zor, Thayyem Rutbah, is expected to produce about 0.2 BCM/Y and possibly more from nearby structures (if it is not all required for reinjection), and the potential supply of non-associated gas in the Souedie area is estimated at 0.5 BCM/Y. Non-associated gas has been discovered in the Palmyra Basin where at least 2.0 BCM/Y (200 MMCF/D) could be produced by the early 1990s and possibly another

2.0 BCM by the mid-1990s. The cost of gas from the Palmyra Basin delivered to Damascus is estimated to be less than $1/MCF, or one-fourth of the cost of fuel oil. These large quantities of gas, at low cost, can be utilized to advantage in power generation and industry. The potential supply and cost of gas from various fields is discussed in detail below and summarized in Table 4.1. An analysis of the potential supply is followed by a description of the demand for gas by consumers in power and industry.

Additional Gas from Jebisse

4.30 Additional supplies of gas through the Jebisse-Homs pipeline are limited by the size of the pipeline. An additional compressor station could double the capacity to about 1 BCM/y, but this is probably the maximum capacity of the pipeline. One possible source of additional gas for the present pipeline is 0.5 BCM/Y of gas from the Jebisse field. Minimum reserve figures for the Jebisse area provided by SPC are 21 BCM. These reserves could support 1 BCM/y for 20 years, but additional supply depends on gas reservoir size, recovery factors, drilling costs and well production levels. Current information on these parameters is not available and more testing is required. Assuming that an additional 0.5 BCM/Y could be produced from Jebisse, and production costs would resemble those reported for the original Jebisse investment, the delivered cost of the additional gas is estimated at $1.50-$2.00/MCF (based on rough estimated cost of US$12 million for compression, US$18 million for treatment, and US$70-150 million for additional wells).

Associated Gas from the New Oil Discovery at Der-El-Zor

4.31 Although it is too early to know the exact gas production rate and results of the 1984 oil discovery, tentative figures indicate 0.20 BCM/Y (20 MMCF/D) will be produced from Thayyem Rutbah. It is likely that there may be additional gas in nearby structures, so possibly 0.35 BCM/Y could be available from the region. This gas is expected to be rich in LPG and may be able to supply 100,000 to 125,000 tonnes per year. Early planning could save gas from Thayyem Rutbah from being flared, since the oil production will no doubt begin as soon as possible. This is low pressure gas, which indicates that utilization of the gas close to the production site, probably for power generation, would be desirable. The supply of this low pressure gas could be supplemented by non-associated gas from Jebisse or Souedie to ensure stable production. For this purpose an interconnection with the Jebisse/Homs pipeline under construction now should be planned.

Non-Associated Gas from the Palmyra Basin

4.32 There is a tremendous potential to produce gas from the fields in the Palmyra area. The exact production profile depends on how fast full evaluation and development can proceed. It should be possible to produce 1.3 BCM/Y by 1990 and 3.2 BCM/Y by 1995, equivalent to 1.2 million toe by 1990 and 3.0 million toe by 1995.

4.33 Gas discoveries have been made by SPC, Marathon and Shell in the Palmyra region. Some 60 billion m^3 (BCM) of gas reserves have been identified, but their full evaluation has not been completed. The productivity of discovery wells has been reported to be fair to good. Past exploration work has been minimal, but there are indications of numerous structural trends with large anticlinal features. This area, located 60 kilometers from Homs, is highly prospective, and the geological reserves of natural gas there are estimated to range from 60 to 230 billion m^3 (2 to 8 TCF) of gas, or about 75-200 million tonnes of oil equivalent. Well data indicate the production per well could average 110-170 thousand cubic meters per day (4 to 6 MMCF/D), and one field at least (Najeeb discovered by Shell-Pecten) could produce gas without any treatment for removal of acid gases or recovery of natural gas liquid required. In addition, the quality and pressure of raw gas from the well test was fully up to pipeline and market needs. The minimum expectations of gas from these fields would support an annual supply of 2 BCM per year for 20 years. This is not only a very practical and economic volume from a production and pipe-lining standpoint, it is also the appropriate volume which would readily be absorbed in the Damascus area by power stations, industry, commerce and residential customers by the late 1980s or early 1990s. Taking this volume as an example, it would displace some 1.7 million tonnes of petroleum products from the Damascus area, or 24% of all 1983 energy consumption.

4.34 An accelerated program of delineation and testing could allow initial gas production to start in 1989 which could build up to a plateau production of 2 BCM/Y by 1993. A second increment of supply might begin production in 1993, increasing to 2 BCM/Y by 1995. Plateau production is maintained for about 20 years, so total production in 20 years at 4 BCM/Y is 80 BCM of reserves. This production profile is on the low end of the likely reserves in the Palmyra area (60-230 BCM). Gas composition figures indicate a rather low LPG content for Najeeb. Data is not available on the other fields, but if this low LPG content applies to the other fields, the approximate LPG production from Palmyra would be around 40,000 tonnes in 1990 and 122,000 tonnes in 1995.

4.35 Approximate investment costs required to develop and pipe the first 2 BCM/Y from Palmyra to Damascus were estimated. However, these figures are only rough estimates so actual costs may be higher or lower. Total investment cost assumptions to develop the first 2 BCM/Y are US$430 million (US$30 million for appraisal wells, US$200 million for developing wells, US$40 million for processing and, US$160 million for the pipeline to Damascus). The production cost based on these assumed figures is US$0.70/MCF, or one-fifth the price of fuel oil (valued at US$3.50/MCF). The internal rate of return for gas valued at US$3.50/MCF is over 38% and the net present value on the US$430 million investment is more than US$1.2 billion (at 10%). The costs of not proceeding rapidly with the development are high and represent a loss of about US$150 million in present value for each year of delay.

Table 4.1: POTENTIAL GAS SUPPLY IN SYRIA
(Gas in units of billion cubic meters per year
(million cubic feet per day),
LPG in units of 1000 tons per year)

		Status	1984/85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000
Associated Gas														
1. Souedie	- Gas	Producing	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182
			(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)	(19)
	- LPG		47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5
2. Der-el-Zor	- Gas	Will be produced with oil			0.08	0.17	0.25	0.34	0.34	0.43	0.43	0.43	0.48	0.43
					(9)	(18)	(26)	(35)	(35)	(45)	(45)	(45)	(50)	(45)
	- LPG				29	42	91	125	125	155	155	155	160	155
Non-Associated Gas														
Jebisse	- Gas	Under construction - piped to Homs a/ primarily for fertilizer		0.256	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
				(26)	(47)	(47)	(47)	(47)	(47)	(47)	(47)	(47)	(47)	(47)
	- LPG			13	22	22	22	22	22	22	22	22	22	22
Jebisse	- Additional	Potential-depending on reserves and tests					0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.50
							(28)	(50)	(50)	(50)	(50)	(50)	(50)	(50)
	- LPG						10	20	20	20	20	20	20	20
Palmyra Basin	- Gas	Potential					1.0	1.30	1.7	1.9	2.0	2.0	2.0	2.0
							(100)	(130)	(170)	(190)	(200)	(200)	(200)	(200)
	- LPG						32	42	(56)	60	64	64	64	64
Additional from Palmyra Basin	- Gas	Potential									0.50	0.9	1.2	2.0
											(50)	(90)	(120)	(200)
	- LPG										24	43	58	96
Souedie	- Gas	Potential								0.5	0.5	0.5	0.5	1.5
										(50)	(50)	(50)	(50)	(150)
	- LPG									24	24	24	24	72
TOTALS	- Gas		0.182	0.438	0.71	0.80	2.13	2.77	3.17	3.96	4.56	4.96	5.31	7.06
			(19)	(45)	(75)	(84)	(220)	(281)	(321)	(401)	(462)	(502)	(536)	(711)
	- LPG from Gas		47.5	60.5	98	112	203	257	270	329	356	375	395	477

a/ Capacity is 0.511 BCM per year, but annual throughput is assumed to operate 330 days.

Source: SP^ and mission estimates.

4.36 The above forecasts are based on conservative reserve estimates of the Palmyra region but further delineation work is expected to result in substantial additional reserves. In the second phase, possibly 2 BCM/y or more could be produced at unit costs similar to the first phase of development from Palmyra. If gas reserves eventually prove to be very large, export possibilities could be considered as well as channelling the gas to meet the demand in the high priority domestic market.

Non-Associated Gas from the Souedie Area

4.37 Additional gas could be produced from the Souedie region. This gas is located farther from markets than the Palmyra or Jebisse gas but there certainly is the possibility to supplement gas for the Jebisse-Homs pipeline or generate electricity in the northeast. It is estimated that about 0.5 BCM/Y could be produced beginning in 1991. Gas composition figures indicate that about 24,000 tonnes of LPG per year would also be produced. The cost of producing the gas is estimated to be around US$1/MCF.

4.38 The total potential gas supply from all sources by 1990 is projected to be 2.8 BCM, and supply 260,000 tonnes of LPG, as shown in Table 4.1. This is equal to 2.5 million toe. By 1995, potential gas production is projected to be 5.31 BCM and production 395,000 tonnes LPG, a total of about 4.7 million toe. These potential gas production figures indicate what could be achieved if a large accelerated effort to develop gas quickly was undertaken.

Demand for Gas

4.39 The utilization of gas in Syria is likely to be limited, not by demand, but by the rate at which gas can be produced, as shown in Table 4.2:

Table 4.2: POTENTIAL GAS PRODUCTION AND DEMAND

Year	Potential Gas Production Base Case (BCM)	(Million toe)	Fuel Demand in Million toe Power	Fertilizer	Cement	Domestic, Commercial and Manufacturing	Total
1983	0	0	1.270	0.260	0.494	2.19	3.72
1990	2.8	2.5	2.2 to 3.1	0.473	0.725	1.5 to 2.8	4.9 to 7.13
1995	5.3	4.7	3.1 to 4.5	0.910	1.100	2.5 to 3.7	7.6 to 10.2

Note: Low fuel figures for power correspond to Alt. 2 electricity demand forecast whereas high fuel figures correspond to Alt. 1 demand.

As shown, the demand for fuel (fuel oil, naphtha and diesel) in industry is much greater than the supply of gas in the base case. In fact, the power sector alone could utilize most of the gas produced until 1995.

4.40 The most efficient allocation of gas to its various uses is a complex subject which depends on the value of the fuel displaced, location of industry, conversion costs, and many other factors. The process of developing an optimal gas development plan requires a full gas utilization study in which supply, demand and price are simultaneously analyzed. A gas utilization study therefore should be completed as soon as possible. This report cannot do a full study but important points are outlined regarding the value of fuels for which gas could be substituted and the potential demand for gas in various industries.

4.41 The opportunity value of the fuel replaced by natural gas depends on the international price of the fuel, whether it is imported or exported, and the specific use of the fuel. Approximate values are shown below.

Table 4.3: STRAIGHT SUBSTITUTION VALUES OF NATURAL GAS

Exported Products	$ ton			$/MCF (=$1/million Btu)	
	FOB Italy	Ex Banias	Ex Homs	(Gross)	(Net) a/
Fuel Oil b/	163	15[illegible]	151	4.07	3.90
Naphtha c/	257	248	245	5.04	4.84

Imported Products	$/ton			$/MCF (=$1/million Btu)	
	Imported from Italy	Internal Distribution	Cost Total	(Gross)	(Net)
Gas Oil d/	251	14	266	6.0	5.76
Kerosene e/	265	20	285	6.33	6.10

a/ Net Calorific values used for substitution value comparisons.
b/ 42 million Btu/ton.
c/ 1 ton of naphtha replaced by 0.92 x 52.886 x million Btu (gross) of natural gas in fertilizer production.
d/ 44 million Btu/ton (gross).
e/ 45 million But/ton (gross).
Average Italian prices for the first half of 1985.

As shown above, the highest substitution values of gas, in order of decreasing value, are kerosene, gasoil, naphtha and fuel oil. All equal or exceed US$3.90/MCF. Exact netback prices for gas may be somewhat different after equipment conversion costs are included; clearly, the largest potential volumes for gas substitution are fuel oil in power and industry (as shown in Table 4.2). However, the most valuable uses are for relatively small quantities of naphtha replaced in fertilizer production and gasoil in other industrial and power uses. The process of developing a plan for the most efficient use of gas must allocate gas first to the highest value uses and then to lower value uses until the marginal cost of supply equals the opportunity value of the fuel replaced (including conversion costs).

Fertilizer Industry

4.42 The substitution value of gas for naphtha is estimated to be US$4.84/MCF, which is higher than that for fuel oil (US$3.90/MCF). Assuming that the fertilizer plant is economic to operate, a high value use for gas is in fertilizer production. The Jebisse-Homs pipeline capacity has been designed to meet the design capacity of the Homs fertilizer plant, which has been running at 50% capacity in recent years. If this low output continues into the future, excess gas may become available in the next few years when the gas begins to be delivered in 1986. This excess gas could be used for power generation or for refining in Homs.

4.43 The demand for process steam at the fertilizer plant in Homs (currently requiring approximately 280 tonnes of fuel oil day) combined with the clear need for power in the plant and in the neighborhood of Homs provides an opportunity to install a cogeneration plant to supply both process steam and power. Natural gas is the ideal fuel for cogeneration. In other, similar projects thermal efficiencies of around 75-80% have been achieved. The sizing and design of a cogeneration plant should allow it to meet all the steam requirements not generated in the plant processes. Surplus electricity can be fed into the national grid.

4.44 The demand for fertilizer in Syria will probably exceed the design capacity of the Homs fertilizer plant in 1988/89. The neighboring super phosphate plant will reach the same situation about one year earlier. At that time low cost fertilizer imports are likely to be available from the Persian Gulf. However, if it is decided to construct a new fertilizer plant in Syria, it should be located to take account of natural gas feedstock.

4.45 Gas can be used for power generation in existing and proposed power plants as well as gas turbines. However, the lowest cost electricity generation based on gas is provided by combined cycle gas turbines. For a gas cost of US$3.50/MCF, the unit generation cost is 4.5¢/kWh for combined cycle at 75% load factor. Combined cycle has a lower cost than steam or gas turbine at both 50% and 75% load factors. The conclusion, as discussed earlier, is that new electricity investment should be produced from combined cycle based on gas. Since power demand must be met before the gas can be made available, then installing gas turbines (using distillate - naphtha or diesel) and retrofitting them to combined cycle is the least cost option. For those steam plants running or intended to run on fuel oil, retrofitting to gas where feasible is desirable. The specific location, size, and fuel type need to be studied within a least cost development plan as outlined in the power sector. However, to understand the potential for natural gas utilization some indicative figures for gas use in power have been estimated and are described below (summarized in Table 4.4).

4.46 One BCM of gas by 1990 probably could be utilized in gas turbines or combined cycle at Souedie, Der-el-Zor and Homs. Given the urgent need for power, gas turbines installed in Homs could use distillate until retrofitted to combined cycle, when additional gas from the Jebisse-Homs line becomes available. Der-el-Zor associated gas, supplemented with non-associated gas from Jebisse or Souedie, could also generate power using gas turbines or combined cycle from the start. Also, 1.3 BCM/y of gas from Palmyra could be used in the steam turbines at Damascus which could be converted to use gas. By 1995, at least 2.2 BCM/y of gas could be generating electricity, primarily through combined cycle turbines, and one BCM for steam turbine at Damascus.

Table 4.4: NATURAL GAS SUPPLY AND CONSUMPTION - SYRIA - INDICATIVE FIGURES

VOLUMES IN $M^3 \times 10^9$ PER ANNUM

Project	1984/5	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2000
A Existing and Under Construction												
A 1 SOUEDIE (Romeilan Complex)												
Supply	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182
Consumption - Power (GT)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)	(0.182)
A 2 JEBESSE - HOMS												
Supply		0.25	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Consumption - Fertilizer Plant		(0.25)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)
B Associated Gas to be Absorbed												
B 1 DER-EL-ZGR (Shell-Pecten)												
Supply a/			0.08	0.17	0.25	0.34	0.34	0.43	0.43	0.43	0.48	0.43
Consumption (GT/CC)			(0.08)	(0.17)	(0.25)	(0.34)	(0.34)	(0.43)	(0.43)	(0.43)	(0.48)	(0.43)
C Non-Associated Gas Developments												
C 1 JEBISSE - HOMS Expansion Supply					.25	.50	.50	.50	.50	.50	.50	.50
Consumption - Power					(.25)	(.50)	(.50)	(.50)	(.50)	(.50)	(.50)	(.50)
C 2 PALMYRA BASIN - DAMASCUS												
Supply					1.00	1.30	1.70	1.90	2.00	2.00	2.00	2.00
Consumption - Power (ST)					(.60)	(.90)	(1.00)	(1.10)	(1.10)	(1.10)	(1.10)	(1.10)
- Industry					(.40)	(.40)	(.70)	(.70)	(.80)	(.80)	(.80)	(.80)
- Comm/Res								(.10)	(.10)	(.10)	(.10)	(.10)
C 3 PALMYRA BASIN - NW SYRIA												
Supply									0.50	0.90	1.20	2.0
Consumption												
HOMS - Refinery/Industry									(.20)	(.20)	(.20)	(.20)
HAMA - Cement/Industry									(.10)	(.10)	(.30)	(.30)
TARTOUS - Cement										(.20)	(.20)	(.20)
BANIAS - Power/Refinery										(.40)	(.50)	(1.00)
C 4 SOUEDIE												
Supply								.50	.50	.50	.50	.50
Consumption - Power (CC)								(.50)	(.50)	(.50)	(.50)	(.50)

a/ Preliminary figure.

Note: GT = gas turbine, CC = combined cyle, ST = steam turbine.

Other Industry

4.47 Gas could be utilized in cement, refining and other manufacturing industries, primarily as a substitute for fuel oil. In the cement industry, 0.24 BCM of gas could support a 5,000 ton per day plant. Gas from Palmyra could be used in cement at Damascus and eventually at Tartous and Homs. Gas could be used in the glass industry where 0.10 BCM would support a 30,000 ton per year plant.

4.48 The efficiency of the Homs refinery operations could be improved if a suitable supply of natural gas were made available for fuel. If all refining fuel was based on gas, about 0.450 BCM, of gas would be needed. A cogeneration opportunity also exists in the Homs refinery where a 32 MW generating plant is being planned and process steam is required. Gas eventually could be used in the Banias refinery. As discussed before, if gas resources eventually prove large enough, gas might be exported after higher value domestic uses are met.

Residential

4.49 The large demand for diesel fuel in the commercial sector indicates that there is potential to substitute gas for diesel in residential consumption, particularily in Damascus. Pipeline systems for residential use are expensive and this use for gas is likely to be economic only after large industrial gas load is established. However, by the late 1990s it may be economically feasible to put in such pipelines. A large share of gas in many European countries and Pakistan is used for residential consumption and this may also be feasible for Syria.

Other Uses of Gas

4.50 Several other potential uses of gas which are not likely to be viable for Syria are CNG, methanol and middle distillate synthesis.

4.51 Compressed Natural Gas (CNG). Natural gas can be used in compressed form as a motor fuel. Motor vehicles fitted with high pressure cylinders and networks of filling points to fuel them have been developed in a number of countries. However, the use of natural gas in this manner seldom is economically attractive, and substantial investment is required before any significant fuel substitution or gas utilization is achieved. It is likely that such a use for natural gas would not be economically or logistically suitable for Syria.

4.52 Methanol (Methyl Alcohol). The manufacture of methanol from natural gas is a well established technology. However, the market for methanol at present is almost entirely confined to petrochemical intermediates. Some research has been conducted on the use of methanol as a gasoline extender and even as a full substitute for gasoline. Much of this work on methanol is part of the effort to find economic uses for gas which cannot otherwise be carried to market economically. However, to date no major natural gas development based on fuel use for methanol has been profitable anywhere in the world and such uses are unlikely to be attractive where there are higher value uses for gas, such as for power or fertilizer uses as in the case of Syria.

4.53 Manufacture of Middle Distillates. A new process for converting natural gas to kerosene, gas oil and naphtha has recently been announced by Shell. While the process is technically proven its economics are not yet clearly defined and not likely to find any applications in Syria in the forseeable future.

Pricing of Natural Gas

4.54 The cost to produce and deliver the projected new gas produced in Syria is estimated to average about US$1/MCF, while the value of the gas as a substitute for fuel oil is near US$3.90/MCF. This leaves quite a wide range for setting gas prices between cost and substitution value. The projected supply-demand balance for gas (as shown in Table 4.2) shows that the projected expanded supply of gas is less than the potential demand for gas, assuming the proved reserves in northeastern Syria and the lower estimate of reserves in the Palmyra region. In this deficit situation, the correct price of gas is just below the opportunity cost of the substitute fuel at the margin, about 80-90% of the current substitution value for fuel oil (US$3.90/MCF), or about US$3.50/MCF. (This price, or a slightly lower one, would also be the correct price to use if imported coal for power generation represents the substitute fuel at the margin.) Since the supply of gas is less than potential demand, as well as supply constrained for possibly as long as 10 years, it would make sense to price gas at this higher level in the beginning to encourage the efficient use of available gas. This higher price would signal to power investment planners to use combined cycle instead of gas turbines, which would be the least cost option if gas costs below $1.50/MCF. In the medium term, with a limited supply of gas, the more efficient use of gas by combined cycle will result in overall savings in fuel costs which more than offset the higher capital costs of combined cycle (when compared with less fuel efficient but lower cost gas turbines). The price discussed above refers to the consumer price. If gas costs (plus a sufficient rate of return) are much lower than this price, it would make sense to have a second lower price, paid to producers, such as production sharing contractors.

4.55 If much more gas were discovered and this resulted in a surplus, the value of the gas would be determined by adding the cost to the "depletion premium." A unit of surplus non-associated gas consumed today will not be available for consumption in the future when the gas resource is close to exhaustion. At the point of exhaustion consumers must switch to another, higher cost fuel such as fuel oil. The value of the depletion premium is the opportunity cost of this gas consumed in the future and is calculated as the difference between the substitute fuel value in the future minus the gas cost, which is discounted to the present. For countries very rich in gas, the depletion point is far in the future and the depletion premium is low, so the "value" of the gas is near cost. For gas-poor countries, the depletion point is near and the depletion premium is high, so the "value" of the gas is near the substitute value. Syria is a moderately gas-rich country. A rough calculation of the depletion premium for Syria is between US$0.15/MCF and US$0.65/MCF, depending on whether the depletion point is 25 years or 40 years in the future (using a discount rate of 10%, fuel oil price of US$8/MCF in real terms at depletion). The "marginal value" (cost plus depletion premium) of gas thus is between US$1.15 and US$1.65/MCF. In a surplus gas situation the price of gas both to consumers and producers should be in this range, and the price should be raised over time as depletion proceeds. However, it is important to stress that this is not the case in Syria today and that the depletion premium-based price calculation of price is only true in the event that there is an overall surplus of gas.

4.56 The various costs and benefits of various alternative price strategies should be weighed carefully. Based on available information, the gas should be priced at 80%-90% of the fuel oil substitute value, which means a price today of about US$3.50/MCF.

The Importance of Gas Development

4.57 The important benefits of developing gas are numerous and include the financial savings from additional oil exports, reduced LPG imports, and encouragement of more efficient investment in power and refining. Using the assumed gas production profile and approximate investment figures outlined in the previous sections, the benefits of gas development were estimated. For capital investments of $US 639 million between 1985 and 1990 and $US313 million until 1995 the net present value is $US 2.6 billion (the internal rate of return is over 43% and payback time is five years). This is assuming a gas value of $3.50/MCF and LPG value of $200/ton. Cumulative net earnings (revenues minus costs) over ten years until 1995 are $US2 billion, or an additional 1.0% of the annual GDP growth rate. These calculations imply a delivered gas cost of about $0.70/MCF using a discount rate of 10% and $1.22/MCF for a discount rate of 20% (both assume an LPG price of $200/ton). 3/

4.58 Another major benefit of the gas development program is a major reduction in LPG imports to Syria, and supplies may even allow Syria to become an LPG exporter.

4.59 Another benefit from the development of gas is the savings in investment in new refining since LPG and gas will stretch available product supplies. In addition, electricity generation will be more efficient from the use of combined cycle plants.

3/ A 10% discount rate represents a social opportunity cost of capital and results in a lower social price of gas than the price calculated at a discount rate of 20%, which is closer to rates of return for private oil companies, which include a risk premium.

Table 4.5: LPG SUPPLY AND DEMAND
(Thousand Tons)

	1983	1990	1995
LPG from Refineries	120	286	304
LPG from Gas			
planned	0	70	70
potential	0	187	325
Total LPG Supply	120	543	699
LPG Demand	223	543	699
Exports (Imports)	(103)	0	0

4.60 These potential benefits indicate that the development of gas resources should proceed as rapidly as possible. Each year of delay represents a present value loss of about US$200 million.

Recommendations on Natural Gas Development and Utilization

4.61 The mission has the following recommendations in this area.

(a) There is an immediate need to accelerate the development of gas from the Palmyra region. Each year of delay represents a loss of US$150 to US$250 million dollars, measured by present value cost. Considerable exploration, delineation and evaluation work should be done immediately. However, work should start with the most prospective structures where gas already has been tested (Sharifa, Najeeb, Bishri, Sukhine). If possible, agreements should be reached expeditiously with the foreign companies who made some of the above discoveries, in which these companies would solely or jointly (with SPC) exploit these fields.

(b) Immediate plans should be made for the utilization of available associated gas from the new oil discovery at Der-el-Zor with particular emphasis on using the gas for power generation using combined cycle plants. The benefits of establishing a gas pipeline should be analyzed link between this field and the Jebisse-Homs pipeline should be analyzed so that gas from Der-el-Zor can be supplemented with additional non-associated gas from the Jebisse area and/or the Souedie area, as required.

(c) Use the Jebisse gas for the fertilizer plant in Homs as planned. If the supply of gas is not fully utilized in the near-term, utilize the extra gas for electricity generation and study the possibility of cogeneration using process steam for the fertilizer plant.

(d) Expand the supply of gas to Homs to as large a throughput as possible given the pipeline in place. Supplement the present supply with additional gas from Jebisse and/or Souedie. At times this pipeline may also be able to take associated gas from Der-el-Zor. Develop plans to utilize this gas for power generation in gas turbines that can be retrofitted to combined cycle.

(e) Develop and evaluate plans for utilizing large quantities of gas from the Palmyra area. Particular emphasis should be placed on plans to pipe this gas to Damascus for primary use in power generation and secondary use in industry. Development plans may be designed for production in two stages, the first for Damascus and the second for gas piped to Homs, Tartous, Banias and, possibly, other cities. The primary use of this gas should be for power generation.

(f) The cement plants in Damascus, Tartous and possibly Homs should be converted when gas becomes available.

(g) Initiate demand studies of gas utilization in the power, industry and residential sectors of Damascus. This should be followed up by demand studies of Tartous, Homs, Hama and Aleppo.

(h) Begin training program within the Ministry of Mines and Energy and the Ministry of Electricity on gas development, planning and utilization. Visits and collaboration with experts from other gas producing developing countries, particularily Pakistan, should be included.

(i) Gas initially should be priced marginally below (10% to 20% below) fuel oil equivalent so as to encourage its substitution for fuel oil and other more valuable oil products.

V. REFINING SECTOR — ISSUES AND OPTIONS

Present Refining Situation

5.1 Historical petroleum product demand and market shares in the years 1980 to 1983 are shown in Table 5.1. The growth rates throughout this period were high, particularly in fuel oil and LPG, as shown in Table 5.2. Fuel oil consumption for use in power and industry has been unusually high. Unfortunately the data for imports, exports and production is not reconciled with inventory changes to provide a closed weight balance. Some allowance therefore must be made for inaccuracies, presumably of a relatively minor nature.

Table 5.1: PETROLEUM PRODUCT CONSUMPTION AND MARKET SHARES 1980 TO 1983

	1980		1981		1982		1983	
Product	'000 tonnes	% share	'000 tonnes	% share	'000 tonnes	% share	'000 tonnes	% share
LPG	119	2.3	141	2.5	172	2.8	198	2.8
Gasoline a/	716	13.9	745	13.2	788	13.1	879	12.7
Kerosene	331	6.4	273	4.8	248	4.1	240	3.5
Gas Oil	2526	49.2	2441	43.2	2592	42.9	2738	39.5
Fuel Oil b/	924	18.0	1346	23.8	1587	26.3	2032	29.3
Asphalt	247	4.8	364	6.4	330	5.5	386	5.6
Others c/	276	5.4	347	6.1	321	5.3	458	6.6
Total	5139	100.0	5657	100.0	6038	100.0	6931	100.0

a/ All grades plus naphtha.
b/ Includes refinery fuel oil.
c/ Coke, sulfur, lubes, refinery gases and losses equal to production.

Table 5.2: PETROLEUM PRODUCT RATES OF GROWTH 1980 TO 1983

	Annual Rates of Growth			Annual Average
Product	80-81	81-82	82-83	1980-1983
LPG	18	22	15	18.5
Gasoline a/	4	6	12	7.1
Kerosene	(18)	(9)	(3)	(10.2)
Gas Oil	(3)	6	6	2.7
Fuel Oil b/	46	18	28	30.0
Asphalt	47	(9)	17	16.0
Others c/	26	(7)	43	18.4
Total	10	7	15	10.5

a/ All grades plus naphtha.
b/ Includes refinery fuel oil.
c/ Coke, sulfur, lubes, refinery gases and losses equal to production.

5.2 The Ministry of Petroleum owns and operates both refineries in Syria. Homs refinery, the older of the two, began production in the second half of 1959 with a throughput of 1.0 million tonnes per year. It has since been expanded and now has a design capacity of 5.20 million tonnes/year and was designed to process about 50% Syrian crude (predominantly Souedie crude, 24° API) and 50% Kirkuk or equivalent imported crude oil. Banias refinery began production in 1980 and was designed to process up to 6 million tonnes per year (assuming 333 operating days per year) on a variety of crude blends ranging from 100% Iranian to a 50/50 blend of heavy Syrian and Kirkuk crudes. The performance guarantees for the Banias refinery were based upon 20% Syrian and 80% Kirkuk crudes. The pipeline for transporting Iraqi Kirkuk crude to the Syrian coast was closed in 1982; since then Iranian crude has been processed instead of Iraqi Kirkuk crude. Iranian crude is provided under a complex concessional arrangement to Syria.

5.3 The design capacities of the major processing units is summarized in Table 5.3. The table includes the sixth extension for reforming and hydrotreating facilities presently under construction at the Homs refinery.

Table 5.3: SUMMARY OF MAJOR PROCESSING UNIT DESIGN CAPACITIES a/

	HOMS	BANIAS
	('000 tonnes/yr.)	
Crude distillation	5,200	6,000
Vacuum distillation	411	2,694
Catalytic reforming	380	833
Hydrotreating b/	1,781	4,642
Coking	1,095	-
Visbreaking c/	-	1,200

a/ 333 operating days per year.
b/ Including hydrotreating of reformer feedstocks.
c/ Assuming 300 operating days per year.

5.4 The actual production of major products for the two refineries in 1983 are compared to design in Table 5.4.

Table 5.4: 1983 ACTUAL AND DESIGN PRODUCTION OF MAJOR PRODUCTS

Stream	Actual Production '000 tonnes/yr	Design a/ Production '000 tonnes/yr	% Difference
Crude Charge	9,295	11,200	-17
Syrian	3,002	4,800	-
Kirkuk	-	7,400	-
Iranian	6,293	-	-
LPG	107	171	-38
Gasoline b/	1,268	1,720	-27
Middle distillates c/	2,857	3,681	-23
Fuel oil	4,219	4,489	- 6
Asphalt	386	354	+10
Sulfur	14	107	-87
Coke	167	230	-28

a/ Assuming completion of 6th extension at Homs. This does not materially alter clean product yields.

b/ Includes naphtha.

c/ Includes jet fuel, kerosene and gas oils.

The design production is based on refinery configuration flow sheets and material balances and a mix of crude throughput for the two refineries as indicated. The above table indicates that in 1983 when crude throughput was 17% below design capacity, fuel oil production decreased by only 6% while gasoline and middle distillate production decreased by nearly 25%, thus resulting in a lower production of high value products and a higher production of low value products.

5.5 Fuel use and losses are somewhat high, as Table 5.5 illustrates. The coker at Homs is not used to its potential; the visbreaker at Banias has hardly run at all, LPG production is well below potential; and the extremely low sulfur production at both refineries indicates serious problems with these units. Low sulfur recovery indicates that there has been an increase in air pollution. There are also reported shortages of crude and power interruptions causing complete refinery outages. The costs and hazards involved in shutting down (particularly in emergency situations) and starting up units do not seem to be fully recognized. In addition, the conditions of the refineries and the frequency of shutdowns for maintenance indicate that some improvements in operating, maintenance and inspection practices would be very beneficial. The mission found a large number of errors after examining the process flow diagrams that formed the basis for the design of Banias and Homs, leading to the conclusion that unit-by-unit analyses are not carried out regularly. Some of these aspects of refinery operations are discussed in the following paragraphs.

Refinery Fuel and Losses

5.6 Refinery fuel use at Homs and Banias in 1980-84 was as follows:

Table 5.5: REFINERY FUEL AND LOSSES AT HOMS AND BANIAS
(Weight Percent of Crude Processed)

	Refinery	1980	1981	1982	1983	1984
Fuel:	Homs	3.4	3.2	2.9	3.1	3.6
	Banias	4.7	6.7	7.0	6.7	5.9
Losses:	Homs	2.4	1.7	1.8	1.5	2.5
	Banias	1.1	1.5	1.2	1.4	2.0

5.7 Fuel consumption at Homs is approximately 10-20% higher than is normal in a refinery of this configuration. This is satisfactory in view of its age and high operating factor. On the other hand, fuel consumption at the newer refinery at Banias (assuming the visbreaker is shut down) theoretically should be 90% or less of that of the older Homs refinery (which is less integrated). Banias fuel use seems unusually high. Actually, the fuel oil and gas rates are probably not properly metered, so the values in Table 5.5 could be inaccurate. Refiners outside Syria in competitive situations now find that it is essential to spend money on more efficient equipment to monitor fuel use.

5.8 If correctly calculated, the losses in each refinery are excessive and can be reduced to about 1% with a little investment plus attention to detail. A reduction in loss to less than 1% is probably also achievable with modest expenditures. Loss of fuel gases to the flare means that fuel oil has to replace the loss. A 1% loss on a 10 million tonne throughput would represent 100,000 tonnes/yr fuel oil which is almost 5% of demand and about 16 MM$/yr of additional export earnings. This is an indication of how much Syria can afford to invest in a loss reduction program.

Refinery Configuration

5.9 The design data showed the design yields contained either extremely high losses or high fuel gas production (it was not clear which). In addition, the original design did not optimize for middle distillate (kerosene and diesel) recovery. A 1% increase in middle distillate yield means recovery of an extra 100,000 toe/yr or $20 MM/yr of gas oil, at full capacity.

Banias Refinery

5.10 The yield of middle distillates is not optimized in the Banias refinery which has the following design yields based on either Kirkuk 100%, Souedie 100%, or a 50/50 input of the two crudes.

Table 5.6: BANIAS REFINERY

Product	Kirkuk	Souedie	50/50
Fuel gas	4.8	3.77	4.285
LPG	1.6	0.9	1.25
Gasoline	13.81	7.73	10.77
Naphtha	4.39	6.09	5.24
Kerosene	10.68	0	5.34
Gas oil	17.61	8.94	13.275
Fuel oil	44.99	69.23	57.11
Asphalt	1.5	2.36	1.93
Coke	0.61	1.0	0.805
Total	99.99	100.02	100.005

5.11 Because of the present Banias refinery configuration, middle distillate production is low and fuel oil production is high. When Souedie crude is processed, fuel oil production is as high as 70%. Given that fuel oil is already surplus to Syria's requirement and is being exported and middle distillates are imported to meet domestic demand the refinery should have provided for some cracking facilities. In the absence of cracking facilities at Banias, it would have been desirable to restrict operations at Banias to Kirkuk crude or possibly some lighter crude (e.g. Hassi Massa or equivalent) until such time as cracking facilities could be commissioned. Table 5.7 illustrates the product mix obtained by adding FCCU facilities at Banias (for a throughput of 3.73 million tonnes/yr and an FCCU of 1.250 million tonnes/yr) and the net refinery gain.

5.12 The net additional cash flow is estimated to be US$77.2 million for a throughput of 3.73 million tonnes and would be correspondingly higher at US$124.3 for the full design throughput of 6.0 million tonnes. The benefits of a cracker would be even higher if a mix of Kirkuk and Souedie crudes (either 80/20 or 50/50) is assumed. A similar calculation was made for a hydrocracker utilizing the same quantity of fuel oil (1.123 million tonnes). The net cash flow was estimated to be higher (42 million) than the FCC. The cost of an FCC or hydrocracker varies between $90 million and $120 million. The choice between the most appropriate cracking facilities cannot be analyzed fully here. However, these figures do indicate that cracking facilities are likely to have a rapid payback and should be seriously considered.

Table 5.7: SUMMARY OF IMPACT OF FLUID CATALYTIC CRACKER AT BANIAS
(Thousand Tonnes)

Product	Kirkuk	Ex FCCU	Combined	Percent	Change	M$/yr
Fuel gas	179	40	220	5.9	40	0
LPG	60	135	195	5.2	135	38,534
Gasoline	515	382	897	24.1	382	106,059
Naphtha	164	-	164	4.4	0	0
Kerosene	398	-	398	10.7	0	0
Gas Oil	657	405	1,062	28.5	405	99,086
Fuel Oil	1,678	105	658	17.7	-1,020	-166,428
Asphalt	56	-	56	1.5	0	0
Sulfur	23	-	23	0.6	0	0
Coke	-	56	56	1.5	56	0
Total	3,730	1,123	3,729	100.0	-1	77,251

Note: Prices derived from price ratios in Table 5.9 using average OPEC crude at $204/ton.

5.13 The inescapable conclusions are: (a) that cracking facilities be planned at an early date; (b) that until such time as the cracker is commissioned, crude similar to Kirkuk (preferably with some additional lighter imported crude) should be used at Banias; and (c) that Souedie crude should not be processed at Banias until the cracker is in place.

Homs Refinery

5.14 The Homs refinery configuration optimizes the production of middle distillates, but the coker capacity may not be adequate for a 100% Souedie crude throughput at a design capacity of 5.20 million tonnes. It may be desirable to restrict throughput to 4.80 million tonnes consisting of a 50/50 blend of Kirkuk and Souedie crudes.

Refining Policy

5.15 Although day-to-day processing appeared to function well, operations planning did not appear to occur in a smooth and integrated manner. The proper tools are not available to allow rapid, in-depth analyses of refining options. There is a shortage of trained staff to regularly analyze options. Refining personnel are largely insulated from the world of spot trading/refining and therefore do not appreciate how their operation is affected by external factors.

5.16 Refining policy has consisted of operating the refineries at as close to design capacity as possible and attempting to meet middle distillate demand. This policy results in large export surpluses which exceeds 3.0 million toe/yr. During 1984, Syria processed all of the 5.146 million tonnes Iranian crude obtained under its standing agreement and processed 4.36 million tonnes or half of the Souedie Heavy, exporting the rest. Spot crudes amounting to 1.012 million tonnes were also processed resulting in total refinery runs of 10.52 million tonnes or 40% (3.02 million tonnes) over the level of domestic consumption. Syria was therefore acting as an export refinery, although internally it might be argued that the refineries were just being run to meet diesel demand which was still in deficit even at this feedrate.

5.17 Syria has been refining crude which is surplus to its needs and selling low value products like fuel oil into a depressed international product market (i.e., a market where the spot refinery is not recovering costs). It has incurred processing costs involved in refining the crude and has not recovered them (by definition, since the market is depressed). These costs are the material costs such as refinery fuel and refinery losses (which in Syria's case are higher than they should be, as discussed earlier) and the costs of additional maintenance, expensive equipment, etc. Syria could have benefited by restraining its refining throughput to about the level of its domestic consumption, trading the surpluses and deficits, and it could have been willing to sell all its Souedie heavy when the price of heavy crudes worldwide was strong relative to light crudes. Because it can match a considerable portion of its domestic consumption with its own crude and has a total refining capacity that is 30% greater than the present total product demand, Syria essentially has refining independence. The imbalance of some specific products can be corrected at a relatively small cost and is not related to the question of overall refining capacity or independence.

5.18 Many changes have occurred in the world oil market in the last several years. One major development is the fact that heavy crude prices have risen relative to light crude prices. High investment in conversion facilities and, probably more importantly, a sharp decline in world petroleum consumption, has resulted in excess supply of refining capacity worldwide. (In 1982, worldwide refining capacity utilization was 73% of a total capacity of 76 million barrels per day. In Italy refining capacity utilization has been less than 50%. This overcapacity situation is expected to get worse as OPEC export refineries come on stream in the near future. The result has been an unexpected shortfall in fuel oil production and increase in demand for fuel oil and heavy crudes as inputs into the conversion refineries. This has caused an increase in fuel oil prices relative to lighter products which translates into higher prices for heavy crude (like Syrian Souedie) compared to light crude (like Iranian light). This indicates that, given Syria's present refining configuration, often it would be more profitable to export more heavy crude and cut down somewhat on refinery runs.

5.19 The mission has estimated the penalty that Syria pays in achieving higher than optimal refinery throughput. The important product export is fuel oil, the price of which has been fluctuating according to the demand by conversion refineries and energy demand in Europe. Based on the price ratios presented in Table 5.9, the mission estimates that the penalty for every million tonnes of extra throughput, over that required for a balance of fuel oil production with demand, is as follows depending on the relative prices of fuel oil and Souedie crude.

Table 5.8: PRODUCT TO CRUDE PRICE RATIOS

Fuel	Price Ratios
LPG	1.4
Gasoline	1.36
Naphtha	1.26
Kerosene	1.3
Gas Oil	1.2
Fuel Oil	0.8
Average OPEC Crude	1.0

Table 5.9: RATIO OF FUEL OIL PRICE/
SOUEDIE CRUDE PRICE

Ratio	Savings
	(US$ million)
0.90	4.2
0.84	11.1
0.79	18.5
0.67	32.0

5.20 When the F.O.B. price ratio of fuel oil to Souedie crude is less than 0.90, it is more profitable to export a marginal tonne of crude than to run this crude through the refinery. Since there is a continual variation in product price relationships, similar calculations should be carried out monthly by refinery managers to optimize refinery operations and profitability. These estimates are made assuming the structure of product prices shown in Table 5.8. Savings are substantial as shown by Table 5.9.

5.21 During periods of strong heavy crude prices, Syria could have switched from refining crude in excess of fuel oil needs, this would provide a gain in incremental income from strong heavy crude prices. This would have meant selling more Souedie heavy and processing the Iranian plus some imported light crude. An example of a country with sizeable production which switched crudes to balance internal needs is the United Kingdom. It regularly sold Forties and imported sour crudes such as Arabian light in order to avoid "product quality giveaway".

5.22 The present objective of refinery operations would seem to be to run refineries at a level to meet as much of the middle distillate demand as possible. What the above analysis indicates is that an objective of running the refineries at a level adequate to meet fuel oil demand may be more appropriate and more closely approximate optimal refining profitability.

Other Aspects of Refinery Operations

5.23 Several projects to improve operations in the refining sector are described and reviewed in the following paragraphs.

5.24 Optimization and Debottlenecking. The scope for this ongoing study is described in the "Book of Conditions for the Optimization of Refinery Operations in Syria for Product Demand through Year 2000". In addition to reviewing optimization, debottlenecking, operating changes and evaluating the crude mix for both Homs and Banias refineries, the scope presently involves consideration of new conversion capacity and the possibility of a third refinery. Emphasis is placed upon balancing demand/supply for middle distillates, the use of Syrian crude, and the addition of new conversion facilities. The responsibility for implementing this study currently rests with the General Company for Engineering and Consulting. There exists significant potential for efficiency and throughput improvements at both refineries. It might be feasible to increase capacity beyond design ratings for a relatively low capital investment.

5.25 Lube Oil Complex and Conversion of an HDS Unit to Mild Hydrocracking. A preliminary technical offer has been received pertaining to the Banias refinery for a 100,000 tonnes/year lube oil complex and conversion of the heavy oil desulfurization unit. No economic analysis is possible on these projects with the data presently available but a review seems to be in order before any further detailed work is performed. Preliminary calculations indicate a penalty in the range of US$25 to 50 million per year for the project.

5.26 Visbreaker Operations at Banias. Apparently, considerable difficulty was experienced in obtaining satisfactory operations on the original visbreaker design located at Banias. Minor modifications were made which did not resolve all the problems, so this unit has not been in regular operation. Bids have been solicited to provide recommendations for further modifications to resolve the outstanding difficulties. The major equipment appears to be adequately sized and the modifications required to achieve satisfactory operations are not likely to be significant. As the original unit design guarantees did not specify any fuel oil stability requirements, these and other operating guidelines need to be established.

5.27 Environmental Study. The Government of Syria is concerned about the environmental impact of the continued program of industrialization and associated urbanization. The location of the Homs refinery is one area of concern but the most pressing problems are thought to exist in the coastal region from Tartous north and including the Banias refinery and terminal. Proposals are being solicited to review environmental problems in this area, which is still primarily agricultural. In both

Homs and Banias refineries the sulfur dioxide emissions are higher than they ought to be. There are areas where pollution could easily be reduced. At present there are no closed loop sample systems, the separators are not covered, and insufficient attention is paid to leaks.

5.28 Coke Disposal. Although the coker at Homs allows the refinery to significantly upgrade heavy crude to clean product, there is a disposal problem for the coke and a large inventory has been stockpiled for the lack of a suitable market. Some offshore sales have been made and the government is considering is being given to provide coke burning capability in a new power generation facility in the Homs area. At cement plants a logical use for the coke would be as supplemental fuel fed directly in with the kiln charge. A problem appears to be the high sulfur in the coke. While this may not affect cement, it may have a harmful affect on the equipment in the cement factory and this problem needs to be evaluated.

Recommendations in the Refining Sector

5.29 The recommendations on refining policy are:

(a) There is no need to consider a third refinery now for several reasons. First, there currently is excess capacity. Second, it appears more economically beneficial to run the two existing refineries at less than full throughput and export heavy crude. Third, refineries in the region (such as Italy) cannot even cover operating costs, indicating that a new refinery could not begin to cover interest, depreciation or operating cost. Interest cost alone would be $2-4/bbl. Fourth, the export refineries in the Arab Gulf are likely to export products much more cheaply than Syria. Fifth, and most important, large gas reserves in Syria will produce large quantities of LPG and provide gas for power generation, thereby reducing demand for middle distillates in the domestic sector and fuel oil for power generation.

(b) A detailed study of the Banias refinery configuration should be made and the benefits of installing cracking facilities (FCCU or hydrocracker) should be evaluated for early implementation.

(c) Refinery throughput and crude mix need to be evaluated on a continuous basis to ensure maximum gain to the economy. For this purpose a refinery economic model should be developed for management to take appropriate decisions.

(d) Until such time that cracking facilities are installed at the Banias refinery, it should process only light crude (not Souedie crude).

(e) In the context of the current world prices of petroleum products it would be advantageous to restrict refinery throughput to a level where fuel oil production meets demand and exports are minimal.

(f) Present study plans to improve efficiency and debottleneck Homs and Banias refineries should proceed as soon as possible. The potential benefits in increased throughput, reduced operating expense and improvements in yield could easily amount to US$50.0 million per year and capital investment requirements are unlikely to exceed US$25.0 million. The total cost of the process study would probably be less than US$0.50 million.

(g) The study for the visbreaker at Banias should proceed without delay. The study and engineering costs are not likely to exceed US$25,000 and the cost of mechanical modifications should be no more than US$150,000. The potential income improvement in running this unit is well in excess of $7.0 million/yr.

(h) Before proceeding further with the Lube Oil complex, a study should be commissioned to review the choice of technology, market demand in Syria and potential export markets, and the economic viability of the concept. Yield estimates and costs for conversion of the heavy oil desulfurization unit to mild hydrocracking should be solicited from various catalyst vendors. Stability specifications should be developed for the refinery heavy fuel production bearing in mind end use (refinery and power plant and export sales, particularly bunkering). The cost savings from conversion then should be calculated which reflect the impact on visbreaker severity.

(i) The environmental study for the Coastal area should proceed and some initial guidelines and standards formulated for the rest of Syria.

<u>Petroleum Product Distribution and Storage</u>

5.30 One of the operating companies within the Ministry of Petroleum and Mineral Resources is responsible for distributing most petroleum products. Exceptions are heavy fuel oil and export products. The distribution activity involves planning, construction and operation of pipeline systems, distribution center tankage, loading facilities, rail cars, and some tank truck delivery facilities particularly for LPG, which is currently transported primarily by trucks, initially in bulk and then in cylinders.

5.31 The existing and planned clean product pipelines are as shown in Table 5.10.

5.32 There is also a heavy fuel oil pipeline from Banias refinery to supply a local power plant. It was originally proposed that the pipeline would be constructed from Aleppo to supply Raqa. The considerations that have resulted in the current plans for a new pipeline directly from Homs in addition to the proposed Homs-Aleppo line have not been reviewed.

Table 5.10: CLEAN PRODUCT PIPELINES a/

Connections	Diam. Ins.	Design b/ Capacity m^3/hr.	Comments
Banias-Homs	6	82	Existing. Was originally part of Homs/Banias/Latakia system
Banias-Homs	24	700	Old crude pipeline. Expect to be in service in 1985
Homs-Aleppo	6	100	Existing
Homs-Aleppo	-	180	Planned. Exact sizing and capacity to be finalized
Homs-Raqa	-	150	Planned. Exact sizing and capacity to be finalized
Homs-Adra	6	100	Existing
Homs-Adra	12	180	Existing. Plans to expand in the next few years to 320 M^3/hr with addition of booster stations

a/ Clean product in this table and elsewhere is defined as naphtha, gasoline, jet fuel, kerosene and gas oil.
b/ Based on gas oil.

5.33 The latest available data on clean product demand by distribution area indicates an approximate division of the total demand as follows:

Southern	38%
Central	18%
Northern plus Eastern	36%
Coastal	8%

5.34 With the exception of the pipelines serving the northern and eastern regions, there does not seem to be any immediate need for pipeline expansion. Once the 24" line from Banias to Homs is in service, the 6" line from Banias to Homs could be dedicated for jet fuel to Homs. Additional pumping stations on the Homs/Adra 12" line appear to have marginal economic justification even if the 6" Homs/Adra line is dedicated to jet fuel.

5.35 Bulk LPG is currently all delivered by truck. Railcar facilities are being installed to reduce distribution costs but insufficient information is available at this time to comment on this except to note there seems to be a lack of information concerning industry standards for tankcar loading and transporting of LPG. The majority of LPG consumption is in the commercial and residential sectors with delivery in small cylinders. There is one cylinder manufacturing plant and another is nearing completion. Present shortages of cylinders should be eliminated when the new manufacturing facility is commissioned. Different LPG specifications in terms of maximum propane content appear in various documents but the Reid Vapor Pressure (RVP) specification of 8 kg/cm^2 maximum is consistent throughout the documents. The RVP specification limits the propane content to about 25% in practical terms and hence potential refinery production of LPG. The design of equipment would appear to be adequate for a higher RVP specification but there is some question regarding handling, maintenance and inspection practices of system equipment, particularly the cylinders.

5.36 Metering. There is an interest in developing better metering facilities throughout the distribution system. Since there are no telemetering installations and hence any pipeline leakage must be visually evident. There is no automatic custody transfer and because there are apparently no data communication links or computer facilities, information on the distribution systems is all prepared manually. This leads to delays both in handling day to day transactions and in preparing management information reports and records. The absence of adequate metering would also raise questions concerning the accuracy of data collected, especially in reconciling inputs and outputs to ascertain losses or potential theft. It was not possible to identify what measurement and reporting systems would be most beneficial but some improvements in metering and in the data gathering and documentation systems would seem to be needed.

Recommendations on Transportation and Distribution of Oil Products

5.37 The mission has three main recommendations in this area:

(a) There seems to be an immediate need for expansion of pipeline capacity to service the requirements of the northern and eastern distribution areas. The study to optimize the sizing and routing of pipelines to Aleppo and Raqa is justified because of the many options that can be considered.

(b) Expanding of the pipeline capacity to Adra does not seem too critical in the near term and the justification for this expansion and the use of the existing six inch line in jet fuel service should be examined in some detail.

(c) A study should be undertaken to review not only metering and measurement capabilities throughout the distribution network but also the information that should be generated and disseminated for effective management of the system. This is another potential application for a data processing facility and is discussed in the following section.

VI. ELECTRIC POWER — ISSUES AND OPTIONS

Past Electric Power Development

6.1 During the 1973 Middle East War, the generating facilities of the state electricity company (PEE) were severely damaged. The immediate problems were overcome by installing a large number of gas turbines including a number donated by other Arab states. As a result, electricity generation was low until repairs were completed and a new, larger plant could be constructed. The Soviet-financed hydro facilities at Thawra, with a final capacity of 800 MW, started operating in 1974. The World Bank provided two loans to finance the 2 x 150 MW Mehardah thermal plant on the Orontes River, which started operating in 1979, while the Government arranged the construction of a similar plant (2 x 170 MW) near the refinery at Banias, the first unit of which was commissioned in 1982. Thus, from about 1975 onward, PEE has been able to meet the rapid growth in demand.

6.2 PEE's effective capacity, including the hydro plant at Thawra, was 1,700 MW in 1983 compared with a (suppressed) maximum demand of 1,122 MW which, unsupressed, is estimated at 1,250 MW. 4/

6.3 The Bank loans financed a number of studies for the sector which, except for a rural electrification study, were finally combined in a single report (1978) covering least cost development in generation and transmission, interconnection with neighboring countries, and the use of gas in the economy, including fueling of power plants. Although the main recommendations were followed, PEE did not have the report updated annually. Subsequently PEE commissioned a Japanese and a Swiss firm to prepare development studies. Neither of the reports has resulted in a long term least cost development program. In the meantime, energy and capacity demand grew at an annual rate of about 20% and losses increased dramatically. However, because a new plant was commissioned just in time, this demand was met, but at somewhat lower reliability.

6.4 For political and social reasons the Government raised electricity tariffs only once in 1980 (when at the same time fuel oil prices were tripled to about international levels), by a planned 80%. However, in effect, due to a number of factors 5/ the effective increase was only about 60% in current terms and, in real terms, only about 15%, and was left unchanged in nominal terms until July 1985 when prices were raised

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4/ The approximate inventory of lines, substations and transformer capacity is shown in Annex 15.

5/ For example, the complicated tariff structure was a simplified one and consumers were transferred to other categories; rates for large industries, although raised, started from a low base.

an average of 7%. Consequently, PEE's financial position has deteriorated to the extent that its annual operational deficit is around SL 1 billion.

6.5 Investments in power in the fifth development plan (1981-1985) were fixed at about SL 1.1 billion annually, which was less than what was required to meet rising demand. Due to financial constraints, the allocation was reduced by 25% in 1984, although when the Government became aware of the potential power shortage, it allowed an expenditure of SL 1.2 billion for 1985. PEE was authorized to procure, on short notice, two additional 150 MW units at Mehardah, two 170 MW units at Banias and 150 MW in gas turbines, while a 2 x 200 MW Soviet-financed steam-electric station has been contracted for construction at Rabil near Damascus.

Rural Electrification

6.6 Under IBRD Loan 1144 SYR a study of rural electrification was executed and thereafter, the Bank assisted in financing (MUS$32.7 Loan 1531-SYR), together with parallel financing from USAID (MUS$26.7) the electrification of 1,200 villages selected out of some 5,000 villages on the basis of a priority scheme, to provide some 900,000 people with electricity.

6.7 The spread of electricity throughout the country has been impressive, but the quality of service is still in question. As of early 1985, PEE had electrified some 3,200 villages out of the target number of about 5,000 that have populations exceeding 500 people. Almost 100% of the people in urban centers inhabitants have access to electricity and 76% of rural or an average 88% of the country in 1985.

Present Supply and Demand Situation

6.8 After many years of substantial growth in generation averaging 20% per year, growth declined in 1983 to 16% per year. Losses also peaked in 1983 at 31%, and were only slightly lower at 28% of generation in 1984 (total losses as percent of gross generation). Hydroelectric generation, which in previous years had been far above average, dropped from 2,937 GWh in 1982 (54% of total generation) to 2,169 GWh (34%) in 1983 and to 1,928 GWh (28%) in 1984. The Banias thermal station was just completed in time (1982) to generate most of the energy lost because of the poor hydrological conditions in 1983. Nevertheless, about 145 GWh could not be met, particularly during the winter months, as thermal plant availability also had deteriorated and curtailment was necessary up to about 130 MW. Although hydro conditions were even more critical in 1984, full availability of Banias and better availability of other steam plants kept curtailments to a minimum. Because no new plant was added, the capacity margin in 1984 dropped to about 22% (372 MW, or about equal to the two largest units, i.e., still satisfactory), but the average energy margin fell to about zero. In part, the improved situation was because PEE started attacking the problem of exponentially growing losses in 1983 and succeeded in maintaining them at the 1983 level.

6.9 Because no new plant can be commissioned in the next two years (except gas turbines), the short-term situation is expected to deteriorate further, the extent depending on the hydrology of the Euphrates River. PEE expects the raising of the dam at Thawra by 4 m to be completed by early 1986, as well as the addition of the 3 x 25 MW Baath hydro station at the new regulating dam. During an average year, these developments are expected to contribute about 2300 GW (an increase of some 20% over 1984). At the same time, however, the filling of the Karakaya in Turkey would start, requiring about 10 billion m^3 or one-third of the average annual river flow.

6.10 PEE provides practically all of the electricity consumed in the country, except where combined heat and electricity are required (e.g., the refineries). However, the reliability of supply has been declining in recent years and captive plant may have increased, but the capacity is not known. The power data presented by PEE and the Ministry is limited and unreliable because the quantity and quality of the information provided differs considerably from region to region. In addition, the number of staff in the head office available to compile and analyze the statistical data is inadequate for the volume of work involved.

Losses and Generating Plant Efficiency

6.11 Losses in the Syrian power system are very large, in 1983 they amounted to 27.5% of net generation. This figure was reduced slightly to 24.3% in 1984. This loss level is still extremely high considering that, at today's fuel prices, losses in a predominantly thermal system should not exceed 8-10% of net generation. PEE instituted a committee in 1983 to reduce them. The committee focused on non-technical losses by checking the accuracy of substitution metering and the meters of industrial customers. The committee succeeded in reducing losses (mainly non-technical) by about 60 GWh, or roughly 1% of net generation in 1984. At the current tariffs this represents a financial savings of about SL 14.8 million (or US$3.7 million). PEE created a department with offices in every province for monitoring technical and commercial losses since November 1985.

6.12 More effective loss reduction will depend on accurate classification of losses. The two classifications are: non-technical losses due to statistical errors, metering errors and theft of energy; and technical losses due to inadequately rated transmission and distribution lines and equipment. The effects of these two types of losses are quite different. Non-technical losses represent a financial loss to the utility since the energy is used but not paid for. On the other hand, technical losses result in both an economic loss to the country and a financial loss to the utility. The methods of reducing non-technical losses are mainly administrative in nature, whereas the reduction of technical losses requires changes in system design criteria. The mission suspects that technical losses may be high due to the regional expansion of the rural distribution systems in an environment of limited cash resources. Under these circumstances design criteria often are based on a minimum capital outlay to supply the maximum number of customers rather than attaining economic loss levels.

6.13 In addition to the reduction of losse· substantial savings can be realized by improving the conversion efficiency of thermal plants and reducing the auxiliary power usage. Although the mission did not obtain detailed data to estimate the present conversion efficiencies and potential improvements, the mere absence of an organized efficiency improvement program indicates that there is likely to be considerable scope for improvement. PEE has executed a vast program of rural electrification, adding several thousand villages and many thousands of kilometers of 20-kV and 0.4-kV lines over the last five to seven years. Thus, of the total SL 2,100 million investment in distribution during the first four years of the current (1981-1985) five-year program, 46%, or MSL 975, pertained to rural electrification (constituting 24% of PEE's total investment during the period). Statistics on the number of consumers added, their demand, and the actual voltage of supply have not yet been extracted from the data available at the regional level, but it is obvious that line losses compared to rural supply must be rather high. The main implication is that large funds have been diverted to distribution expansion (rural and urban) rather than to maintenance and system improvement.

6.14 Since 1984 an energy committee has been addressing the problem of losses, proper measures are needed to reduce losses to an acceptable level of 15-17%, including station supply, compared to the present 28-30%. With the pressing demand for funds for additional generation and system improvement, the rural electrification program should be geared back. A slowdown in rural electrification would also permit improvements in the quality of supply to areas already electrified. The commissioning of the power station (Rabil) at Damascus and the conversion of transmission lines from Homs to Damascus from 220 kW to 400 kW, are expected to reduce technical losses substantially.

6.15 The availability of the steam power plants is 69% (6,000 hours per year), which is low compared to industry standards of about 85% or about 7500 hours per year. Improved availability would reduce the reserve capacity requirements of the system. The cost of attaining improved availability is usually small compared to the benefits. Improved availability comes from instituting a rigorous program to carry out regular scheduled maintenance. The time required for the scheduled maintenance can be minimized by stocking adequate amounts of spare parts, using carefully planned maintenance procedures, improving the skills of technicians, and making design modifications to improve the ease of maintenance and remove chronic problems.

Recommendations on Losses and Generating Plant Availability

6.16 The benefits of reducing losses are immense, as present losses in the system are about 600 GWh too high. There are significant financial benefits to PEE from reducing non-technical losses and economic savings to the country from reducing technical losses. While some of these recommendations are being implemented by PEE, the engagement of consultants for a loss reduction study would be highly profitable. Their tasks would be:

(a) to classify the losses according to whether they are technical or non-technical (station service, technical loss, statistical error, metering error, theft and diversion);

(b) to determine the amounts of the technical losses at various voltage levels;

(c) to prepare a comprehensive action-oriented program for reducing non-technical losses including improvements in metering, billing and commercial operations;

(d) to prepare a comprehensive program for reducing technical losses including optimizing real and reactive power dispatch, the addition of capacitors if required, changes in design criteria, changeout of transformers, etc;

(e) to assess the capability of the present organization for implementing loss reduction prospects and define any necessary improvements in organization, equipment, training, staffing;

(f) to commission an experienced firm to design a comprehensive maintenance management system. The firm should also be responsible for introducing the enhanced maintenance procedures in PEE operations and for the associated training of PEE's staff.

Electricity Pricing

6.17 PEE applied a simplified system of pricing throughout the country in July 1980, when a substantial rate increase was granted. A detailed description of past and present tariffs, as well as time of day pricing is given in Annex 14. The level of actual selling prices in 1984 compared to 1974 is shown in Table 6.1. The tariff has remained unchanged from 1980 until the present, except in July 1985 a fourth block was added to the domestic and commercial category and minimum charges were increased. Together these changes are not expected to increase revenue by more than 7%.

Table 6.1: ACTUAL RATES CHARGED BY PEE
(piasters/kWh)

	Dom. + Comm.	Govt.	Sm. Ind.	Lg. Ind.	Average
1974	18.8	17.3	9.6	6.6	12.9
1984	26.4	33.0	34.0	11.3	25.6
Percent Change					
Nominal prices	40	90	254	71	90
Real prices a/	-46	-28	34	-34	-28

a/ Nominal prices deflated by WPI; see Annex 14 for details.

6.18 The new rates still do not cover the cost of PEE's operations. In 1984 revenue was around SL 1,200 million, whereas accounting costs were about SL 2,100 million. The rates also do not reflect the long run marginal cost of supply. In real terms (1980 prices), the average price per kWh decreased an average of 8% per annum from 23.9 piasters/kWh in 1974 to 16.2 ps/kWh in 1979, just prior to the rate increase. The 1980 rate increase did not improve the average price (about 17.5 ps/kWh) because block rates were introduced. In 1984, large industries paid only 11.3 ps/kWh, whereas the average fuel cost was estimated to be 24.0 ps/kWh generated. Monthly electricity costs are just 1% to 2% of income for middle and higher-income households, or $US5/month (SL 20/month) for an family consuming 100 kWh.

6.19 Not only should rates be increased to allow PEE to recover its costs so that the cash deficits do not form an exponentially growing burden on government resources (some SL 150 million in 1982, SL 163 million in 1983 and about SL 700 million in 1984), unrestricted growth due to low tariffs also may cause an energy crisis in the near future unless the Government is willing and able to increase its capital contributions to investments by a factor two or three. Demand will have to be curtailed and one of the most effective tools for doing this is to sharply increase rates over a relatively short period. Growth rates of electricity demand could be reduced by 1-2% per year if rates were increased sharply.

6.20 There are important opportunities for demand management through peak pricing. The load factor in Syria could be improved by appropriate time of day (TOD) tariff structure, especially considering the expected weight of cement and water irrigation consumption in Syria, two sectors that are generally very responsive to TOD tariff incentives. If the cement sector alone were to suppress its load at peak time, this would represent a reduction of about 100 MW and globablly, a reduction of 300 MW could be a reasonable target. The present TOD tariff seems to be impaired by metering problems. It seems certain, however, that its implementation with appropriate meters could have some high payoffs and its effects would be reinforced by raising the tariff level. The application of the present tariff with appropriate metering could be reinforced, even before a global study of tariffs based on economic costs is performed. To insure the greatest efficiency the TOD tariff could be offered only as an option with consumers paying for their meters. In addition, special contractual agreement for off-peak or night operators of small pumps (where metering costs associated with TOD tariffs would become significant) could be developed.

Recommendations on Electricity Pricing

6.21 The immediate actions required to alleviate the situation are to implement tariff increases to achieve proper financial and economic objectives. As a minimum there should be:

(a) an increase in tariff levels in the short run to achieve short term cost recovery (recovery of operating expenses plus fixed asset depreciation or debt service, whichever is greater). In order to achieve this, an average increase of 75% was required from January 1985. The actual rate increase was only 7%, or close to the rate of inflation. It is therefore necessary to increase rates by 75% above inflation to cover short run cost as a first step toward economic pricing. The tariff for large industry needs substantial revision and at a minimum should meet fuel costs. This could be achieved in one single step or in two or three annual installments. The proposed increase, if announced in advance, would induce customers to plan in advance for energy conservation measures. Such an increase would have the effect of reducing the base case demand (Alt. 1) growth rate by 1-2% a year. Since there are limits to the financial resources which can be allocated to power supply, price increases are necessary if a severe power crisis is to be avoided.

(b) an adjustment of rates for various consumer categories such that they would eventually achieve the objective of efficiency pricing. No marginal cost study is available, but accounting costs at each voltage level have been calculated by PEE. In order to ensure equity a social rate could be established for the smallest consumers of perhaps up to 50 kWh/month, cross-subsidized by all other consumer categories, but particularly domestic. A substantial increase in prices would have a small impact on middle-income and upper-income household budgets because electricity is a small share of total expenditure. For domestic consumers the first 100 kWh of consumption costs US$5/month, or just 1-2% of an average family income. A related problem that needs to be considered is the cost of metering and billing on a monthly basis small customers who consume less than 50 kWh/month; perhaps a quarterly billing may be adopted in such cases.

(c) immediate institution of effective time of day pricing. This is strongly recommended for the cement sector and water utilities. Peak load could be reduced by 100 MW in the cement industry alone and possibly up to 300 MW overall. In the short term, the emerging power capacity constraint could be substantially alleviated up to a possible 100 MW, thereby allowing PEE adequate time to install additional gas turbines.

(d) a proper recapitalization of PEE (whose accumulated losses exceed its capital) by conversion of PEE's long-term debt to the government into permanent capital.

Future Developments and Options

6.22 In the absence of a least cost development program for generation, the mission has prepared a tentative plan to meet the deficit in Alternative I, taking into account PEE's present expansion plans.

6.23 Annex 11 shows the existing generating plant and Annex 12 identifies future additions to the generating plant necessary to meet demand levels under the two alternative scenarios (including an additional 450 MW of gas turbine capacity proposed by the mission in para. 6.24). Annex 13 gives the capacity and energy balances up to 1991, when the next generation of steam plants is expected to be in place. Mehardeh Units 3 and 4 were ordered in the beginning of 1985 for commissioning in March and June 1987 -- unit No. 3 has an extremely short contracted delivery time of 26 months. Bids for Banias expansion were expected to be opened in June 1985. PEE expects bids generally to conform to Mehardeh's results: favorable prices and short delivery times. The contract for units 1 and 2 of Rabil (a new plant with air-cooled condensors and 200 MW unit size) about 40 km from Damascus, was signed in 1984 and the addition to the contract of another two units is being contemplated. Bid documents for 150 MW of effective capacity in gas turbines were issued in March 1985 and bids have been received. The gas turbines will be installed near Souedie and fueled by gas. The Ministry of Petroleum is transferring to Souedie 85 MW in older gas turbines to be fueled by gas to provide an effective capacity of 35 MW to PEE as captive plant assistance. Other industrial plant is expected to provide assistance, up to about 30 MW, over the next few years. PEE has placed an order for the 64 MW extension of Kattineh in 1985 with a delivery period of 36 months. Bid documents for 2 x 60 MW capacity based on petroleum coke at Homs have already been issued. Lebanon is completing a 600 MW steam-electric station, and agreements have been reached to make available to Syria 100 MW during 1986.

6.24 If all the above plans are executed in time the capacity balance shows deficits as high as 193 MW in 1985 and 268 MW in 1986. The reserve capacity for these two years is only 284 MW and 247 MW, which is only slightly higher than the largest unit (170 MW), indicating insufficient reserve capacity. The energy balance, which assumes all thermal plants will be operating for 5,000 hours at total available capacity, shows shortfalls of 8-10% during an average hydraulic year and 11-16% during a dry year (hydro conditions up to the middle of April 1985 were favorable). No plant can be procured and operated in time to avoid the shortages in 1985 and 1986. PEE can only hope that all factors work in its favor that: (a) load would grow less than forecast; (b) the loss reduction committee would continue to be successful; (c) both 1985 and 1986 would be wet years; (d) the Government would rapidly increase rates so as to force consumers to conserve electric energy; and (e) fine tuning of maintenance could be accomplished and no major breakdown occurs.

6.25 In any event, the capacity balance shows that by 1991 800 MW in new capacity would be required (in addition to Rabil 3 and 4) under Alternative 1, whereas investments can be deferred under Alterative 2. Because only preliminarily plant sites have been selected and no surveys executed, action should be taken immediately to ensure that new plant will be ready as required (including studies, surveys, preparation of bid documents, bidding and award of contract) under the two alternative scenarios.

6.26 The capacity balance and the energy balance is tight through 1990, taking into account that less than average hydrology may require additional thermal generation up to 1,500 GWh, representing some 300 MW in gas turbine plant. No firm forecast can be made, of course, without a complete simulation of hydrological conditions, but the range of capacities required can be observed in the estimate below (Annex 11).

Table 6.2: ADDITIONAL CAPACITY UNDER ALTERNATIVE 1 AND 2 DEMAND

	Planned PEE Gas Turbine Capacity	Additional Capacity required due to:		
		Capacity Reasons	Energy reasons	
			Average Year	Dry Year
	(MW)	Available in each year (MW)		
1985	--	200	200	200
1986	--	300	150	300
1987	150	200	300	600
1988	150	220 (500)	- (400)	- (700)
1989	150	200 (800)	- (500)	- (800)
1990	150	300 (700)	- (600)	- (700)
1991	150	600 (1,100)	- (500)	- (700)

Note: Figures rounded to nearest unit of 50.
Figures in brackets are Alt. 1 scenario.

6.27 Although the plant required to meet the 1985 and 1986 capacity and energy deficits cannot be commissioned in time, it should be possible to meet the capacity and energy deficits beyond 1987 by taking suitable advance action. Weighing all factors and taking into account slippage in the commissioning of committed steam electric plant expansion and the effect of shortages in the economy as a whole, it may be prudent to allow PEE to double its procurement of gas turbine capacity, to be commissioned in early 1987, to 300 MW and to allow it to include in the contract an option, to be exercised within 12 months, for increasing the capacity by an additional 300 MW in 1988, so that installed gas turbine capacity by 1988 is 600 MW and the capacity deficit is fully recovered. The feasibility of converting these units to combined cycle using gas should be investigated.

6.28 The availability of gas in large quantities provides Syria with many options for power generation. Gas will be available from the Souedie and Jebisse fields by the end of 1985. A gas pipeline project is under execution to provide the fertilizer plant at Homs with gas for feedstock. The pipeline has been sized to meet the demand of the fertilizer plant at its rated capacity, but the fertilizer plant is currently operating at less than capacity. Therefore, in the short run, it may be possible to install a gas turbine at Homs to utilize surplus gas. The capacity of the pipeline could be augmented by an additional compression station, when gas would be available for power generation on a long term basis at a level of 200 MW in gas turbines or 300 MW in combined cycle gas turbine. An early option that should be examined by Syria is to install gas turbines of 200 MW capacity at Homs immediately with a provision for retrofitting waste heat recovery boiler and steam generator of 100 MW capacity at a later date (out of the 600 MW proposed in para 6.24).

6.29 In addition, associated gas may be available at Der-el-Zor from the recent oil discovery by Shell-Pecten in the next two or three years if it is not needed for reinjection. The only likely use for this low pressure gas is in power generation so the mission recommends that one of the proposed gas turbines be installed near the oil fields by the time oil production starts and gas becomes available. Some gas discoveries have been made in the Palmyra Basin and these can be developed and gas piped to Damascus and Homs at a cost well below the replacement cost of fuel oil and substantially below the replacement cost of diesel. Syria has interesting and attractive options in planning electricity generation. Gas an be used to replace fuel oil in existing steam electric plants and diesel in gas turbine plants. In fact, replacing fuel oil with gas in existing steam power station would be economically attractive as it would release additional quantities of petroleum products for export. The steam electric plants at Rabil, Meherdeh and, at a later date, at Banias could be converted to gas as it becomes available in sufficient quantities at Damascus, Homs and Banias.

6.30 All future generation also could be based on gas because reserves are sufficient for a few decades. It is in this context that the use of combined cycle power plants becomes very attractive. These combined cycle gas turbine plants operate at an efficiency of about 43% compared to 32-34% for steam electric and about 24% for ordinary gas turbines. The capital cost of combined cycle is also lower than steam. In addition, the cooling water requirements for a combined cycle plant are expected to be only a third of the requirements for a steam electric plant of the same size. This is of considerable importance in areas like Damascus where air cooled condensors are being planned for steam electric generation (Rabil). The option of installing 300 MW of combined cycle gas turbines in place of Rabil 3 and 4 should be seriously considered as these would allow it to operate at a much higher efficiency. Table 6.2 compares the economics of power generation based on steam, gas turbine and combined cycle gas turbine systems.

6.31 It is difficult to compare these systems because prices for generating plant still vary widely. Recent bids for steam power plant in Syria have been as low as $US550/kW, and bids for combined cycle plants in other countries have been as low as $US350/kW. The cost of a steam plant has been taken at $US650/kW ($US800/kW may be more realistic) and the combined cycle gas turbine at $US550/kW ($US450 may be more realistic).

Table 6.3: COMPARISON OF GENERATING COSTS PER kWh OF ALTERNATIVE GAS FIRED PLANTS (300 MW size)

	Steam	Gas Turbines	Combined Cycle
Capital cost, $/kW installed	650	300	550
Useful life, years	25	15	20
Annual capital charge, $/kW (at 10%)	72	39	64
Annual OM & R costs, $/kW	32	21	30
Non fuel costs, ¢/kW			
(6570 hrs p.a.) 75% load factor	1.58	0.91	1.43
(4380 hrs p.a.) 50% load factor	2.43	1.37	2.14
Heat rate, Btu per kWh	10,000	12,000	8,500
Fuel cost per kWh, in US¢			
for $US3.50/MMBtu of fuel cost	3.5	4.2	2.97
Comparative unit generation costs, ¢/kWh			
(a) 75% load factor			
Gas at $3.50/MMBtu	5.08	5.11	4.40
Gas at $5.00/MMBtu	6.58	6.91	5.67
(b) 50% load factor			
Gas at $3.50/MMBtu	5.93	5.57	5.13
Gas at $5.00/MMBtu	7.43	7.37	6.38

6.32 Table 6.3 shows that the combined cycle plant provides the least cost power for mid-range load under all three alternatives. It is recommended in Chapter IV that gas be priced slightly below the replacement value of fuel oil, which now corresponds to a value of $3.90/million Btu. If gas were priced at cost (including depletion premium), or about $1.50/million Btu, gas turbines would be more economical, but the savings would be notional as a valuable resource would be underpriced and consequently used inefficiently.

6.33 As gas turbines can be installed and commissioned in just 12 to 18 months, the projected capacity and energy deficits could be met by immediately installing conventional gas turbines. At a later date -- 12 to 24 months -- these gas turbines could be retrofitted with waste heat recovery systems and steam turbines.

6.34 Although the Ministry of Petroleum is assisting PEE by transferring gas turbines to Souedie, better coordination between PEE and the Ministry would be desirable. The Ministry of Electricity apparently has repeatedly requested rapid development of the Jebisse gas fields for use in gas turbines, but no action has been taken by the Ministry of Petroleum.

Nuclear Power

6.35 Syria has a proposal under study to build a nuclear power station of 2 x 440 MW capacity at alternative sites. These are planned to be built with Soviet assistance and the first unit is expected to be commissioned by 1992/3 and the second by 1993/4. The unit capital cost of a nuclear power station is much higher than a combined cycle gas turbine, International Atomic Energy Agency (IAEA) estimates of nuclear costs are $1900/kW to $2,700/kW (including interest during construction) but as only the USSR now produces 440 MW units it is impossible to determine the price. The fuel has to be imported, and it is unlikely that nuclear power would be cheaper than electricity generated by combined cycle gas turbines at US¢4.40 to 5.13 per kWh [at a gas cost of $3.50/million British thermal units (Btu)]. If more gas is discovered and large gas surpluses develop, combined cycle generation costs would become even cheaper. A rough comparison of nuclear power plant, coal fired steam power plant, and combined cycle plant using gas indicates that gas is likely to be cheaper (US$4.32/kWh). Breakeven costs for nuclear, when compared to gas, would have to be $1,750/kW or less. Delays in construction of nuclear plants can add considerably to the cost of interest during construction. Also there are extra costs of bringing safety standards up to international levels. The comparisons are subject to uncertainty, but it does indicate that a very careful evaluation of nuclear power needs to be made before proceeding with its development. Without first conducting an overall least cost study for the combination of power and gas-use projects (i.e., a follow-up study to the Bank-financed study completed in 1978), a full evaluation of the economic worth of a nuclear power station would be premature. However, recent large gas discoveries and the good possibility of using large amounts of gas in power generation indicate that a decision on developing nuclear power should be postponed until a full least cost study is completed.

Recommendations to Study Least Cost Development

6.36 Consultants should be appointed to assess the short-term development requirements for power. The study should be completed in 3-5 months (at a low cost possibly around US$200,000), and cover:

(a) the capacity, timing and location of gas turbines needed to fill the capacity and energy gap until new plant is operational (1987-89 and around 1991);

(b) the physical and financial requirements for fueling of gas turbines with gas and for their operation (location, type of gas, gas cleaning, supply lines, possible gas compression, substations, transmission, stability, logistics, etc.);

(c) a preliminary plan and cost estimates for locating and constructing the next generation of power stations identified as A,B, and C in Annex 13;

(d) the further expansion of Banias and Rabil, assuring least cost to the extent possible within the time frame of availability of gas;

(e) preparation of terms of reference for a comprehensive least-cost development study for power and gas until the year 2000, including an assessment and phasing of gas supplies through time for power in the context of the priorities to be set for least cost gas use and possible options such as coal imports for coastal plant.

VII. RENEWABLE ENERGY — ISSUES AND OPTIONS

7.1 This chapter describes the issues and options related to renewable energy (primarily solar and wind), energy conservation (primarily in the cement industry) and the energy pricing (focussing on electricity and LPG).

Solar

7.2 The Syrian Arab Republic lies between the 32nd and 37th degrees of latitude north of the equator. The climate varies from a mediterranean weather along the coast to a desert environment further to the interior. With the exception of the narrow coastal strip, Syria experiences an average of 3,100-3,400 hours per year of suhshine. The country enjoys high solar insolation with yearly averages of 450 cal/cm^2 day (1.883 KJ/cm^2 day).

7.3 In Southern Syria (Damascus) the average duration of sunshine in winter is 6.7 hours which is 63% of possible duration. In the summer duration of sunshine goes up to 11.8 hours, which corresponds to 90% of the possible duration. Overall, average sunshine duration is relatively high at 9.2 hrs/day or 77% of possible duration.

7.4 Solar insolation varies markedly with the time of the year. During January, the average solar insolation averages a low 200 to 250 cal/cm^2 day (.837 to 1.046 KJ/cm^2 day). Summer insolation rises significantly and reaches a peak level of 700 to 750 cal/cm^2 day (2.928 to 3.138 KJ/cm^2 day) during the month of June. The variation in seasonal value of solar insolation is due in most part to Syria's latitudinal location. However, regional variations are apparent and iso-insolation lines seem to follow climatic patterns. Interior areas close to the desert area exhibit the highest sunshine duration. Sunshine duration diminishes toward the coast or the northern areas.

7.5 Solar data is available from only three sites in Syria. Currently only one station (Kharabo) is in working condition. Data gathered from all three sites is limited to direct solar radiation in addition to meteorological information. Meteorological department personnel did not seem very confident of the quality of the data collected. Kharabo station has recently been completely refitted with a modern solar radiation collection system coupled to a digital recorder. A complete set of solar information is available for this site for the last couple of years.

7.6 Rainstorms, cloudiness, and sand storms are the main causes of scattering or diffusion of direct solar radiation. These occur during the October to May period with more than six cloudy day. per month present during December, January, and February. Annex 16 presents the daily average total solar insolation data for the three existing sites in

Syria. Annex 17 presents the average daily sunshine duration for nine sites in the country. Annex 18 presents the monthly breakdown of cloudy days and monthly average solar insolation data.

7.7 Solar energy could be used in the domestic and commercial sectors in Syria for water and space heating. Syria is one of the few developing countries with high solar insolation even in winter months with mean temperatures of around 8°C and absolute minimum temperatures down to -8°C. The major energy source for heating now is gas oil with an annual consumption of 1.2 million toe or nearly 0.7 toe per household. A substantial part of this gas oil consumption in the domestic and commercial sectors can be eliminated by a well planned program for utilization of solar energy for water and space heating.

Population Demographics and Households

7.8 The population growth rate during the 1970-1981 period was a high 3.4% leading to a population increase of 43% over the same period. The urban population is evaluated at 47% of total population in 1981, up from 43.5% in 1970. The urban population is distributed among 63 towns of more than 20 thousand inhabitants whereas rural inhabitants are spread among 6501 villages. Household sizes differ among urban and rural settings. The average household size in towns is 6.0 persons per household and reflects the continual rise in household size over the 1970 figure of 5.9 persons per household and the 1960 figure of 5.3 persons per household. Due to the forecasted drop in population growth rate the mission will assume that the household size will remain constant over time.

Residential Housing Stock

7.9 The identified housing stock in Syria is about 1.5 million housing units, of which urban dwellings comprise 49% of the stock. The average size of a housing unit is approximately 3 rooms, although urban dwellings averaging 3.35 rooms. Similarly the floor area in urban dwellings is approximately 100 m^2 versus 80 m^2 for rural housing. Annex 19 details the size and structural distribution of the Syria housing stock in 1981.

7.10 Housing construction has been a key growth sector in Syria over the last decade. An important trend in housing starts is the substantial increase in floor area per dwelling over the average size of older houses. The mean urban housing unit is 110 m^2 in size compared to a past average size of 99 m^2. Increases in rural dwellings were proportionally even larger, 117 m^2 compared to 81 m^2.

Residential Energy Demand

7.11 The consumption of commercial energy in the commercial and domestic sectors in 1983 is estimated at 1.808 million toe. The breakdown is 0.152 million toe of electricity (8.4%), 0.451 million toe of LPG/kerosene (24.9%), and 1.205 million tonnes of gas oil (66.7%). More than 85% of the population has access to electricity. In the next five years or so electrification of households is expected to reach near saturation. The average electricity consumption per connection in 1983 is estimated at 1,155 kWh/year for the domestic and the commercial sectors. Disaggregated figures are not available for the domestic sector alone but the average consumption per household probably would be less than this figure and may be in the region of 600 kWh/year. This would indicate that the electricity is likely to be consumed largely or entirely for lighting and very little is used for heating, air conditioning, or cooking. LPG and kerosene are used for cooking. The total consumption of LPG in 1983 was 212,000 toe and kerosene consumption was 239,000 toe. As LPG availability increases in the near future, it will increasingly displace kerosene for cooking purposes. Gas oil is used mainly for water and space heating and solar energy could replace a substantial part of this consumption in the future.

Solar Water Heating

7.12 Detailed figures of gas oil consumption for domestic water heating based on sample surveys are not available and certain assumptions had to be made in order to arrive at an order of magnitude figure for gas oil consumption for domestic water heating. Based on certain assumptions regarding hot water usage in households, the annual gas oil consumption for water heating is estimated at 274 liters or 0.221 toe per households.

7.13 Syria has an emerging industry for the production of solar water heater and in Damascus alone, the mission identified seven manufacturers including one in the public sector. These units are not operating to capacity due to (a) lack of appropriate incentives and information on converting to solar systems; and (b) the relatively high capital costs of a solar system as compared to a simple gas oil heater. In addition, the industry suffers from lack of raw materials for manufacture of solar systems on an assured and regular basis. Government policies should favor adoption of solar water heating systems whenever possible and provide incentives and information and make available loans for households to install solar water heating systems. A typical system costs SL 4,300, compared to only SL 750 for a gas oil heater, with a payback period of about six years. Detailed calculations are presented in Annex 20. The solar water heating system becomes even more attractive if coupled to solar space heating systems as discussed in subsequent paragraphs. Syria should encourage solar water heaters as domestic manufacturing capability exists and could potentially substitute for 0.287 million toe of gas oil being used for this purpose.

Solar Space Heating

7.14 The climate in Syria ranges from a mild mediterranean climate on the coast to a continental desert in the East. In addition, the chains of mountains separating Syria from Lebanon and paralleling the coast attract fairly heavy snowfalls during winter. Yearly average temperatures range between 15° and 20°C. Annex 21 provides the monthly temperature profile for Damascus. Like most interior regions, Damascus experiences occasional temperatures below freezing for six months of the year. The temperature data collected for Damascus forms the basis for all the simulations developed to evaluate solar applications.

7.15 As in the case of water heating, scant statistical data is available with regard to use of gas oil for space heating based on sample surveys. Based on the data collected by the mission and certain assumptions regarding temperature differentials, duration of space heating and household areas, the gas oil consumed yearly in each urban household is estimated at 0.348 toe. Average rural household consumption may well be below this figure. If a factor of 0.8 is assumed between urban and rural households, the average rural household consumption is estimated at 0.278 toe. The total consumption by all households for space heating is estimated at 0.450 million toe.

7.16 The alternatives to gas oil space heating are: (a) solar space heating; (b) electric heating; and (c) heat pumps. The total heat demand per household per year is estimated at 1417×10^3 kcal, with a maximum of 418×10^3 kcal required in the month of January. A conventional solar space heating system with 8 m^2 of panel area would provide only about 70% of the heat load required during January and would have to be backed by electric or gas oil heating. The net consumption for the three options is:

Table 7.1: DOMESTIC ENERGY COSTS

Heating System	Consumption	$SL/10^3$ kcal	At Economic Rates
Gas oil heating	348 toe	0.39	0.45
Solar/electric	258 kWh	0.46	0.76
Heat pump	588 kWh	0.38	0.47
Electricity	1,648 kWh	0.43	0.72

A range has been indicated for solar heating as capital costs and efficiencies vary substantially for different manufacturers. These costs are for stand alone systems and the cost of a solar water space heating system which would provide heat only during the day could be a viable alternative. The heat pump costs are for an air/air system, and this option could be more attractive if coupled to a solar water heating system. Another advantage of the heat pump option is that it could be used for air conditioning during summer months and the cost would be lower if credit was given for this in analyzing capital costs. Whenever air conditioners are installed for summer cooling, conversion to reversible heat pumps would be advantageous. Another alternative that may provide heat during day time only is the solar window panel at a cost of SP .33 per 10^3 kcal. A study of these alternatives is beyond the scope of this report and these options need to be studied in more detail. It is suggested Syria undertake some demonstration trials on each of these systems either on a stand alone basis or in combination.

Wind

7.17 According to the Meteorological Department, wind data is being collected throughout the country by a network of approximately 30 meteorological stations. Data provided is of limited usefulness for detailed sizing of wind turbine systems but provides a data base for a rapid evaluation of the wind regime. A moderately important wind regime covers the whole country with average speeds ranging from 3 to 5 meters/second. The wind regime is steady and distributed around the mean wind speed.

7.18 The wind regime is generally favorable for installing wind mills in Syria and, in fact, a few thousand have been installed in the past decade or so. As in the case of solar water heaters, indigenous manufacture of wind mills for pumping of water is well developed and several thousand have been installed in the countryside without any specific encouragement from the Government. While these tend to be competitive with diesel driven pumping systems, their high capital costs make them uncompetitive where electricity is available. The market is slowly becoming restricted as rural electrification programs are implemented and access to electricity increases. The low tariffs for electricity also operate against large scale use of wind mills, but wind energy remains an important renewable energy source in Syria.

7.19 As electricity becomes available in rural areas, the market for wind mills will become restricted. This trend is likely to continue and wind mills are likely to play a diminishing role in the economy as a whole, while continuing to be attractive in areas without electricity. See Annex 22 for detailed analysis.

Biomass

7.20 Syria has an area of 182,000 square kilometers. Natural forests cover 485,000 hectares of land or approximately 2.7% of the total area. Natural forest area seems to have remained at a roughly constant level since 1973. Reforestation efforts are recent with a 12,000 hectares per year program underway since 1978. Total reforested area reached 81,000 hectares by the end of 1983.

7.21 Official figures for fuelwood consumption in Syria are suspiciously low: 7,600 tonnes in 1983. Charcoal production is estimated at 1,900 tonnes and wood harvesting for industrial use is 11,680 tonnes.Ministry of Agriculture officials indicate that the availability of electricity and the widespread use of gasoil and butane bottles has practically eliminated the use of fuelwood. Official estimates for charcoal and fuelwood consumption correspond to 3,744 toe or 0.2% of domestic and commercial energy use.

7.22 Syria's reforestation program is impressive for a country of its size. Since 1978 the goal of 12,000 hectare of plantations has generally been exceeded. The plantations established up to 1984 cover 81,000 hectares and are equivalent to 17% of the existing natural forest area. According to Agriculture officials, the reforestation program is being doubled in scope with up to 24,000 hectares to be reforested yearly starting in 1985. Clearly, Syria is one of the few developing nations where forests are increasing in the aggregate, but biomass resource is unlikely to have any significant role in meeting Syria's energy needs.

Geothermal

7.23 Natural hot springs have been known in Syria since ancient times. Presently 14 geothermal localities (hot springs or wells) are known in Syria and are listed in Annex 3 and the locations are shown in Annex 4. The water temperature varies from 25-60°C. All of these geothermal localities are in limestone formations, mostly of Cretaceous age. The geological conditions in Syria suggest that geothermal water can be found widely in the Cretaceous limestone formations. The temperature of the water, however, depends on a) the regional thermal gradient; b) the depth to which the water flows; c) the flow rate from depth towards the surface and cooling on the way; d) cooling due to mixing with colder water at shallower depths. No estimates have been made of the heat flow in Syria. There are, however, tens if not hundreds of deep wells in the country that can most likely be used for an assessment of the heat flow and the measurement of thermal gradients in the country. But assuming an average thermal gradient of 25°C/km, and assuming the mean annual temperature in the recharge areas of the thermal water to be about 15°C, water flowing at 1 km depth can be expected to reach 40°C and at 2 km depth the water temperature could be 65°C. It is suggested that the first step in further geothermal exploration in Syria should be estimates of the underground temperatures by means of chemical analyses of all the thermal waters, and a country wide program of temperature measurements in existing deep wells.

7.24 It should not be difficult to obtain thermal waters with temperatures high enough for therapeutic baths in several places in Syria. For space heating, however, the temperatures of the thermal water should preferably be over 50°C. The results of the chemical survey of thermal waters and the proposed temperature measurements in available drillholes in Syria, may give an indication as to how many places are likely to produce thermal waters with temperatures high enough for space heating at reasonable drilling depths. In any event, geothermal energy can play only a very limited role in meeting Syria's energy needs.

Conclusion

7.25 Among renewable sources, solar energy seems to be the most attractive. Solar energy for water heating is already cost effective and only needs suitable governmental policies to be more widely used. Solar energy for space heating requires more detailed studies and demonstration projects to assess the costs, risks and benefits more fully. Biomass and geothermal are likely to have only limited application in meeting energy needs of the domestic and commercial sector.

VIII. INSTITUTIONS IN THE ENERGY SECTOR

8.1 The important institutions in the energy sector are (a) Syrian Petroleum Company; (b) PEE; (c) Banias Refinery; and (d) Homs Refinery. In addition, there is The Syrian Company for Oil Product Storage and Distribution (SADCOP) and the Syrian Company for Oil Transport (SCOT). The organization of the major institutions in the energy sector are discussed below.

Energy Planning/Advisory Unit

8.2 The energy planning/advisory unit within the Ministry of Petroleum should be strengthened. It should expand its activities, prepare energy balances and study options and policies on a regular basis. To do this a large and more up to date database should be provided to this unit. Clearly, computer facilities (mini-computer is sufficient) would be of great assistance in carrying out planning responsibilities. An Energy Balance Committee was set up in the Ministry of Petroleum in 1980 for carrying out energy audits in industry and this needs to be strengthened and activated.

Syrian Petroleum Company

8.3 SPC is headed by a General Director who oversees six main directorates: technical, financial, planning, general and the two districts (Hassaka and Jebisse). In addition to the main directorates, nine department heads report to the General Director [administration, commercial, legal, internal auditing, service contracting, exploration, petroleum studies, gas exploration (Bulgarian contract) and gas processing]. In all there are 15 people reporting to the General Director. The total labor force is 9,600, out of which about 9.6% are university graduates (including 5% engineers) and 16.7% high and middle school graduates.

8.4 SPC is run by competent top management and a strong base of skilled workers. Middle management and professionals with long experience are few and those present are carrying more than their share of the work load. Consequently, about 100 expatriates (skilled workers, foremen, engineers and advisors) are retained to support the SPC operations.

8.5 SPC has a very challenging task ahead; to allow it to meet these challenges some organizational changes will be required, such as (a) improve the professional expertise of its management and technicians by exposing them to world class technology; (b) integrate technical disciplines (geology, geophysics, petroleum, engineering and technical support services) under one vice president; (c) improve and strengthen communication channels between districts and headquarters; (d) encourage and allocating enough resources for studies, research and pilot operations and providing the requisite support services (geoscience laboratories, data bank, computers and software for seismic data processing and reservoir modelling studies); (e) improving management information system and devising criteria for evaluating investment options, (f) developing a medium and long term strategy for SPC to operate on its own and/or as a partner with foreign companies, and (g) divesting SPC of so-called technical services (civil, mechanical and electrical works) through contracting to local firms and concentrating on the basic task of exploring, finding and developing oil and gas resources.

Natural Gas Development

8.6 Gas will play an important role in Syria's economy and activities relating to exploration, evaluation, testing and development of gas reserves needs to be strengthened. Inadequate data compilation and analysis concerning natural gas discoveries, the absence of testing equipment, and the slow development of major gas reservoirs all indicate considerable scope for improvement. This failure to utilize a most important national resource can be explained by a number of factors:

(a) Lack of a comprehensive energy sector study and a long term energy plan;

(b) Syrian isolation from commercial and technical developments in countries beyond its borders. The capacity of Syria to benefit from the experience of other countries has been limited. The flow of commercial and technical intelligence through periodicals needs strengthening;

(c) Thinking that natural gas broadly remains "the oil man's nuisance";

(d) Lack of adequate communication between the gas producing agencies (SPC) and the consuming agencies (power, industry, etc.).

8.7 It is clear that Syria has substantial natural gas resources which can be developed with considerable economic benefit to the country. However, the difference between doing it well and doing it indifferently could be massive in economic terms.

8.8 Natural gas development and utilization calls for technical and organizational skills which are different from those which apply to oil. Organizing for natural gas development should concentrate mainly on two areas: (a) acquiring an understanding of the dynamics of gas development in other developing countries; and (b) creating a management structure which can tackle the complexities of gas development and marketing. To achieve these objectives, the following recommendations are made:

(a) Natural gas inevitably moves within pipes or process vessels from the moment it leaves the well until it reaches the burner tip. With all facilities in the chain being fully operational all the time there is little intermediate storage capability;

therefore there is a need for a greater degree of operational reliability from the consumers' viewpoint, as in the case of electric power. Syria may have difficulty finding suitably experienced staff from within the country to make the best of the natural gas opportunities in the short term. In order to train Syrian technicians and managers in gas development programs, the following recommendations are made.

(i) visits to developing countries like Pakistan which have a history of natural gas development or are engaged in it;

(ii) attendance of selected Syrian personnel at formal courses, which are available in a number of disciplines, particularly:

- Project evaluation, management and coordination;
- Engineering of natural gas systems;
- Natural gas, international supply and pricing;
- Natural gas, economics;

(iii) using experienced consultants on planning, project formulation and implementation.

(b) Another important aspect of gas development is the close coordination required between potential users and gas producers and the integration of gas development plans with those of the user agencies.

(c) It is important to ensure that gas development projects go on stream as scheduled and coincide with completion of user facilities, which would largely or entirely be under state ownership. In order to achieve this, close coordination between the different Ministries and the organizations under their control is essential. For this purpose it is recommended that a Board (or division) be created within the Ministry of Petroleum to oversee gas related activities and to coordinate these activities with those of other Ministries and their subordinate organizations in power generation and industry. While the day to day operation of the Board would be the responsibility of the Ministry of Petroleum, a two-tier Management Committee is recommended for achieving the coordination with user Ministries/Institutions. The first is a Ministerial Committee which approves overall targets, financial allocations and all gas related projects. An operating committee at a working level (of heads of departments) would ensure coordination among the different directorates and periodically review progress of projects. The functions of the Board should include the following:

- drawing up a master plan for gas development and usage;

- planning and programming of gas development projects in consultation with the supply and demand sectors;

- approving of all investment plans with time targets for completion;

- reviewing progress of approved projects periodically;

- coordinating activities of private sector organizations, particularly foreign oil companies, with those of SPC to ensure optimal and least cost development including sharing of pipelines and facilties where required;

- negotiating and setting tariffs for supply of gas by SPC and foreign companies to ensure an equitable and assured return on investments;

- setting tariffs to different categories of users to ensure that a valuable resource is used economically;

- monitoring of major contracts awarded in the gas sector and ensure adequacy of technical support and consultancy.

8.9 The size of the two committees should be limited to ensure that it concentrates on the core matters and avoids the temptation to "interfere" with the independence of user agencies with whom it deals but at the same time has representatives of all Governmental agencies involved in gas development and usage.

Institutions in Refining and Distribution

8.10 The Homs refinery (built in 1959) and the Banias refinery (built in the early 1980s) are separate companies under the authority of the Ministry of Petroleum. Information on petroleum product demand comes from the distribution company. The policies on importing and exporting crude and petroleum products are set by a committee under the Prime Minister's office.

8.11 While the decentralized nature of the oil import, refining and distribution activities has some advantages, a closer coordination and flexible operation in response to changes in both the international market and domestic market would be beneficial. It is suggested that one refining enterprise, or a strong planning unit within the Ministry of Petroleum, oversee the operation of both refineries and retain major responsibility for imports and exports of oil and oil products. This more coordinated structure, in conjunction with better refinery planning and refinery modelling, would create a more flexible institutional framework. A strong planning unit is necessary to determine how changes in crude/product import and export opportunities fit with the refinery operation, and also relate to supply and demand projections and optimization of refinery operations. These activities should be coordinated closely with SADCOP and SCOT operations.

8.12 To carry out this planning and coordination function a much better database must be provided to this unit. What is clearly needed is better data on the refining system, week to week crude and product flows, stock levels, yields of various crudes within the refineries and day to day international price changes. Simple refinery models on a minicomputer would be beneficial to this planning activity.

8.13 Within the refineries subordinate to the Technical Director there should be a clear division of responsibilities between the Technical Services (design, planning and lab work) and Operations Superintendents.

8.14 There does not seem to be a group in each refinery whose job it is to continuously review current operations from a theoretical point of view, as well as from a practical one. This has been left to senior operating personnel but these people are far too busy with day-to-day problems to have time to properly analyze the more difficult problems or the wide variety of small investment opportunities that are always present in an operating system.

8.15 SADCOP was established in 1966 to take over the operations of all foreign marketing and distribution oil companies following nationalization. SADCOP is responsible for the storage, distribution by road, rail and pipeline, and the marketing of all petroleum products in Syria. Local distribution is by private trade. SADCOP is managed by a Director General and comprises six departments each headed by a director. Planning of LPG distribution will be an increasingly important activity in the future. SCOT operates the crude pipeline system (formerly of the Iraq petroleum company) from the border with Iraq to the Banias and Tripoli terminals. The pipeline system's capacity is about 1.4 million barrels per day and consists of two 32-inch pipelines, one 16-inch pipeline and one 12-inch pipeline together with three booster pumping stations. Pipeline transport of Iraqi crude stopped in 1982. Part of the pipeline will transport newly discovered oil at Der-el-Zor.

Solar Energy Institutional Structure

8.16 Some organizational structure is required for the promotion and demonstration of solar energy, particularly solar space heating. There is a need to study and promote solar energy use and to provide resources to outside institutions for research and demonstration projects. These activities are dispersed among the Ministry of Industry, the Ministry of Petroleum and other institutions. Possibly the Ministry of Petroleum would be the best place to consolidate these activities.

Power Sector Organizational Structure

8.17 PEE, which was created in 1965, is the sole entity responsible for public supply in Syria. In 1974, when practically all larger industrial enterprises were nationalized and the work of various Ministries was reorganized the Ministry for Electricity was created to which PEE was transferred.

8.18 Although day-to-day business is generally the responsibility of PEE's General Manager (who is assisted by a Management Committee), all major decisions are taken in the Ministry, which is housed in PEE's head office. Autonomy, except in routine matters, is virtually non-existent. Salaries are restricted to civil servant regulations and turnover is rapid among higher level technical staff. As a result, PEE's head office never succeeded in regulating the regional offices, whose technical and financial performance varies widely.

8.19 The Minister, in practice, is the highest authority in PEE, discharging his functions through a Deputy Minister for Planning, Statistics and Training and a Deputy Minister for Generation, Transmission and Operations. PEE has a Board of Directors comprising the General Manager (normally its Chairman, when the Minister does not wish to chair a meeting), the Director of Finance, the Director for Legal Matters, the Director for Procurement and Stocking, the Director for Power Plant Constructive, and two Workers' Representatives. Thus, the Board comprises only PEE personnel; the voice of the consumers is not in any way represented on the Board.

8.20 Although nominally PEE has four Departmental Directors, who form, together with the General Manager, the Management Committee, there is little delegation of authority; PEE is largely organized horizontally and has some 33 Directors. Each of the 15 regions has its own Director, as have some 10 general service departments. The head office is spread over six buildings in Damascus, and the training and repair centers near the Adraa substation (each having its own Director) together are considered part of the head office.

8.21 PEE has no centralized planning department -- the Planning and Statistics Department with only 15 people should not be considered to be a planning unit. Planning for generation is largely by committee, while design is usually left to consultants or to the manufacturers. The transmission department is reasonably staffed and appears competent to plan future expansion (consultants were appointed in 1985 in view of the large expansion program). Centralized distribution planning is limited to a small unit which largely provides only guidelines, while actual planning is left to the regions. A least cost development program is not prepared due to lack of expertise. However, a WASP (generation planning) program is available, but it is incompatible with the computer available in PEE.

8.22 PEE's lacklustre performance is largely due to two factors:

(a) Lack of expertise due to inadequate remuneration, which causes a steady outflow of staff as soon as they have obtained sufficient experience in PEE to be attracted by better opportunities in the private sector or elsewhere in the world;

(b) Lack of autonomy -- the decision-making procedures are at a Governmental or Ministerial level with minimal responsibility at the organizational level.

8.23 As a result, PEE's organization is poor; bureaucratic procedures are stifling, communication between offices is difficult, accounting is inadequate. Only in the purely technical areas is the situation good. Power generation and transmission facilities have been constructed ahead of demand for over a decade and an immense rural electrification program has been executed. These achievements are considerable. About 100 higher technical staff are being satisfactorily trained annually. However, training of administrative staff has not been similarly developed and at a lower level, training is substantially on the job only.

8.24 A national dispatch center (and a local center for Damascus) was financed by an Abu Dhabi credit, at about the time of the Second Mehardeh Loan (1144-SYR, 1975). It became operational by the end of 1983, by which time it was almost obsolete because the system had grown and no funds were made available to keep the center up to date. Computerized dispatch, central frequency control, and computerized printing of data were never instituted -- in part due to lack of trained staff. The national center functions largely by telephone. A three-year program planned and executed by the manufacturers, is being instituted to rectify the situation, but lack of experienced personnel continues to inhibit progress.

8.25 A modern transformer repair center including a fully equipped testing lab has recently been completed at Adraa (some 20 km north of Damascus), as well as a smaller circuit breaker repair shop. Advisors and training experts have been training people, but with very poor results: qualified people cannot be engaged in sufficient number (because the site is far from town, family and friends, and there is a lack of housing); and the transformer repair center stands virtually idle.

8.26 Finances are in a poor state. Since 1970, only two rate increases have been granted. The first one was implemented in July 1980 and effectively amounted to an average of 60% in current prices. It fell far short of requirements and with inflation the situation has continued to deteriorate. The second rate increase, implemented in January 1985, made only minor adjustments and is expected to result in an average increase of some 7%. The exact shortfall is not known because PEE's accounts are not up-to-date (an effort is being made once more to be up to date by the end of 1985). The 1984 revenue for sale of electricity was probably around SL 1,250 million and the fuel bill some SL 1,050 million, thus the fuel bill alone may exceed revenue by the end of 1986 unless tariffs are raised immediately.

8.27 The IBRD power loans financed numerous studies. A tariff study was executed between 1975 and 1977 but never implemented because of the Government's unwillingness to increase rates. The recommendations from a Load Research Study were to achieve an improved data base in order to continuously review tariff structures and rates. These were not implemented.

Personnel

8.28 Since 1980, total manpower had grown from 14,120 people to 17,197 at an average annual increase of about 8%. Although this appears high, it is modest in comparison with other PEE growth indicators over the same period, such as sales (16%/a), generation (19%/a), number of customers (11%/a). As an illustration of the difficulties of engaging qualified staff, the target set for the engagement of university graduates in 1977 (IBRD Appraisal of the Regional Electrification Project Loan 1531 SYR) for the year 1980 was 1058, while actually PEE had 690 employees in this class in 1980.

8.29 It is difficult to retain and increase qualified staff and there is a rather rapid turnover in engineers and other graduates. The year 1984 apparently was a "good" year with respect to recruiting engineers. However, in the three previous years, on average about 12% of the engineers left PEE, indicating a rather low average employment time of eight years. If operations and planning are to be improved, it is very important to increase the qualified staff and retain them.

Organizational and Institutional Reforms

8.30 That reforms throughout PEE are urgently required has been obvious since the first IBRD loan, when consultants were appointed in 1975 to recommend a new organization and administrative and accounting systems. However, no action was taken by PEE to implement the recommended systems. A second firm was appointed in 1980, which submitted its recommendations in 1983. As yet, no action has been taken.

8.31 It was hoped that the present fragmentation of PEE's head office would end with the completion of the new head office, construction of which started in 1982. However, as the annual budget for the purpose is restricted the building will not be completed before the end of 1986. Because most of the departments are now spread out and lack direct communications, the appropriate time to implement drastic institutional changes can only be after the move.

8.32 As indicated above, the Government's performance for electrification of the country to meet industrial and residential demand and to reach most people, has been impressive, but there are distortions that need to be corrected in the near future:

(a) The past unrestrained growth and waste of energy caused by inadequate pricing should be arrested through proper pricing and conservation incentives. New facilities might be partly financed by existing consumers through internal generation of funds. This would reduce the financial burden on the Government and allow PEE to contract out for facilities;

(b) Because of the limited past investment in generation, Syria should prepare to meet requirements in this area that will be considerably higher over the next five years. This is particularly important because funds also will be required to execute other energy related projects;

(c) Efforts should be made to tamper the use of funds for and rate of rural electrification to improve service quality and release funds for higher value uses. This would help to keep overall losses within reasonable limits;

(d) The reorganization of PEE should no longer be postponed so that the management of this growing and complex power system can be approved;

(e) As PEE has no centralized planning office, such an office should be created and provided with adequate facilities and consulting expertise. PEE's planning staff, which are now scattered throughout various offices, could be transferrred to the new planning office and constitute a substantial portion of the planning staff. However, planning would be the responsibility of the consultants under direct supervision and authority of the Deputy Minister for Planning of the Ministry of Electricity.

IX. INVESTMENTS

9.1 As energy development forms part of the Government's five-year plan and planning for the sixth plan (1986 to 1990) is ongoing, this chapter will discuss investment costs in the petroleum sector (oil, gas and refining) and in the power sector. Major emphasis should be placed on the high priority and high rate of return investment options in the petroleum sector, particularly accelerated gas development, maintaining oil production from oil fields, and making some modifications to present refineries. The minimum new investment necessary for this sector is estimated to be SL 9.2 billion, or SL 1,840 million per year. Of this about SL 1,600 per year is for oil and gas development and exploration, activities currently handled by SPC. Given these high investment requirements options should be investigated on ways by which joint ventures with foreign companies might reduce the overall investment cost to the Government, particularly in the area of gas development. In the power sector the primary emphasis should be on policies and investment choices which reduce losses, improve efficiency, increase prices and efficiently supply power to meet demand at higher tariff levels. An analysis of the investment necessary to meet the Alternative 1 demand scenario (or high demand-low price scenario), similar to PEE plans under consideration, indicates that SL 10.7 billion (excluding SL 2.24 billion for nuclear) would be required for investment. It is unlikely that such large investment resources would be available solely for power. Therefore urgent measures are required to cut losses, improve efficiency and reduce demand growth, if serious power shortages are to be avoided. Investment requirements to meet the resulting lower demand (Alternative 2) are estimated to be SL 8.0 billion.

Petroleum and Gas Investments

9.2 In 1983, expenditures on oil and gas exploration and development by the Syrian Oil Company were SL 1.55 billion. Approximately 40% was for equipment, the rest classified as construction. This is a substantial increase (129%) over the SL 0.675 billion spent in 1982.

9.3 Future expenditure priorities should be on the development of gas, expenditures necessary for maintaining petroleum production from the old oil fields, acquiring new equipment, and a balanced exploration program. In the refining sector there is clearly no need to build a new refinery, although conversion facilities at Banias are required and would have a rapid payback. A summary of the approximate investment cost is given in Table 9.1. Gas investment is given in more detail in Annex 23. This list identifies the largest and most important potential investments and it gives approximate investment cost, but it is not a comprehensive list. The total identified new investment is US$2,325 million in constant prices (SL 9.18 billion). Of this, US$2,000 million (SL 7.9 billion) is for new investment required for oil and gas exploration and development under SPC. On an annual basis this is a modest increase over the 1983 actual level. This level should be considered a minimum annual investment level (constant prices) for SPC. The approximate value of oil and gas output this investment would produce would be between US$4 to 6 billion dollars over the next ten years, compared to an investment of $2.0 billion in five years. This is an excellent return on investment. Refining investment would have a rapid payback, indicating high returns. Given the high level of investment cost and limited funds for total investment in all sectors, it would be useful to investigate ways in which foreign investment (in gas development, for example) might allow the necessary investments to be made at a lower overall cost to the Government.

Table 9.1: MINIMUM INVESTMENT PLAN RECOMMENDATIONS IN PETROLEUM, GAS AND REFINING FOR 6th PLAN (1986 to 1990)
(in US$ million, in constant prices)

	1986	1987	1988	1989	1990	Total
I. Oil and Gas Exploration (SPC)						
A. Seismic (all Syria)	12	12	12	12	12	60
B. Palmyra basin gas field						
- Exploration (10 wells)	6	6	8			20
- Delineation (20 wells)		12	14	12	12	50
C. Oil exploration						
- Northeast (80 wells)	40	40	40	40	40	200
- Outside N.E. and Palmyra (10 wells)			10	10	10	30
II. Gas Development (SPC)						
A. Palmyra gas	15	150	160	60	40	425
B. Other gas	75	60	60	40	40	275
III. Oil Production (SPC)						
A. In fill drilling (500-600 wells)	130	130	130	130	130	650
B. Field rehabilitation	38	38	38	38	38	190
C. Seismic data acquisition and processing facilities, drilling rigs, geochemical and reservoir engineering labs	20	20	20	20	20	100
IV. Refining (Banias and Homs)						
A. Banias cracking facilities	10	60	30			100
B. Debottlenecking, efficiency improvements	10	10	5			25
V. Distribution						
A. LPG						
- filling				25	25	50
- bottle mfg			30	40	40	110
B. Pipelines, meters	5	5	10	10	10	40
Total million US$	361	543	567	437	417	2,325
(billion SL at 3.95 SL/US$)	(1.4)	(2.14)	(2.2)	(1.7)	(1.6)	(9.18)

Power Generation Requirements for the Sixth Five-Year Program

9.4 PEE has only recently initiated budgeting for the next (1986-1990) five-year program, and no firm details are yet available. A preliminary development program was prepared for Alternative 1 and Alternative 2 demand forecasts in order to assess the power situation over time and the estimated capital cost of meeting these demand forecasts. Existing plant and planned capacity are shown in Annex 11 and Annex 12 respectively (see assumed commissiong dates). A substantial part of the planned capacity is already committed, although in practice changes can be expected. Only two units have been contracted for Rabil, the power station to be constructed near Damascus. It was assumed, in view of power demand under Alternatives 1 and 2 in the 1990s that a further two units would be added. The Tichreen hydro plant on the Euphrates, although only preliminarily studied, was assumed to be firm and the nuclear plant was included in the evaluation, as site studies have been initiated recently. Private plant and the Lebanon are expected to assist PEE in overcoming the capacity and energy shortages in the next two to three years.

9.5 It should be noted that PEE cannot meet demand under the Alternative 1 (or high) forecast with the existing and presently planned capacities until about 1991 or after. New power stations, including surveys, etc., require a five to six year gestation period, but no actions have yet been taken to realize the preliminary plans. Measures could be taken (but not assumed here) such as the extension of Banias with more than two units (as presently planned) so that one or two years can be gained. The tentative plans are shown in Annex 13, which provides the capacity and energy balances for both forecasts in accordance with the above outline. Reserve targets would be 18% (1/0.85) of maximum demand plus the largest unit until the early nineties, when the next generation of stations becomes operational, and 38% (1/0.85 x 0.85) of maximum demand subsequently. All thermal plant is assumed to operate 5,000 hours per year of the available capacity.

9.6 Immediate needs can only be met by gas turbine capacity, for which delivery times are relatively short. No actions have yet been taken by the Government for constructing the next generation of power stations, and it was assumed that the best locations for a balanced system would be near Tartous in the northwest, near Meskene in the east and Deraa in the south, as referred to in PEE reports. The unit size of new plant was taken at 400 MW, simply because it is a multiple of the 200 MW units to be installed at Rabil and about equal to the effective capacity of the nuclear units.

9.7 Under power demand forecast Alternative 1, deficits are expected for the years up to and including 1990 as shown in the table below; beyond 1990 the situation would improve to normal levels of plant availability.

Table 9.2: ALTERNATIVE 1 ELECTRICITY FORECAST

Alternative 1 Forecast	Historic 1984	1985	1986	1987	1988	1989	1990
		---------- Forecast					----------
Demand (GW)	1.3	1.6	1.8	2.0	2.2	2.5	2.7
Available Capacity (GW)	1.7	1.9	2.0	2.6	2.8	3.4	3.4
Margin (GW)	0.4	0.3	0.2	0.6	0.6	0.9	0.7
(% of available)	23	15	12	24	20	26	20
Generation required (TWh)	6.8	7.9	9.0	10.2	11.4	12.7	14.0
Energy capability, average year (TWh)	6.8	7.1	8.3	9.6	11.0	12.8	14.5
Margin, (deficit), surplus (TWh)	-	(0.8)	(0.7)	(0.6)	(0.4)	0.1	0.5
(ditto, %)	-	(10)	(8)	(6)	(3)	-	3
Energy Capability, dry year (TWh)	6.8	7.0	7.6	8.1	9.5	11.7	13.4
Margin, (deficit), surplus (TWh)	-	(0.9)	(1.4)	(2.1)	(1.9)	(1.0)	(0.6)
(ditto, %)	-	(11)	(15)	(21)	(16)	(8)	(5)

Assuming average hydro conditions, the shortfall in capacity and energy is serious in 1985 and 1986. However, even a crash program could not change the situation very much; gas turbines, as the only alternative, cannot be expected to be in full operation within a year. Assuming 5,000 hours of operation for gas turbines, the above energy deficits represent the following required additional capacities:

Table 9.3: CAPACITY DEFICITS UNDER ALTERNATIVE 1

Required Additional Capacity (MW) for Meeting Energy Deficits	1985	1986	1987	1988	1989	1990
Average Wateryear	160	140	120	80		
Dry Year	180	280	420	380	200	120

9.8 PEE planned installion of gas turbines compared with that required under the Alternative 1 forecast was given in Table 6.2. For 1985 and 1986 the deficit cannot be avoided; only some off-the-shelf gas turbine capacity could alleviate the situation and PEE can only hope that the years will be favorable with respect to hydrology, that it can fine-tune its plant maintenance program and that it raise thermal generation of its newer plant in excess of 5,000 hours per year. PEE may ensure that any off the shelf gas turbines installed can be converted to combined cycle at a later date.

Power Sector Investment Program

9.9 Investment requirements over the next five years to meet Alternative 1 demand are about SL 10.7 billion, which assumes no electricity price increase. Investment to meet the Alternative 2 lower demand resulting from higher prices is about SL 8 billion. The benefits from reduced investment are thus SL 2.7 billion and in addition about SL 1 billion will be saved by reduced fuel consumption. If tariffs are raised for an average 75%, the PEE revenues over a five-year period would be higher by SL 7 billion. The reduced government budget support to PEE resulting from the price increase is estimated as follows:

	SL billion (1986-1990)
Increase in sales revenues:	
unchanged demand from price increase	+8.0
effect of reduced demand growth	-1.0
net increase in sales revenue	+7.0
Savings on investments	2.7
Savings on fuel costs	1.0
Reduced budget support	10.7

Assumes no change in borrowings which would reduce interest expenses.

9.10 These are only approximate estimates, but they include the magnitude of investment and fuel savings likely to accrue to the economy by increasing electricity tariffs. In order to avoid serious power shortages, the Government has the choice of either not increasing the real prices of electricity and allocating some SL 15 billion for new investment and revenue support over the next five years, or increasing prices and, thus, substantially reducing budget support. Such a large level of budget support is unlikely to be available, as resources would have to be diverted from more urgently needed areas, and the borrowing capacity of the sector is extremely limited given the poor financial situation. In this case, the only alternative to a substantial real price increase would be rapidly growing power shortages, with all the detrimental, disruptive effects it would have on production within the economy. With higher prices, power investment plans will be lower and nuclear plant investment postponed for five years or more. The details of investment plans, past and projected, are described below.

9.11 Previous Power Investment. Power investments under the current five-year program, (1981-1985) are shown in table 9.4 (details in Annex 23).

Table 9.4: POWER INVESTMENTS 1980-84

	1981	1982	1983	1984	Total	
	------	----	MSL	------	----	%
Generation						
Banias	231.6	185.9	90.6	32.9	541.0	13
Other	110.2	96.0	57.5	72.6	336.3	8
Subtotal	341.5	281.9	148.1	105.5	877.3	21
Transmission						
400/230 kV	181.4	120.0	122.9	83.3	507.6	12
66 kV	92.0	64.3	76.3	48.0	280.6	7
Subtotal	273.4	184.3	199.2	131.3	788.2	19
Distribution						
Rural	199.4	253.7	265.1	255.1	973.3	24
Other	262.1	349.6	308.7	198.6	1,119.0	27
Pole factories	15.5	26.9	20.8	11.3	74.5	2
Subtotal	477.0	630.2	594.6	465.0	2,166.8	53
General	76.2	71.0	72.5	49.6	269.3	7
Total	1,168.4	1,167.4	1,014.4	751.4	4,101.6	100

9.12 Since 1980, investment in the power sector has been about SL 1000 million annually except for 1984, when it was reduced by 25%. It seems that the investment outlay is determined more by financial constraints than program requirements as there is no provision for annual growth in investment in the power sector in spite of rising demand. The rural development program was the only one unaffected by the 1984 reduction in budgetary allocation and actually saw its share increasing from 17% in 1981 to 34% in 1984. Nearly 60% of the investment for the period 1982-84 was on distribution (rather than the usual 30-40%), and consequently investment in generation and transmission facilities has suffered. This investment has been decreasing since 1982 and in 1984 generation investments were less than one-third of the 1981 level.

9.13 The Government has become aware of the consequences of an unbalanced investment program and PEE therefore was recently authorized to invest about one million SL 1,200 in 1985 (against an earlier budget cut of 25%). Based on investment figures for the past five years on generation, transmission and distribution facilities, investment costs per kW of peak demand have been calculated. Due to lack of other data, the resulting figures have been used for forecasting investments in generation, transmission, and distribution facilities for the Alternative 1 demand scenario sixth plan period. Using the official rate of exchange for the portion of the cost in foreign currencies (PEE imports all goods at the official exchange rate) and the parallel exchange rate (as a shadow exchange rate) for local expenditures, historic investments amount to the following in Syrian pounds and US dollars per kW.

Table 9.5: INVESTMENT COSTS PER kW

	% of Total Investments	Investments per kW System Demand Increment	
		SL/kW	US$/kW
Generation	23	1,620	390
Transmission	20	1,480	340
Distribution	50	3,530	750
General	7	440	80
	100	7,070	1,560

Because investments have been relatively modest in the last few years, the investment stream was not deflated (prices for electrical equipment have been rather stable in currencies other than the US dollar) and interest during construction has not been capitalized.

9.14 Projected Power Investment for the Sixth Plan. In order to forecast investment requirements the cost of generating plants has been estimated in accordance with the development program in Annex 13 and the relevant expenditure schedule (together with the assumptions) is shown in Annex 24. Investment for transmission, distribution and general per incremental kilowatt has been maintained at the historical level and the annual investment for the power sector to meet the demands of Alternative 1 and Alternative 2 is summarized below:

Table 9.6: COST OF POWER DEVELOPMENT PROGRAM FOR ALTERNATIVES 1 AND 2 DEMAND 1986-90 (SIXTH 5-YEAR PROGRAM) (excluding nuclear plant)

	1986	1987	1988	1989	1990	Total	Share
	MSL						%
ALTERNATIVE 1							
Generation	391	683	925	1,186	1,208	4,393	41
Transmission	318	339	351	363	366	1,737	16
Distribution	742	791	819	847	854	4,053	38
General	95	102	147	109	110	563	5
Total	1,546	1,915	2,242	2,151	2,538	10,746	100
ALTERNATIVE 2							
Generation	391	583	625	686	773	3,058	38
Transmission	318	339	351	363	366	1,737	22
Distribution	462	511	539	567	574	2,653	33
General	95	102	147	109	110	563	7
Total	1,266	1,535	1,662	1,725	1,823	8,011	100

Note: All figures in constant prices.

9.15 If Alternative 1 power demand is to be met in the next five years, investment in the power sector has to be stepped up substantially. The total investment over the next five-year period is very large compared to the fifth plan period (1981-85). The additional investment in nuclear plant is estimated at SL 2,244 million during the sixth plan period and at SL 2,244 million during the seventh plan period. Although cost per incremental kW of system demand is expected to remain about level, total outlays for transmission would average some SL 350 million (compared with some SL 240 million in 1985). Outlays for distribution would have to increase similarly from some SL 600 million to SL 750-850 per year. Due to saturation, rural electrification would gradually decline, but all available funds should be used for urban improvements and reduction in losses.

9.16 Since it is unlikely that sufficient financial resources will be available to finance such an expanded program, ways must be found to reduce costs, cut losses, and slow demand growth. Investment in nuclear plant increases the requirements for funds considerably during the 6th and 7th plan periods because a conventional plant would have been completed by 1993/94 in lieu of nuclear plant and at a fraction of the cost; SL 1,100 million compared with SL 4,400. These lower investment levels in the power sector (Alternative 2) must be accompanied by large electricity tariff increases (to reduce demand growth and improve the PEE financial position), and an accelerated program to cut losses and improve availability and to quickly begin utilization of gas in power generation. If these measures are not taken and if investment levels are considerably below SL 10.7 billion, the inevitable result will be even more serious power shortages and disruption. However, if these measures are taken and the growth in demand is lower (Alternative 2) as anticipated due to higher tariffs, investment requirements are estimated to be SL 8.0 billion. The government budget support required for PEE under Alternative 2 will be substantially below that of Alternative 1 as the revenues will be larger while required outlays for investment and fuel would be lower. With a 75% increase in average tariff the PEE revenues over the plan period would be higher by SL 7.550 billion. In addition, the nuclear plant is not required up to the year 2000 under Alternative 2 and therefore a decision can be deferred by a period of five years.

Annex 1

TRADE IN OIL AND OIL PRODUCTS

	1978	1979	1980	1981	1982	1983	Jan-June 1984
VALUE (SL Million)							
Exports							
Crude oil	2,553	4,449	5,235	5,044	4,082	4,132	2,128
Oil products	58	209	1,286	1,477	1,859	1,063	658
Total	2,611	4,658	6,521	6,521	5,941	5,195	2,786
Imports							
Crude oil	872	1,926	3,155	4,954	4,249	4,656	2,450
Oil products	395	1,298	1,034	1,887	1,679	707	208
Total	1,267	3,224	4,189	6,841	5,928	5,363	2,658
Net Exports, Total	1,344	1,434	2,332	-320	-3	-168	128
VOLUME (Million Tons)							
Exports							
Crude oil	8,106	7,697	6,316	5,542	5,317	5,866	3,026
Oil products	179	373	1,461	2,054	2,702	1,664	1,046
Total	8,285	8,070	7,777	7,596	8,019	7,530	4,072
Imports							
Crude oil	2,238	3,332	3,155	4,994	5,224	6,076	3,032
Oil products	789	2,135	1,257	1,458	1,316	522	148
Total	3,027	5,467	4,412	6,452	6,540	6,598	3,180
Net Exports, Total	5,258	2,603	3,365	1,144	1,479	932	892

Source: Statistical Abstracts of Syria (1979-83); 1984 figures are from the Central Bureau of Statistics.

ENERGY BALANCE FOR 1981
(Thousand TOE)

Year-1981	Primary Energy						Petroleum Products							
	Crude Oil	Gas	Coal	Hydro	Nuclear	Electricity	L.P.G.	Naph/Gaso	Jet/Kero	Diesel	Fuel Oil	Other	Total	Line Totals
Gross Supply														
Production	8592	0		665										9257
Production, Sy Light	0													0
Imports	5373		1											5374
Primary Exports	5542													5542
Stock Changes	-842													-842
Total Available	9247	0	1	665	0									9913
Conversions:														
Petroleum Refining	-8878					0	129	1305	544	1999	4374	527	8878	0
Power Generation		0		-665		1176				-78	-433		-511	0
Conversion Losses	-369					-810							0	-1179
Trans/Dist Losses						-106							0	-106
Available for Consumption	0	0	1	0	0	260	129	1305	544	1921	3941	527	8367	8628
Secondary Supply:														
Secondary Exports						3	-26	520	0	-441	2847	0	2900	2903
Bunkers											26		26	26
Total Domestic Supply		0	1			257	155	785	544	2362	1068	527	5441	5699
Consumption by Sector														
Domestic and Commercial						120	155		275	1134			1564	1684
Agriculture						0				450			450	450
Industrial														0
Cement						27				17	306		323	350
Fertilizer						7		212		3	324		539	546
Manufacturing			1			94				99	433	30	562	657
Extraction						9				27	3		30	39
Transport								573	269	632	3	364	1841	1841
Total Domestic Consumption		0	1			257	149	949	546	2362	1068	356	5431	5689
Increase in Stock			0				0	0	0	0	0	133	133	133

WORLD HEAVY CRUDE AND TAR SANDS SURVY

1 JANUARY 1984 SYRIA

Fields	Layer	Original Oil in place Geological 10^6 M^3	Able to produce 10^6 M^3	Production: 31.12.1983 Cumulative year produ-ation 10^3 M^3	Production: Annual Production 10^3 M^3/983	Depth	Gravity API	Viscosity. CP/Co 20°C	Recovery Methods
Hamzoh	Massive	18.7	6.2	1600.379	259.296	2000	20	300	Pumping
Alian	Massive	6.3	0.95	444.579	40.158	1800	19	350	Pumping &
	Sheranich	14.3	1.00	339.881	42.881	1700	20	350	Flow
Zouraba & Saied	Scheranich	256	7.7	12.350	12.350	1500	13	1000-4000	Pumping
Aoda	Scheranich	74.7	1.5	12,211	11.439	1600	14	3000	Pumping & Flow
Deriek	Massive	5.7	0.17	9,783	6.989	2500	18	1300	Pumping
Lielak	Massive	10.2	0.5	1.642	1.642	2000	19	600	Pumping
Jbeseh	Jreibi	62.8	8.2	1424.6	201.066	600	18	1300	Pumping
	Chelo	14.3	4.0	829 .3	91.725	800	17	4800	&
	Jdaleh	5.9	1.6	513.8	114.000	1805	17	-	
	Shirahnish	8.1	0.41	17.9					Flow
Techrien	Chelo	34	1.7	0.870	0.870	300	18	7500	Pumping
	Jadaleh	9	1.2	0.335	94.350	1000	18	3300	&
	Shirahnish	17.1	1.74	19.024	19.024	1500	18	3800	Flow
Salhia	Cholo	1.6	0.162	12.616	10.291	800	16	-	Pumping
Soufaiuh	Korochini dolomite	21.35	2.135	40.388	40.388	1800	16	3000	Pumping
Wahhab	Korachini dolomite	9.55	0.48	-	-	1800	16	20.000	-
Karatchok	Massive Kamshouka	162.8	[illegible]	[illegible]	1479.704	2000	20	[illegible]	Pumping
Hadran	Massive	1.8	0.035	6.370	2.431	1800	12-15	2635	Pumping
TOTAL		724.4	[illegible]	23480. 955	2428.604				

PETROLEUM GEOLOGY OF SYRIA

I. Petroleum Geological Summary

The surface area of Syria measures some 180,000 km^2, most of which is underlain by sedimentary rocks which are favorable for the generation of oil and gas. Yet there are wide variations in the prospectivity of the different areas, which can be explained by differences in the geological processes which affected the various regions. The following macrogeological plays can be distinguished:

(1) The northeast of the country is part of the Mesopotamian basin, which contains prolific oil and gas fields in Iraq and the other Gulf states. In Syria, the structural complexes of Souedie and Karatchok belong to this oil province.

(2) The Euphrates depression is a graben-like feature which extends southeast from Der-el-Zor into Iraq. The area has a low exploration density. Recently a large discovery has been made at Thayyem (some 10 km of Der-el-Zor); it is expected that exploration activities will sharply increase as a result.

(3) The Mesopotamia foredeep and the Euphrates basin are separated by a structurally high area, the Rawda uplift. This unit can be followed eastward into Iraq, where it plunges towards the Tigris River. The Rawda uplift is characterized by a thin Triassic/Jurassic section and poor development of caprock; its oil and gas potential is limited.

(4) Syria shares another large uplift with Jordan/Iraq in the south. The Rutba uplift is characterized by thin sequences of Mesozoic rocks, but the underlying Paleozoic measures several thousand meters consisting mainly of sands/conglomerates and sandy shales. These sediments appear to be lacking in source rocks and good reservoirs. At present this is considered the least prospective area on Syrian territory.

(5) In the southwestern part of the country, the Jebel Arab depression trends south-southeast into Jordan/Saudi Arabia. SPC geologists have reason to believe that this feature is similar to the prospective Euphrates depression. Deep wells on Jordan territory indeed penetrated Triassic sequences similar to those at Thayyem and Al Furat. Recently, NRA (Natural Resources Authority, the Jordan Petroleum Authority) discovered oil in minor quantities in the Azraq area, some 120 km southeast of Amman.

(6) Syria shares with Lebanon complex structures of the Africa/Levant rift system which extends north-northeast into Turkey. The trend is characterized by complex geology; prospectivity for oil and gas is probably low.

(7) In the northern part of the country a geologically high area, the Mardin uplift, so predominant in Turkey, extends into Syria. The stratigraphgic record is incomplete; much of the hydrocarbons if indeed present were probably lost due to the presence of many faults/unconformities.

(8) Two important plays are confined in Syria, the Palymride mountain system and associated basins (Doud depression and Homs depression) and the Aleppo uplift. In the Palmyride area important finds of gas recently were made; in the Aleppo area heavy oil accumulations have been discovered. This area is also known for extensive surface tar deposits.

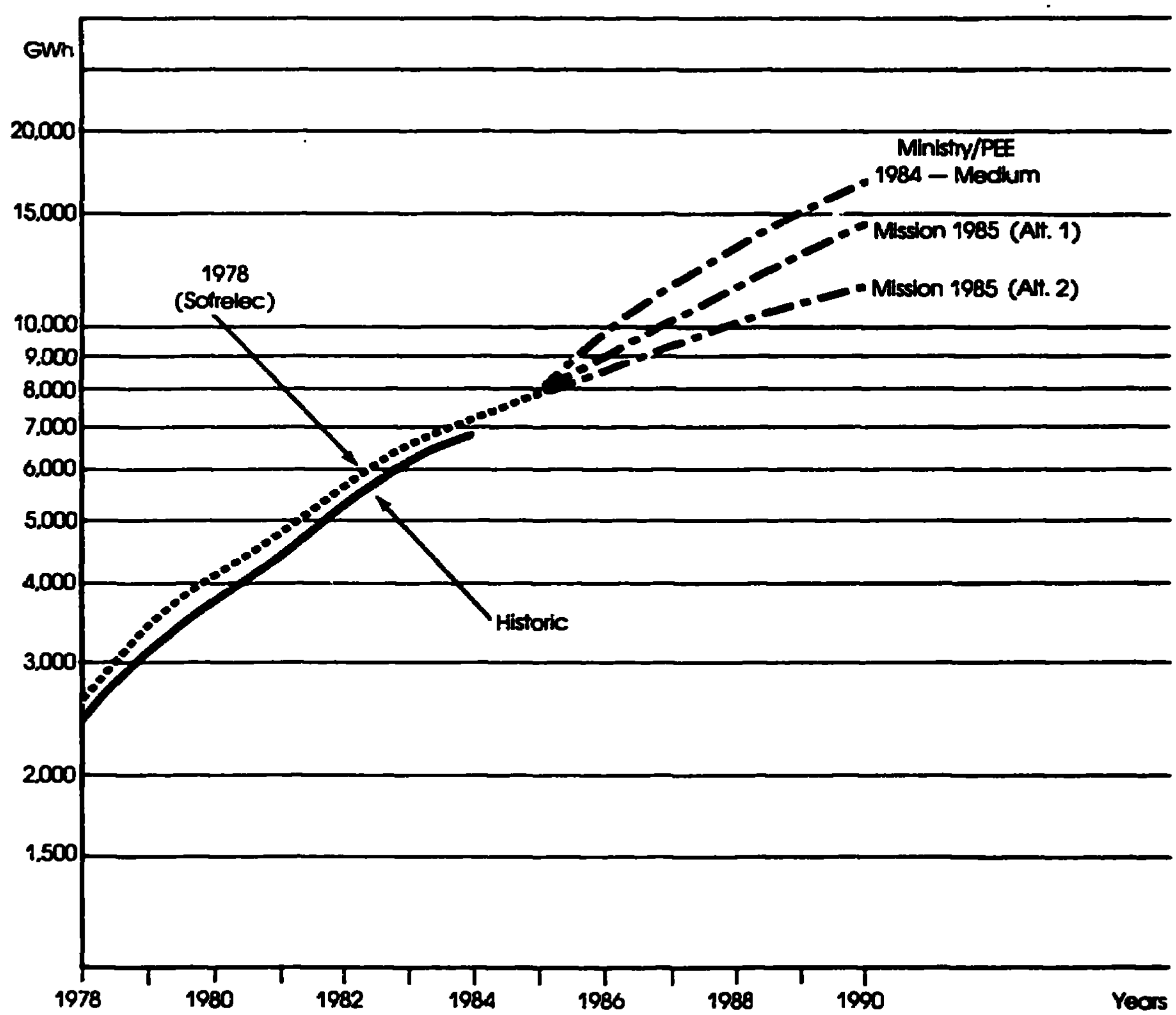
Annex 5

INCOME AND PRICE ELASTICITIES
(t-statistics in parenthesis)

Dependent Variable	Income: GDP	Income: GDP per capita	Real Price: Fuel Price	Real Price: Price Ratio
A. Electricity Sales (Domestic, comm., small industry) per consumer				
Eq 1)		1.44 (7.2)		
Eq 2)	0.75 (11)			
Eq 3)		1.1 (4.3)	-0.4 (-1.9)	
Eq 4)	0.63 (7.0)		-0.30 (-1.9)	
B. Large Industry Electricity Sales	3.0 (8.8)		0 0	
C. Consumption of Gasoline (70 to 84)	1.26 (6)		-.33 (4)	
D. Consumption of LPG and household kerosene	0.72 (5.4)			
E. Consumption of LPG				
Eq 1)				(kero/LPG) 1.0 (11)
Eq 2)	1.34 (4)		.45 (3.0)	

Note: Elasticity is defined as: percentage change in dependent variable divided by percentage change in independent variable (income and/or price). Elasticity estimates were based on time series of Syrian consumption, income and real price data. If the t-statistics are greater than 2.0, this indicates a statistically significant elasticity estimate.

SYRIA PUBLIC ELECTRICITY ESTABLISHMENT
VARIOUS GENERATION FORECASTS AND ACTUALS



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PUBLIC ELECTRICITY ESTABLISHMENT
HISTORIC AND FORECAST SALES, GENERATION AND MAXIMUM DEMAND

	Sales				Losses	Generation	Maximum Demand	Load Factor
	Domestic	Government	Industry	Total				
	GWh						MW	(%)
Historic								
1974	352	75	508	935	197	1,132	214	60.3
1975	442	99	566	1,107	246	1,353	245	63.0
1976	541	110	653	1,320	308	1,628	340	54.7
1977	615	135	828	1,578	431	2,009	409	56.1
1978	745	176	893	1,792	647	2,439	511	54.4
1979	955	230	1,240	2,389	825	3,114	638	55.7
1980	1,078	236	1,425	2,739	24.69	3,637	768	54.1
1981	1,231	282	1,608	3,121	28.71	4,378	876	57.1
1982	1,471	333	1,938	3,649	1,651.39	5,300	1,070	56.5
1983	1,632	432	2,211	4,213	2,007.24	6,220	1,174	55.5
1984	1,995	403	2,463	4,678	2,168.34	6,847	1,324	59.0

PUBLIC ELECTRICITY ESTABLISHMENT
HISTORIC AND FORECAST SALES, GENERATION AND MAXIMUM DEMAND

	Sales						Maximum	Load
	Domestic	Government	Industry	Total	Losses	Generation	Demand	Factor
	GWh						MW	(%)
Alternative 1 Forecast								
1985	2,344 a/	456 c/	2,869 e/	5,669 g/	2,205 h/	7,874 i/	1,571	57.2 j/
1986	2,731	514	3,314	6,559	2,426	8,985	1,783	57.5
1987	3,154	577	3,795	7,526	2,644	10,170	2,009	57.8
1988	3,612	644	4,307	8,563	2,854	11,417	2,243	58.1
1989	4,099	717	4,845	9,661	3,051	12,712	2,485	58.4
1990	4,491	793	5,523	10,807	3,228	14,035	2,729	58.7
1991	5,142	874	5,970	11,986	3,381	15,367	2,973	59.0
1992	5,682	959	6,533	13,174	3,716	16,894	3,269	59.0
1993	6,221 b/	1,047 d/	7,093 f/	14,361	4,050	18,411	3,562	59.0
1994	6,812	1,143	7,696	15,651	4,414	20,065	3,882	59.0
1995	7,809	1,249	8,350	17,408	4,461	21,869	4,131	59.0
1996	8,168	1,363	9,060	18,591	5,244	23,835	4,612	59.0
1997	8,944	1,489	9,830	20,263	5,714	25,978	5,026	59.0
1998	9,793	1,626	10,665	22,084	6,229	28,313	5,478	59.0
1999	10,723	1,775	11,572	24,070	6,789	30,859	5,971	59.0
2000	11,742	1,939	12,556	26,237	7,400	33,637	6,508	59.0

a/ 17.5% over 1984, annually decreasing by 1% until 9.5% is reached in 1993 over 1992.
b/ Annual growth 9.5% until 2000.
c/ Assumed 13% over 1984, annually decreasing by 0.5% until 9.2% is reached in 1993.
d/ Annual growth 9.2% until 2000.
e/ 16.5% over 1984, annually decreasing by 1% until 8.5% is reached in 1993.
f/ Annual growth 8.5% until 2000.
g/ Sum of individual sales.
h/ Assumed to decrease from 29% in 1984 (31% in 1983) by 1% annually, to 22% in 1991, comprising 7% in station requirements and 15% network losses.
i/ Total of sales plus losses.
j/ Plus 0.3 over average of 1974 through 1984, increasing 0.3 annually until 1991, constant thereafter.

Annex 8

DATA ON ONGOING AND PLANNED GAS PROJECTS IN SYRIA

Project 1: Rumeilan - Associated Gas

(a) Began in 1984.

(b) Raw gas composition

Methane and ethane	70%
Propane	11.5%
Butane	6%
Pentane	2.5%
Hexane	1.4%
H_2S	2.7%

(c)

Raw gas production	660,000 m^3/day	= 0.241 BCM/Y	= 25 MMCFD
Flared (20%)	-132,000 m^3/day	= -0.048 BCM/Y	
Sales Gas	500,000 m^3/day	0.182 BCM/Y	= 19 MMCFD
LPG	130 t/day	47,450 t/yr	
S		20 t/day	
C_5t	30 t/day		

(Sales gas is to be used for 3 gas turbines (moved from Homs) + 3 new gas turbines.)

(d) Investment Cost $60 million.

Project 2: Jibesse Non-Associated Gas to Homs

(a) Non-Associated Gas, planned to start delivery to Homs in 1986.

(b)

Raw Gas	1,700,000 m^3/day	= 0.62 BCMY	= 64 MMCFD
Sales Gas	1,400,000 m^3/day	= 0.511 BCMY	= 53 MMCFD

to Homs to substitute for 306,000 tons/yr naphtha (330 days/yr) design capacity beginning in 1986.

LPG	70 tons/day	= 25,550 tons/yr
S	50 tons/day	= 18,250 tons/yr
CO_2	30 mill m^3/yr	= 0.030 BCMY

(c) Investment Cost

Gas Production	185	
Treatment Plant	89	(+2 mill/yr for operating cost)
Pipelines		
Jebisse to T3 point on Iraq pipeline	34	
T3-T4	11	
T4-Homs	2	
	321	

(d) Pipeline 16", gas inlet pressure 57 Kg/cm^2, outlet pressure 17 Kgc^2.

GAS DEVELOPMENT

For capital investments of US$639 million from 1985 until 1990 and US$313 million until 1995 the net present value is US$2.6 billion (the internal rate of return is over 43% and payback time is five years).

Year	Investment ($ million)	Operating Cost ($ million/yr)	BCM/Y	Revenue (at $3.5/MCF)	LPG Vol (th Tons)	LPG Revenue ($/t 200)	Total Costs	Total Revenue	Revenue Minus Costs	Cumlative Cash Flow ($ million)	Net Present Value (million dollars)
1985	6						6	0	- 6		-at 10% 2587
1986	97	1					98	0	-98	-104	-at 20% 713
1987	216	5	0	10	62	12	221	22	-198	-302	-at 30% 200
1988	210	16	0	22	125	25	226	47	-178	-480	
1989	70	27	1	195	167	33	97	229	132	-348	
1990	40	30	2	279	177	35	70	314	244	-103	
1991	96	32	2	331	193	38	120	370	242	138	
1992	107	37	3	434	217	43	144	478	334	472	
1993	40	42	3	513	225	45	82	558	476	948	
1994	40	44	4	565	276	55	84	620	536	1404	
1995	30	46	4	610	291	58	76	669	593	2078	
1996	0	48	5	708	333	66	48	775	727	2805	
1997	0	48	5	708	345	69	48	777	729	3535	
1998		48	5	708	367	73	48	782	734	4269	
1999		48	5	708	377	75	48	784	736	5006	
2000		48	5	708	377	75	48	784	736	5742	
2001		48	5	708	377	75	48	784	736	6478	
2002		48	5	708	377	75	48	784	736	7214	
2003		48	5	708	377	75	48	784	736	7951	
2004		48	5	708	377	75	48	784	736	8687	
2005		48	5	708	377	75	48	784	736	9423	
2006		48	5	708	377	75	48	784	736	10160	
2007		48	5	708	377	75	48	784	736	10896	
2008		48	5	708	377	75	48	784	736	11632	

PRODUCT PRICES IN THE EAST MEDITERRANEAN, 1982-1985

East Med. Prices, $/ton

Product:	Naphtha	Premium Gasoline	Regular Gasoline	Kero*	Gas Oil	Fuel Oil **	Fuel Oil ***
jan 82	298.40	330.75	320.75	345.15	316.17	185.80	162.65
feb	273.55	309.90	299.90	340.10	285.55	179.69	161.90
mar	255.30	281.55	271.55	305.20	263.75	176.00	159.65
apr	271.60	310.00	300.00	286.90	277.80	177.05	162.00
may	317.55	352.10	342.10	306.70	298.25	183.10	168.20
jun	317.30	353.05	343.05	306.75	285.65	181.40	167.00
jul	288.25	330.90	320.90	295.90	274.25	172.40	162.65
aug	295.25	329.95	319.95	306.40	287.55	170.55	154.10
sep	300.30	345.60	335.60	328.35	307.90	178.75	164.00
oct	296.10	338.95	328.95	333.05	311.60	187.85	171.90
nov	277.70	312.45	302.45	328.85	296.00	184.00	161.90
dec	278.15	285.45	275.45	298.90	285.45	175.30	159.25
jan 83	288.20	287.35	277.35	297.00	274.80	171.90	161.70
feb	262.45	263.00	253.00	279.00	241.20	156.20	151.70
mar	245.50	269.45	259.45	261.55	235.05	156.80	156.50
apr	276.85	303.15	293.15	266.05	246.65	161.20	161.15
may	270.05	300.95	290.95	265.80	237.25	169.60	161.45
jun	279.85	308.50	298.50	269.45	243.90	173.75	156.65
jul	282.10	302.05	292.05	269.95	239.80	175.10	160.70
aug	287.45	302.20	292.20	278.50	250.70	177.75	168.75
sep	276.25	284.40	274.40	286.20	245.40	177.75	164.95
oct	270.10	281.15	271.15	281.00	247.20	178.80	168.85
nov	260.90	283.50	273.50	289.35	248.95	177.55	168.70
dec	245.40	269.15	259.15	281.40	248.50	173.40	167.05
jan 84	251.31	260.60	256.14	275.40	254.43	178.52	170.67
feb	251.90	259.58	249.58	279.00	253.65	185.28	171.25
mar	257.09	279.39	269.39	275.73	252.82	184.34	176.55
apr	255.53	275.74	265.74	265.47	245.47	185.79	183.43
may	254.39	271.39	261.39	265.64	239.80	184.23	181.89
jun	247.90	267.29	257.29	267.60	232.81	181.45	177.05
jul	236.60	257.83	247.83	257.24	222.43	179.50	172.55
aug	236.90	255.82	245.82	239.30	224.89	179.50	171.80
sep	238.50	259.13	249.13	247.60	231.79	179.92	174.71
oct	237.55	252.82	242.82	246.95	231.57	182.43	177.75
nov	230.94	248.82	238.82	250.58	229.23	181.93	176.65
dec	222.08	236.64	226.64	249.25	222.92	179.83	176.05
jan 85	218.43	226.61	217.32	254.20	231.50	183.05	178.91
feb	221.47	234.92	224.92	258.26	244.29	185.13	183.11
mar	227.15	241.10	231.10	261.00	238.30	175.95	171.85

* Jet Fuel/Kerosene

** Low Sulfur Fuel Oil (0.3% S)

*** High Sulfur Fuel Oil (3.5% S)

SYRIA

Public Electricity Establishment
Existing Generating Plants

Existing Generating Plants	1984 (Historic)	1985	1986	1987	1988	1989	1990 through 1995
(a) Hydro							
Souk Wadi Barada (6 MW) neglect 1/							
Rastan (8 MW) neglect 2/							
Thawra (800 MW)	720	720	720	720	720	720	720
Subtotal	720	720	720	720	720	720	720
(b) Steam							
Banias (2 x 170 MW)	340	340	340	340	340	340	340
Mehardeh (2 x 150 MW)	300	300	300	300	300	300	300
Kattinah (110 MW, 140 MW 1986) 3/	110	110	140	140	140	140	140
Hamah (25 MW, 35 MW 1986, 30 MW 1990) 4/	25	25	35	35	35	35	35
Ein Tell (15 MW, 10 MW 1987, 0 MW 1990) 5/	15	15	10	10	10	10	--
Subtotal	790	790	830	825	825	825	810
(c) Nuclear							
None	--	--	--	--	--	--	--
(d) Gasturbines Various locations (210 MW all., 140 MW 1988, 70 MW 1989, 0 MW 1990)	210	210	210	210	140	70	--
(e) Imports							
None	--	--	--	--	--	--	--
(f) Captive Plant Assistance							
None specifically known	--	--	--	--	--	--	--
Total existing plant - available capacity	1,720	1,720	1,760	1,755	1,685	1,615	1,530
Largest unit existing plant	170	170	170	170	170	170	170

1/ 2 x 3/5, 6 MW all., seasonal.
2/ 2 x 4 MW, run of river.
3/ One boiler of 30 MW unit under repair, completion July 1986
4/ Cooling water improvements will add 10 MW before end 1986.
5/ Ein Tel -- phased retirement.

PUBLIC ELECTRICITY ESTABLISHMENT IDENTIFIED FUTURE GENERATION PLANT

Identified Future Generating Plants		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994 Through 2000
(1) Hydro											
Baath (3 x 25 MW) a/	Jan. 1986		50	50	50	50	50	50	50	50	50
Raising Thawra Dam (4m) b/	Jan. 1986,										
Tichreen 4 x 100 MW	1992 -1993		--	--	--	--	--	--	180	360	360
Subtotal			50	50	50	50	50	50	230	410	410
(2) Steam											
Mehardeh 3 150 MW c/	Mar. 1987			150	150	150	150	150	150	150	150
Mehardeh 4 150 MW c/	Jan. 1987			150	150	150	150	150	150	150	150
Banias 3 170 MW d/	Dec. 1987			170	170	170	170	170	170	170	170
Banias 4 170 MW d/	Mar. 1988			170	170	170	170	170	170	170	170
Kathreh 64 MW	Dec. 1988					60	60	60	60	60	60
Nabil 1 (Damascus) 200 MW e/	Mar. 1989				200	200	200	200	200	200	200
Nabil 2 200 MW e/	Sept. 1989					200	200	200	200	200	200
Rabil 3 200 MW e/	Mar. 1990 k/						200	200	200	200	200
Nabil 4 200 MW e/	Jan. 1991 k/						200	200	200	200	200
Subtotal				640	840	900	1,500	1,500	1,500	1,500	1,500
(3) Nuclear f/											
Unit 1 (440 MW)	Jan. 1993 k/									400	400
Unit 2 (440 MW)	Jan. 1994 k/									---	800
Subtotal										400	800
(4) Gasturbines g/											
Souedie (150 MW)	Jan. 1987			150	150	150	150	150	150	150	150
Jablsse (150 MW) h/	Dec. 1988 k/			---	150	150	150	150	150	150	150
Homs (150 MW) h/	Jan. 1987/89 k/			150	150	300	300	300	300	300	300
Subtotal				300	450	600	600	600	600	600	600
(5) Import											
Lebanon i/	Dec. 1985	100	100	100	50	50					
(6) Captive Plant Assistance j/											
Paper Factory (25 MW)	Dec. 1985	20	20	20							
Sugar Factories (4 x 6 MW)	Dec. 1985	15	15	15							
Banias Refinery (10 MW)	Jan. 1985	--	5	5	5						
Homs Refinery (2 x 25 MW)	July 1986	--	20	20	20						
Gas turbines Souedie (85 MW)	Jan. 1986		60	60	60						
Subtotal		35	120	120	85						
Total Identified Plant		135	270	1210	1,475	1,600	2,150	2,150	2,330	2,910	3,310
Largest Unit				170	200	200	200	200	200	400	400

a/ Generating plant (3 x 25 MW) at Thawra's regulating dam being constructed; effective capacity 50 MW, generating 12% of Thawra generation.
b/ Theoretically, the capacity increase for raising the dam by 4m, would be about 10%, however this cannot occur in December during peak season.
c/ Contract signed.
d/ Bids opened.
e/ Contract signed for 2 units, further 2 units could be added. The additional units could be steam or combine cycle gas turbines based on gas.
f/ Although site alternatives are still being studied, plant expected to be completed by 1992/93 or 1994/95 depending on views of officials; 1993/1994 was used here; assumed effective capacity 400 MW per unit.
g/ Souedie bid documents are being prepared.
h/ Proposed by mission based on gas.
i/ A new power station (3 x 145 + 170 MW); north of Beirut is nearing completion and 100 MW is expected to be available for Syria by the end of 1985.
j/ Information Ministry Electricity (target capacities). Ministry of Petroleum is transferring 85 MW in gasturbines to Souedie, effective capacity 60 MW.
k/ Not yet committed.

Annex 12

PUBLIC ELECTRICITY ESTABLISHMENT
BALANCE OF CAPACITIES AND ENERGIES
ALTERNATIVE 1 AND 2 FORECASTS

Balance of Capacities (Alternative 1 Forecast)	1984 Historic	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Maximum Demand, MW	1,324	1,571	1,783	2,009	2,243	2,485	2,729	2,973	3,289	3,562	3,882	4,131	4,612	5,026	5,478	5,971	6,508
To be met by:																	
Hydro																	
Souk Wadi Barada; Rastan Neglect																	
Thawra	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
Raising Thawra Dam																	
Baath			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Tichreen									180	360	360	360	360	360	360	360	360
Subtotal	720	720	770	770	770	770	770	7.0	950	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Steam																	
Hamah, Ain Tell	40	40	50	45	45	45	30	30	30	30	30	30	30	30	30	30	30
Kattinah	110	110	140	140	200	200	200	200	200	200	200	200	200	200	200	200	200
Mehardeh	300	300	300	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Banias	340	340	340	510	680	680	680	680	680	680	680	680	680	680	680	680	680
Nabil						400	600	800	800	800	800	800	800	800	800	800	800
Subtotal	790	790	830	1,295	1,525	1,925	2,110	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310
Nuclear a/										400	800	800	800	800	800	800	800
Gasturbines	210	210	210	360 (210+150)	440 (140+300)	670 (70+600)	600	600	600	600	600	600	600	600	600	600	600
New Stations - Steam or CCGT b/																	
Location A							200	400	800	800	800	1,200	1,200	1,200	1,200	1,200	1,800
Location B													600	1,200	1,200	1,200	1,200
Location C															600	1,200	1,800
Import		100	100	100	50	50											
Captive Plant Assistance		35	120	120	85												
Total Available Capacity	1,720	1,855	2,030	2,645	2,870	3,415	3,660	4,080	4,660	5,240	5,640	6,040	6,640	7,240	7,840	8,440	9,040
Target Available Capacity	1,758	2,048	2,298	2,563	2,838	3,159	3,446	4,115	4,525	4,930	5,323	5,718	6,383	6,956	7,582	8,264	9,008
Plant Margin																	
Current, MW	396	284	247	636	627	930	751	1,507	1,391	1,678	1,758	1,909	2,028	2,214	2,362	2,469	3,132
Target, MW	434	477	515	554	595	674	717	1,142	1,236	1,368	1,491	1,587	1,771	1,930	2,106	2,293	2,500
Current-% of Available Capacity	23	15	12	24	20	26	20	35	29	31	30	31	30	30	30	29	32
Target-% of Available Capacity	25	26	25	21	21	20	21	26	27	26	27	27	27	27	27	27	26
(Shortfall) or Surplus																	
MW	(38)	(193)	(268)	82	(32)	256	234	(30)	135	310	267	322	257	284	258	176	632
% of Current Available Capacity	(2)	(11)	(13)	3	(1)	6	(1)	7	2	5	5	4	3	3	3	2	6

a/ Not required under Alternative 2.
b/ Deferred by five years under Alternative 2.

PUBLIC ELECTRICITY ESTABLISHMENT
BALANCE OF CAPACITIES AND ENERGIES
ALTERNATIVE 1 AND 2 FORECASTS

Balance of Energies (Alternative Forecast)	Hours of Operation at Capacity is less than:	1984 Historic	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Maximum Demand MW		1,324	1,571	1,783	2,009	2,243	2,485	2,729	2,973	3,269	3,562	3,882	4,131	4,612	5,026	5,478	5,971	6,508
Load Factor %		59.0	57.2	57.5	57.8	58.1	58.4	58.7	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0
Gross Generation Required GWh		6,848	7,874	8,985	10,170	11,417	12,712	14,035	[illegible]	16,894	18,411	20,065	21,065	23,835	25,978	28,313	30,899	33,637
Supplied by:																		
Hydro																		
Small Wadi, Barada, Rastan			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Thawra Complex			1,900	2,300	3,160	3,110	2,810	2,760	2,710	2,660	2,610	2,560	2,510	2,460	2,410	2,360	2,310	2,260
Tichreen										650	1,260	1,240	1,220	1,200	1,180	1,160	1,140	1,120
Subtotal Hydro		1,928	1,950	2,350	3,210	3,160	2,860	2,810	2,760	[illegible]	3,920	3,850	3,780	3,710	3,640	3,570	3,500	3,430
Steam																		
Hamah, Ain Tell	5000/Zero	250	200	250	225	225	190	150	150									
Kattineh	5000	500	550	700	700	700	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Mahardeh	5000	1,446	1,500	1,500	1,850	2,600	3,000	3,000	3,000	2,940	2,776	2,836	2,776	2,745	2,705	2,664	2,658	2,609
Banias	5000	1,092	1,700	1,700	1,800	2,500	3,400	3,400	3,400	3,331	3,145	3,215	3,146	3,112	3,066	3,020	3,015	2,957
Habil (Damascus)	5000					1,000	1,000	2,000	2,850	3,327	3,700	3,782	3,702	3,661	3,607	3,552	3,545	3,479
Subtotal Steam		4,248	3,950	4,150	4,575	7,025	8,250	9,250	10,100	10,484	9,621	9,621	9,621	9,621	9,621	9,621	9,621	9,621
(Capability)		(3,950)	(3,950)	(4,150)	(4,575)	(7,025)	(8,550)	(9,550)	(10,400)	(12,000)	(12,000)	(12,000)	(12,000)	(12,000)	(12,000)	(12,000)	(12,000)	(12,000)
Nuclear a/	5700										570	2,000	3,700	4,560	4,560	4,560	4,560	4,560
Gas Turbines b/		722 a/	1,050	1,050	1,350	1,850	1,802	2,525	1,507	600	600	600	600	600	600	600	600	600
(Capability)	5000	(1,050)	(1,050)	(1,050)	(1,850)	(2,200)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)
New Stations - Steam/CCGT																		
Location A	5000								1,000	2,450	3,700	3,782	4,165	4,760	5,410	5,329	5,317	5,870
Location B	5000													687	2,390	4,352	5,317	5,218
Location C	5000															666	2,349	4,916
Import (Export)	6000	(50)	100	800	600	300	500											
Captive Plant Assistance	1000		35	120	120	85												
Total Generation, GWh		6,848	7,089	8,270	9,655	11,420	12,712	14,035	15,567	16,894	18,411	20,065	21,065	23,835	25,978	28,313	30,899	33,637
(Deficit) in Average c/			(789)	(715)	(315)	no problems in subsequent years												
Water Year, GWh			(10%)	(10%)	(3%)													

a/ Not required under Alternative 2.
b/ Deferred by five years under Alternative 2.
c/ No deficit for 1988/89 under Alternative 2.

ELECTRICITY TARIFFS

1. This annex describes the recent evolution of electricity tariffs in Syria. Current tariffs are below operating costs for all categories of consumers. The distortions in the present structure of tariffs are greatest in the large industry categories.

2. No current long run marginal cost (LRMC) study is available. It is recommended that a tariff study based on LRMC be completed to evaluate the appropriate levels for various classes of consumers. Accounting cost data from PEE are described in the following analysis. In generation systems similar to the Syrian system accounting costs can provide a rough guide to LRMC in the absence of a detailed LRMC study. Current tariffs would have to be increased 75% to 80% to break even with average accounting cost. The more efficient use of time of day pricing could improve the low load factor and reduce peak demand. In the cement industry 100 MW of peak load could be reduced and up to 300 MW overall, particularly in water supply for irrigation. Steps should be taken immediately to introduce effective time of day pricing.

I. Recent Evolution of Tariffs

3. Prior to the construction of the 230-kV system, PEE's tariff system comprised a number of sub-systems, different for groups of regions and groups of consumers. All tariffs were "flat rates" (i.e., there were no capacity-related charges) with block rates for smaller industrial and commercial consumers and time of the day rates for larger industry.

4. Under Loan 986-SYR a tariff study was completed in 1977 but never implemented. Indirectly, however, the study had some impact because the recommendation to simplify the structure and rates was followed. With the growth of the 230-kV transmission, isolated regions disappeared which contributed to setting uniform rates throughout the country. At the time a rate increase implemented in July 1980, the tariff structure was simple and consistent. Attachment 1 gives the structure and rates applying as of January 1, 1985; the schedule is basically the same as it was in 1980, except that a fourth blockrate (over 300 kWh/m) has been added for the domestic and commercial class, while hotels and similar were reassigned to the commercial category exclusively, irrespective of type of supply and voltage. Otherwise, the rates remained unchanged in nominal terms since the 1980 increase. The changes will probably not increase revenue in excess of 7%.

5. As can be observed, all rates are still flat, although triple kWh-meters installed for time of the day metering are all provided with maximum demand indicators. However, only some 50% of the industrial connections (out of 36,000) for which a triple meter would be warranted, have been provided with time of the day metering. That the number is not higher may in part be due to the fact that the clocks of the meters are of the synchronous type with spring-wound reserve; because curtailments

and interruptions are quite common and frequency control is manual and unreliable, the physical requirements for adjusting the clocks, gradually becomes prohibitive. This situation may get worse in the next few years, when load shedding may be the order of the day.

6. In 1984 average revenue for the sale of electricity was about SL 0.26/kWh. As a measure of the total inadequacy of the rates, this average revenue can be compared with the total cost of fuel (SL 1,185 million for the year) per kWh of sales (4,910 GWh), amounting to SL 0.24/kWh. In 1-2 years total cost of fuel alone can be expected to exceed total revenues for the sales of electricity.

7. The cash operating cost for each of the generating plants have been derived on the basis of average plant capabilities by PEE in 1984 as follows:

Plant a/	Generation Capability	Cash Operational Cost		Total Cost MSL
	(GWh)	(SL/kWh)	(% Fuel)	
Hydro				
Thawra	2,200	0.03		66
Souk Wadi Barada	24	0.12		3
Rastan	14	0.12		2
Shezar	2	0.50		1
Steam				
Ain Tell	125	0.50	(83)	63
Hameh	175	0.30	(82)	53
Kattineh	750	0.28	(86)	210
Mehardeh	1,450	0.24	(82)	348
Banias	1,700	0.24	(82)	408
Gas turbines	780	0.60		468
Total	7,220	0.23		1,622

a/ The diesel capacity still operating has been omitted.

8. Accounting cost at the various voltage levels, in accordance with PEE information, is as follows:

	SL/kWh
Power plants	0.24
230 kV	0.27
66 kV	0.32
20 kV	0.39
20/0.4 kV (direct supply)	0.41
0.4 kV	0.53

The breakdown of sales between the 230 kV and 66kV level and between the 20 kV and 20/0.4kV level is given below. Using the average costs given above, the following revenue would have been required in 1984 in order to meet costs.

1984	Sales (GWh)	Average Cost (SL/kWh)	Required Revenue (million SL)
230 kV,66 kV	1,221	0.295	360
20 kV,20/0.4kV	1,059	0.40	424
0.4 kV	2,581	0.53	1,367
Total	4,861	0.43	2,151

Because 1984 revenues were SL 1,210 million, the required rate increase on the basis of accounting tariffs would have to be in the order of 75% to 80% if "other revenue" is neglected. The above, unit costs of course, were averaged for a single year; in the longer term, without any rate increase, the percentage of the required increase can be expected to continue rising in view of the increasing share of thermal generation and corresponding rise in fuel consumption.

9. The net effect of the 1980 tariff structure and rates, and the real prices for electricity (the deflator is the wholesale price index) are shown in Attachment 2 to this annex.

(a) the rate increase in mid-1980 was reported to amount to 80%. In real terms, however, the average rose from 16.2 ps/kWh in 1979 to 18.6 ps/kWh by the end of 1981, or about 15% only.

(b) one of the major causes for this was that the price for "large industry," although rising by 30% (from 7.5 to 9.8 ps/kWh), did so from from too low a base; it pays only about half the cost it incurs in the 200-kV network (both in current and real 1980 prices);

(c) because the 1980 tariff structure changes introduced blockrates for domestic/commercial consumers, a significant increase in the average selling price could be expected for this category; but, as Attachment 2 shows, the rise was small and short-lived; this indicates that many commercial consumers must have been transferred to the small industry category;

(d) for the small industry category revenue jumped -- in real terms -- from 11.8 ps/kWh in 1979 to 26.3 ps/kWh or 122%. As a consequence, the consumers belonging to this category have borne the brunt of the rate. On the other hand, for consumers transferred from the domestic/commercial class to small industry, the relative increase was less onerous.

(e) comparisons between average costs at the various voltage levels and current tariffs show that the highest distortions are in large industry and in the domestic commercial category. The price, 21.5/kWh for 100 kWh, in domestic and commercial is almost the price charged to 20kV industrial customers in spite of the added distribution costs, higher contribution to the peak and non-negligible metering costs.

II. Seasonal and Daily Variations of Demand

10. Seasonal variations of demand are not very significant. Daily fluctuations, however, are rather pronounced with a daily load factor of about 70% and a ratio of Maximum/Minimum demand of more than 2/1, leading to an annual system load factor of 55-59%. The daily load curve (Wednesday, 11/14/1984) reproduced below shows three characteristic periods:

- A rather even daytime load period, hereafter called "shoulder period" starting between 7 and 8 a.m. averaging, on this day, 950 MW;

- A four to five hours evening peak period starting between 5 and 6 p.m. (between 6 and 7 p.m. in summer), with a demand about 250 MW above the shoulder period level;

- A night period of eight hours between 11 p.m. and 7 a.m., with an average demand between 12 p.m. and 6 a.m. of some 300 MW below the shoulder period level.

11. On Fridays the average daytime (off peak) level is reduced by 200-250 MW and the day-night difference is much less pronounced (around 100 MW); peak demand is reduced by about 200 MW (-16%) and as a result the evening peak is relatively sharper.

12. The flow of the Euphrates at Thawra is highly seasonal, ranging from 0.67 billion m^3 in September to 6.2 billion m^3 in April and May. Annual productible energy ranges from 1.6 TWh (97% probability) to 3.6 TWh (10% probability) with a median of 2.4 TWh. Maximum power is 800 MW (8x100 MW) to which the 3x25 MW Bauth station will be added in 1986 at the regulating dam under construction, and there is a minimum flow constraint corresponding to about 100 MW during the dry season. The attached load duration curve illustrates the utilization of generation equipments for a day (Wed, September 12, 1984) with hydro generation slightly below the annual average (5.1 MWh).

III. Opportunities for Demand Management through Tariffs

13. The load factor in Syria (55.57%) could certainly be improved by appropriate time of day tariff structure especially considering the expected weight of cement and water irrigation consumption in Syria, two sectors that are generally very responsive to TOD tariff incentives. If the cement sector alone was to supress its load at peak time, this would represent a reduction of some 100 MW and globally a reduction of 300MW could be a reasonable target. The present TOD tariff seems to be impaired by metering problems. It seems certain, however, that its implementation with appropriate meters could have some high payoffs and its effects would be reinforced by a raise of the tariff level. The application of the present tariff with appropriate metering could be reinforced, even before a global study of tariffs based on economic costs is performed. To insure the greatest efficiency the TOD tariff could be offered only as an option with consumers paying for their meters. Also special contractual agreement for off-peak or night operators of small pumps (where metering costs associted with TOD tariffs would become non-negligible) could be developed. Also tariff incentives for storage water heating (operating at night) could be looked for.

PUBLIC ELECTRICITY ESTABLISHMENT TARIFF STRUCTURE AND RATES
JANUARY 1985 a/
Piasters per kWh
(SL 1 = 100 piasters)

Group	I 230 kV	II 66 kV	III b/ 20 kV	IV c/ 20/0.4 kV Transformer
1 Average d/	10	12	20	25
2a Peak	14	15	24	29
2b Day 10	12	20	25	
2c Night	8	10	14	17

Group	V		VI
Monthly kWh Consumption	(a) Government at LT	(b) Domestic, Commercial at LT; Hotels, Restaurants at HT and LT	Streetlighting
1-50	19	19	
51-100	24	24	All: 15
101-300	35	35	
301 and over	35	55	

a/ The changes compared with the July 1980 schedule are:

(i) the block of 301 and over has been added to Group V, effectively splitting the group into Government (a) and Domestic/Commercial (b);

(ii) hotels and restaurants have been included in Group V (b), independent of the supply voltage; and

(iii) the minimum charge for group III was increased from 2,500 kWh/m and the minimum charge for group IV is a new feature.

b/ Minimum charge for group III: 10,000 kWh/m.

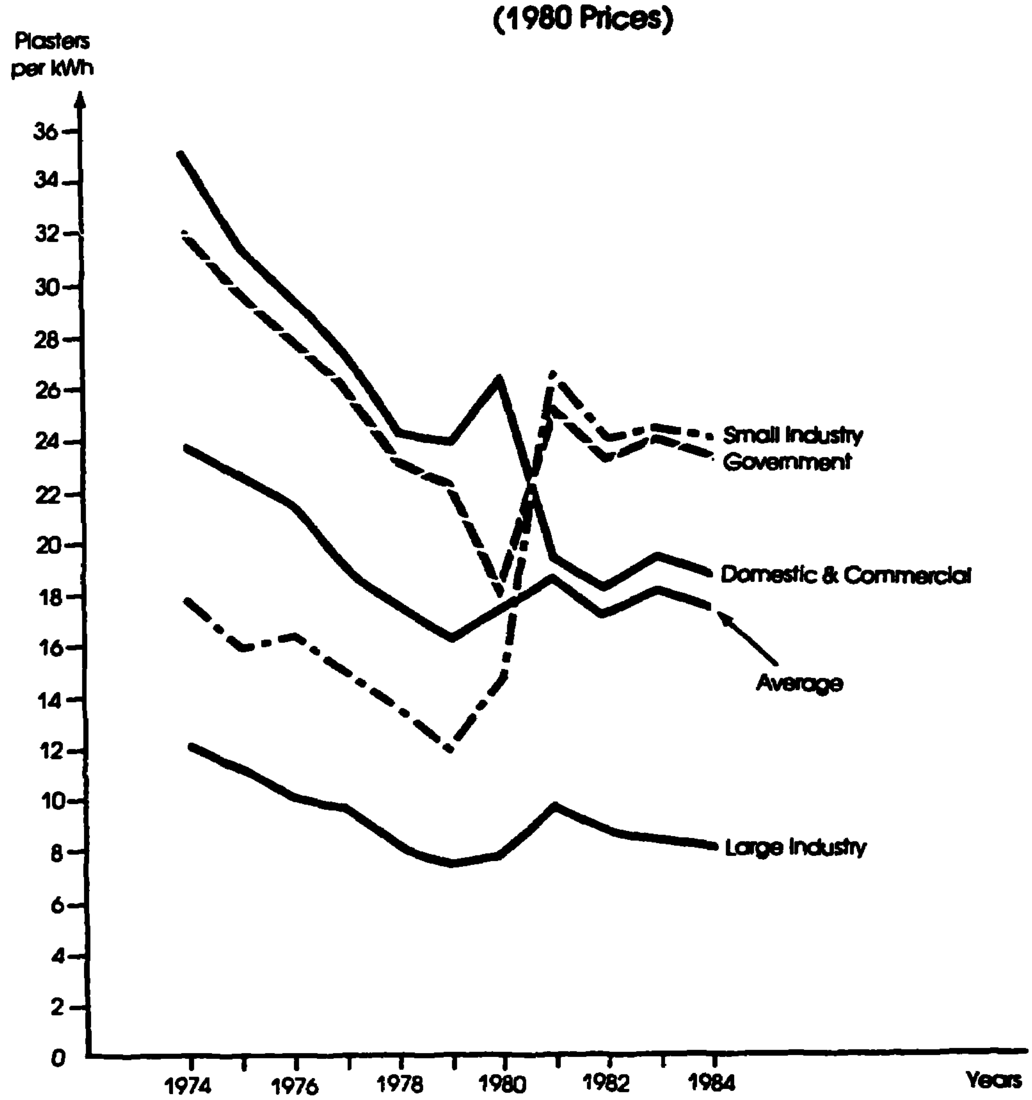
c/ Minimum charge for group IV: 380,000 kWh/m.

d/ The average (i.e., daytime rate) is applied if no triple kWh meter has been installed.

PUBLIC ELECTRICITY ESTABLISHMENT CURRENT AND REAL ELECTRICITY PRICES
(Piasters per kWh)

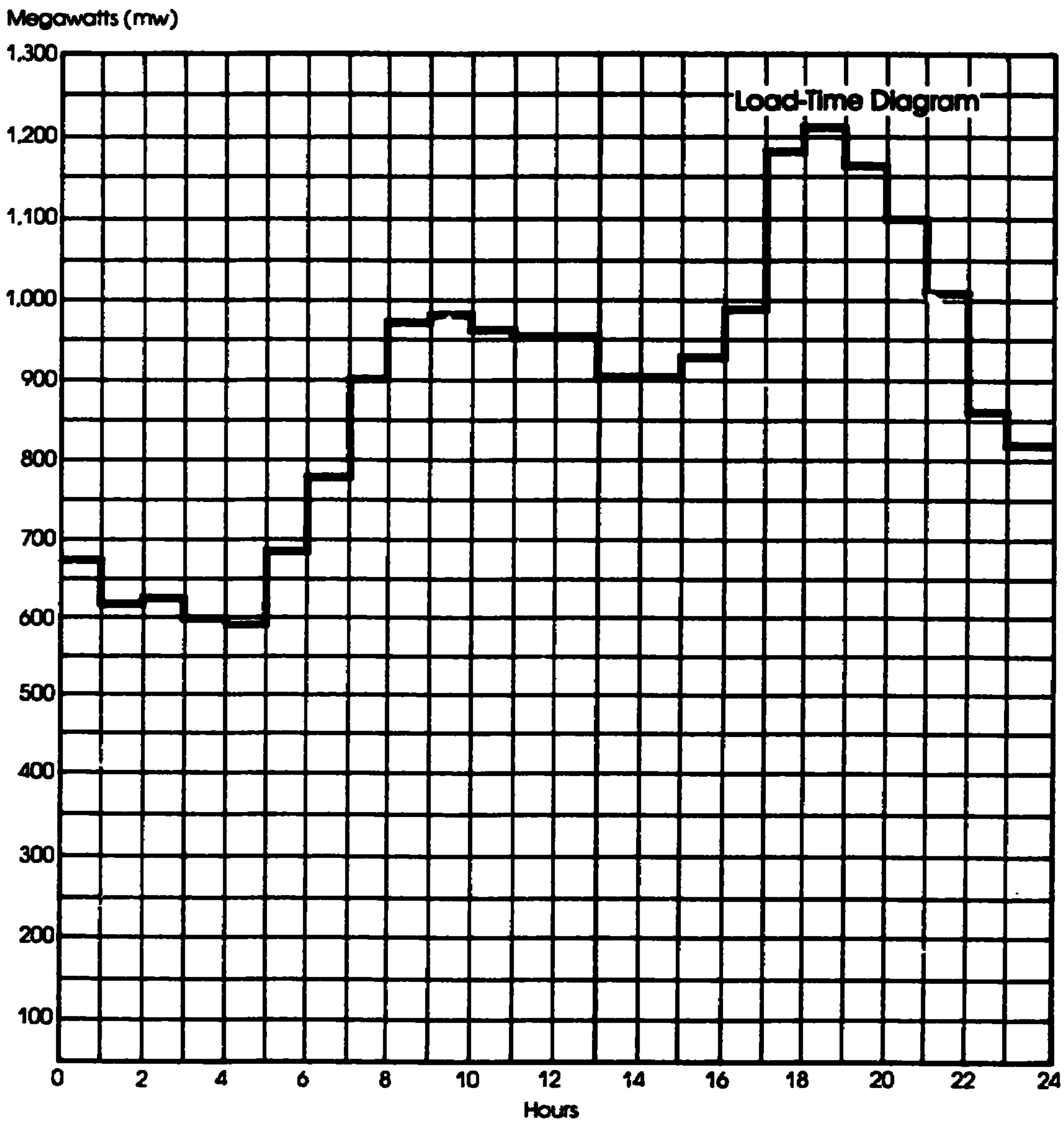
Year	Wholesale price index	Domestic and Commercial Current	Domestic and Commercial Real	Government Current	Government Real	Small Industry Current	Small Industry Real	Large Industry Current	Large Industry Real	Total Current	Total Real
1974	54.0	18.8	34.8	17.3	32.0	9.6	17.8	6.6	12.2	12.9	23.9
1975	57.9	18.3	31.6	17.2	29.7	9.2	15.9	6.5	11.2	13.0	22.5
1976	65.1	19.3	29.6	18.2	28.0	10.7	16.4	6.5	10.0	14.0	21.5
1977	70.9	19.3	27.2	18.5	26.1	10.5	14.8	6.5	9.2	13.5	19.0
1978	80.1	19.3	24.1	17.6	22.0	10.9	13.6	6.5	8.1	13.9	17.4
1979	87.0	20.8	23.9	17.7	20.3	10.3	11.8	6.5	7.5	14.1	16.2
1980	100.0	26.4	26.4	17.8	17.8	14.7	14.7	7.9	7.9	17.6	17.6
1981	122.0	23.4	19.2	30.9	25.3	32.1	26.3	11.9	9.8	22.7	18.6
1982	135.0	24.5	18.1	31.2	23.1	32.3	23.9	11.8	8.7	23.0	17.0
1983	137.0	26.6	19.4	32.7	23.9	33.4	24.4	11.5	8.4	24.6	18.0
1984	142.0	26.4	18.6	33.0	23.2	34.0	23.9	11.3	8.0	24.6	17.3

SYRIA
PUBLIC ELECTRICITY ESTABLISHMENT
REAL PRICE OF ELECTRICITY
(1980 Prices)



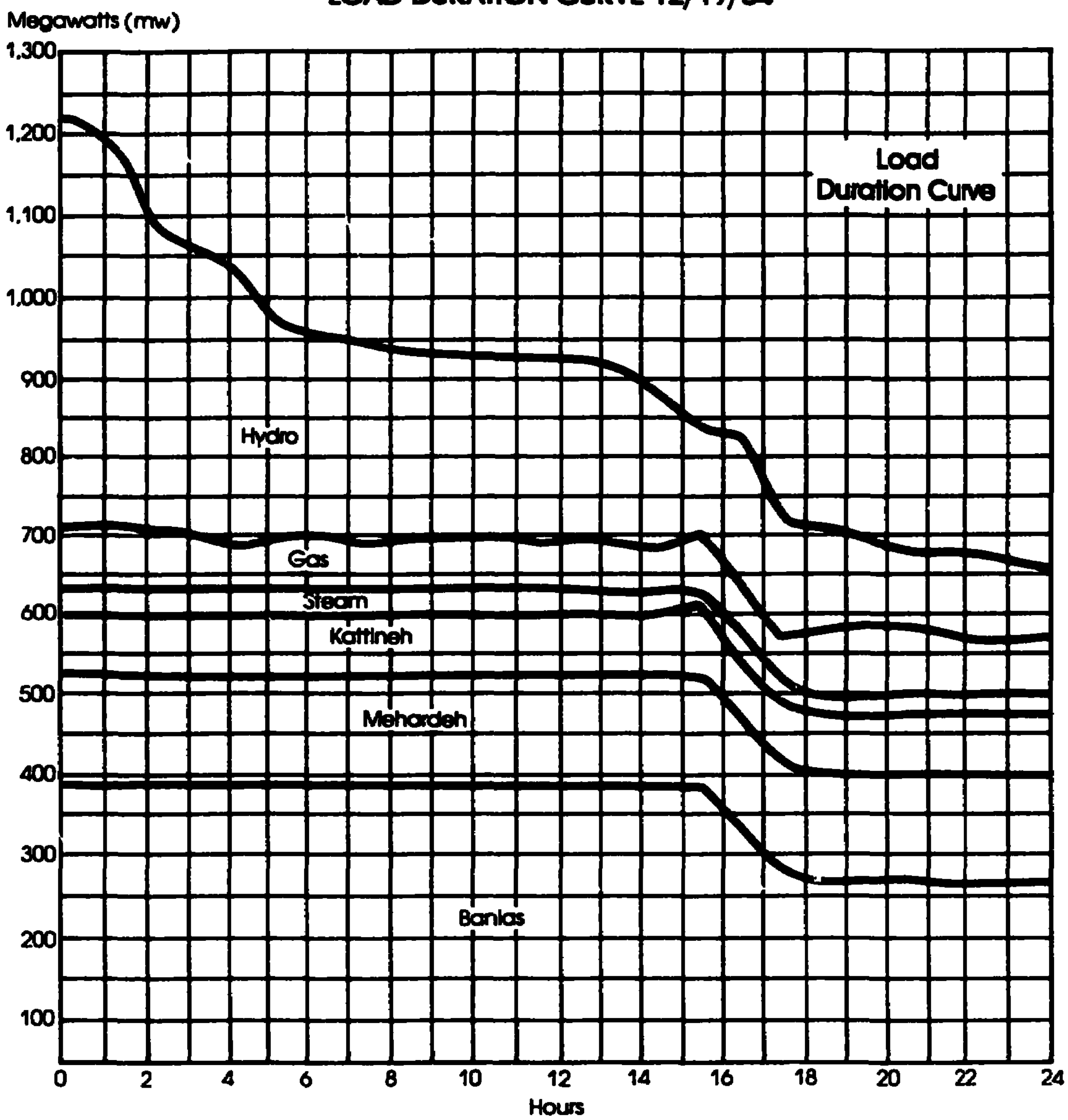
World Bank—30283:2

LOAD-TIME DIAGRAM 11/14/84



World Bank—30283:3

LOAD DURATION CURVE 12/19/84



World Bank—30283:4

Annex 15

PUBLIC ELECTRICITY ESTABLISHMENT INVENTORY LIST OF TRANSMISSION AND DISTRIBUTION FACILITIES a/

Lines	km	Substations	Number	Transformers kVA
400 kV	133			
230 kV	4,175	230/66 kV	23	3,220
66 kV	3,969	66/20 kV	121	3,400
20 kV	23,328	20/0.4 kV	12,520	6,610
0.4 kV	34,064			

a/ Although the kilometers of lines is reasonably correct, the transformer capacity and number of substations, particularly at the 20/0.4 kV level, may have an error of plus or minus 5%.

DAILY AVERAGE TOTAL SOLAR INSOLATION (cal/cm^2-day)

Station	Month of the Year												Yearly Average
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	
Ar-Raga a/	211	283	411	489	640	673	646	592	480	366	264	210	439
Al-Moslemia b/	199	261	375	468	609	668	636	589	479	355	238	182	422
Kharabo c/	247	349	455	542	637	733	711	635	533	411	311	255	483

a/ Ar-Raga is situated on the Euphrates River. Data is developed from the 1972-1975 time series.

b/ Al-Mohlemia is situated near Aleppo. Data is developed from the 1970-1975 time series.

c/ Karabo is located near Damascus. Data is developed from the 1971-1975 time series.

AVERAGE DAILY SUNSHINE DURATION IN HOURS

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average	Period of Record
Lattakia	4.7	5.8	6.4	7.3	9.9	10.7	10.3	10.3	9.5	7.9	6.7	4.8	7.9	1969-1978
Aleppo	4.2	5.4	6.7	8.0	10.7	12.4	12.7	12.0	10.6	8.6	6.7	4.3	8.5	1958-1974
Damascus	5.4	6.8	8.1	9.1	10.9	12.6	12.7	12.0	10.8	9.1	7.5	5.9	9.2	1958-1974
Hama	4.1	5.6	7.0	8.5	10.7	12.5	12.8	12.0	10.6	8.5	6.8	4.6	8.6	1960-1974
Deir-El-Zor	5.1	6.6	7.3	8.5	10.2	12.1	12.3	11.9	10.6	8.5	7.1	5.4	8.8	1958-1974
Ar-Raqa	4.7	5.9	7.1	8.3	10.2	12.0	12.2	11.7	10.4	8.6	7.0	4.8	8.6	1960-1979
Al-Moslemia	4.0	5.0	5.8	8.0	10.6	12.1	12.6	11.9	10.4	8.2	6.1	4.2	8.2	1968-1974
Kharabo	5.1	6.7	7.7	8.6	10.5	12.3	12.3	11.8	10.5	9.3	7.3	5.3	8.9	1968-1979
Palmyra	5.4	7.1	7.7	8.8	10.4	12.3	12.5	11.9	10.7	8.9	7.4	5.9	9.1	1958-1974

Source: Meteorological Department, Damascus and Samih El-Gaby, "Complementarity of Solar Energy and Thermal Energy in Heating", Damascus, 1982.

MONTHLY AVERAGE SOLAR INSOLATION AND NUMBER OF CLOUDY DAYS IN DAMASCUS (STATION KHARABO)

Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Total
$10^6 cal/m^2$	76.57	97.72	141.05	162.60	197.47	213.60	220.41	196.85	159.90	127.41	93.30	79.05	1,762.95
MJ/M^2	320.37	408.86	590.15	680.32	826.21	893.70	922.19	823.62	669.02	533.08	390.36	330.74	7,376.18
Cloudy Days day/month	6	8	5	3	2	-	-	-	-	2	4	8	38

Annex 19

NUMBER OF RESIDENTIAL DWELLINGS AND FLOOR AREA (1981)

Current Stock	Urban	Rural	Total
Number of Dwelling Units (10^3)	752	790	1,542
Number of Rooms (10^3)	2,519	2,007	4,527
Floor Area (10^3 m^2)	74,523	63,968	138,491
Rooms per Dwelling	3.35	2.54	2.93
Floor Area per Dwelling (m^2)	99	81	90
Yearly Construction			
Number of Dwelling Units (10^7)	27.3	10.2	37.5
Floor Area (10^3 m^2)	2,999	1,199	4,198
Floor Area per Dwelling (m^2)	110	117	112

COST COMPARISON OF SOLAR HEATING WITH GASOIL AND ELECTRIC HEATING

Gasoil Heating																
Price of fuel (sp/liter)	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Capital cost	750															
Parts						225					225					
Maintenance	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Fuel	0	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2	603.2
Total	750	653.2	653.2	653.2	653.2	878.2	653.2	653.2	653.2	653.2	878.2	653.2	653.2	653.2	653.2	653.2
Discount Rate	0.1															
Inflation	0															
Net Present Cost	5,404.31															
Electric Heating																
Price of fuel (sp/Kw-Hr)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Capital cost	700															
Parts			125		125		125		125		125		125		125	
Maintenance	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Fuel	0	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55	781.55
Total	700	831.55	956.55	831.55	956.55	831.55	956.55	831.55	956.55	831.55	956.55	831.55	956.55	831.55	956.55	831.55
Discount rate	0.1															
Inflation	0															
Net present Cost	6,784.84															
Solar Heating																
Price of fuel (SP/Kw-Hr)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Capital cost	4,300															
Parts						550					550					
Maintenance																
Fuel	0	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2
Total	4,300	53.2	53.2	53.2	53.2	603.2	53.2	53.2	53.2	53.2	603.3	53.2	53.2	53.2	53.2	53.2
Discount	0.1															
Inflation	0															
Net Present Cost	4,780.18															

MONTHLY TEMPERATURE VARIATION FOR DAMASCUS (1951-1976)
(In ° Celsius)

Element	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly
Mean Temperature	7.1	8.6	11.8	16.2	21.0	25.1	26.8	26.9	24.1	20.0	13.8	8.6	17.5
Mean Maximum Temperature	12.1	14.1	17.8	22.8	28.5	33.2	35.5	35.7	32.4	27.1	19.8	13.7	24.4
Mean Minimum Temperature	2.4	3.3	5.4	8.8	12.4	15.9	17.2	17.3	15.3	12.2	7.6	3.6	10.1
Absolute Maximum Temperature	22.7	25.0	31.3	35.5	38.4	40.9	43.6	44.0	42.0	36.6	29.7	26.1	44.0
Absolute Minimum Temperature	-8.3	-5.3	-3.7	-3.3	3.7	9.2	10.8	10.8	8.7	3.8	-4.4	-6.4	-8.3

ECONOMIC COMPARISON OF PUMPING USING WIND ENERGY, DIESEL ENGINES, AND ELECTRICITY

I. Wind Pump.ng

Assumptions:

Life	20 years
Windmill efficiency	.5
Pump efficiency	.5
Pumping head	20 m
Startup speed	3 m/s
Shutdown speed	10 m/s

A medium size El Nafury Windmill (126 is considered).

Capital cost	15000 SL
Annualized capital cost	1761 SL/yr
Maintenance cost	200 SL/yr
Annualized cost	1961 SL/yr

Based on Homs data the windmill can pump 20,000 m^3 of water/yr.

The calculation took into account the need to translate the mean monthly wind speed into a mean energy wind speed by substracting the wind energy produced at high and low speeds.

Cost/m^3 pumped = 0.98 SL/m^3

II. Diesel Engine

Life	7 years
Efficiency	.25
Pump efficiency	.5
Operating factor	.25

Engine sizing:

P=QHg

$$P = \frac{20{,}000\ m^3/yr\ (1000\ l/m^3)}{(3600\ sec/yr)(24hrs/day)(365\ days/yr)} \quad (20m)(9.81\ m/s^2)$$

P=124 W

$$Peffectin = \frac{P}{(Pump\ efficiency)(Operating\ factor)}$$

Peffectin=992 W = 1KW

Economics:

Capital cost	\$600 = 3270 SL
Operating cost	300 SL/yr

$$Energy\ used = \frac{(Peff)(Capacity\ factor)(hrs/yr)}{(Engin\ eff.)}$$

$$= \frac{(1kw)(.25)(8760hrs/yr)}{(.25)} = 8760\ kw\ hr/yr$$

$$Fuel\ used = \frac{(8760\ kwhrs/yr)}{(kwhrs/T\ diesel)} = \frac{8760\ kwhrs/yr}{(12{,}000\ kwhrs/T\ diesel)} = .73\ T\ diesel/yr$$

Fuel cost= (1320 SL/T)(.73 T/yr) = 964 SL/yr

Annualized capital cost: We are also taking into account the 2 engine replacements at years 7 and 14.

Annualized capital cost: annualized (capital cost engine 1 and net present valve of engines 2 and 3).

Annualized capital cost = Annualized (3270 + 1677 + 861) = 682 SL/yr

Total annualized cost = 1964 SL/yr

$$\text{Pumping cost} = \frac{(1946\ \text{SL/yr})}{(20{,}000\ \text{m}^3/\text{yr})} = .097\ \text{SL/m}^3$$

III. Electricity

Capital cost $200 or SL1100

with 1 kw x 8760 x .25 = 2190 kwh = 2190 x .35 = 766.5 SL/yr

Annualized cost = 177.4 + 7.5 = 185 SL

Total = 951 SL/yr

@.35 = $.0476/\text{m}^3$

@.60 = $.0815/\text{m}^3$

IV. Discussion

The cost of pumping using the assumptions listed above shows that a windmill is competitive today with a diesel engine. Any economic evaluation of the two options by taking the border price of diesel, will show a clear advantage for the windmill. Another factor favoring the windmill is the life of the system which in most cases in Syria extends beyond the 20 years design period. Further, the efficiencies assumed for the diesel engine are higher than those experienced in developing countries so far. However, it is likely to be a more expensive alternative where electricity is cheaply available even at limited cost of SL 60/kwh.

APPROXIMATE INVESTMENT COSTS AND PHASING FOR NEW NATURAL GAS DEVELOPMENTS - SYRIA
(US$ MILLION)

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
B 1	DER-EL-ZOR												
	Pipeline		10										
	Compressor		3										
	Subtotal		13										
C 1	JEBISSE - HOMS EXPANSION												
	Install blank valves	1											
	Compressor		6	6									
	Treatment/process/extraction		10	10									
	Production/gathering		40	50	50	10							
	Subtotal	1	56	66	50	10							
C 2	PALMYRA BASIN - DAMASCUS												
	Appraisal wells (6)	5	15	10									
	Treatment/processing/extraction			20	20								
	Production (40 wells) & gathering			40	60	60	40						
	Pipeline to Damascus users			80	80								
	Subtotal	5	15	150	160	60	40						
C 3	PALMYRA BASIN - NW SYRIA												
	Pipelines - field - HOMS (50KM)							13	13				
	HOMS - HAMA							11	11				
	HOMS - TARTOUS							22	23				
	Field treatment/process/extraction							20	20				
	Production (40 wells) & gathering							30	40	40	40	30	
	Subtotal							96	107	40	40	30	
C 4	SOUEDIE												
	Field treatment/process/extraction						20	20					
	Production & gathering					20	25	25	5				
	Subtotal					20	45	45	5				
	GRAND TOTAL	6	97	216	210	90	85	141	112	40	40	30	

Annex 24

PUBLIC ELECTRICITY ESTABLISHMENT INVESTMENTS 1980-1984

	1980	1981	1982	1983	1984
Generation					
Mehardeh		13,437	12,979	1,075	6,254
Banias		231,681	185,876	90,561	32,928
Kattineh		3,001	5,409	573	2,011
Replacements, renovations		63,137	49,896	29,184	38,208
Power Station South Region (Rabil)		2,141	8,169	19,506	23,701
Nuclear project		15	155	1,337	1,275
Gasturbine stations		17,793	22,565	979	44
Diesel power stations		10,598	1,810	4,931	314
Subtotal Generation	187,250	341,803	281,859	148,146	105,535
Transmission					
400 kV		49,239	41,954	56,807	33,424
230 kV		59,821	33,706	20,644	27,556
66 kV		26,215	13,832	22,481	15,713
400/230 kV substations		8	2	1,746	2,213
230/66 kV substations		73,380	64,151	43,605	20,101
66/20 kV substations		62,495	42,830	47,277	24,846
20 kV lines		3,242	7,801	6,613	7,431
Subtotal Transmission	294,285	273,400	184,276	199,172	131,284
Distribution					
20 kV/lines		82,317	104,277	105,311	67,421
20 kV/0.44 kV lines		78,839	73,000	76,134	45,472
Distribution substations		54,082	122,986	85,549	60,411
6.6 to 20 kV conversions		6,976	4,653	2,230	796
110/190 V to 220/380 V conversions		4,870	1,556	480	3
Connections		34,987	43,183	30,043	24,460
Subtotal Normal Distribution	288,872	262,071	349,655	299,747	198,563
Rural: 20 kV lines		87,367	122,572	148,342	134,916
L.T. lines		87,584	103,952	95,911	63,786
: distribution substations		24,477	27,138	20,843	56,407
Subtotal Rural Expansion	223,791	199,428	253,662	265,096	255,109
Pole factories Homs and Deif Eszor	--	15,532	26,932	20,751	11,337
Subtotal Distribution	512,663	477,031	630,249	594,594	465,009
General					
Repair shop Adraa		5,903	4,240	1,644	508
Headoffice and other buildings		54,039	55,572	58,788	33,696
Transport facilities		16,208	11,208	12,061	14,589
Study expansion power stations					825
Subtotal General	58,769	76,150	71,020	72,493	49,618
Total	1,052,967	1,168,384	1,167,404	1,014,405	751,446

PUBLIC ELECTRICITY ESTABLISHMENT
EXPENDITURE SCHEDULE FOR GENERATING PLANT a/
(US$000)

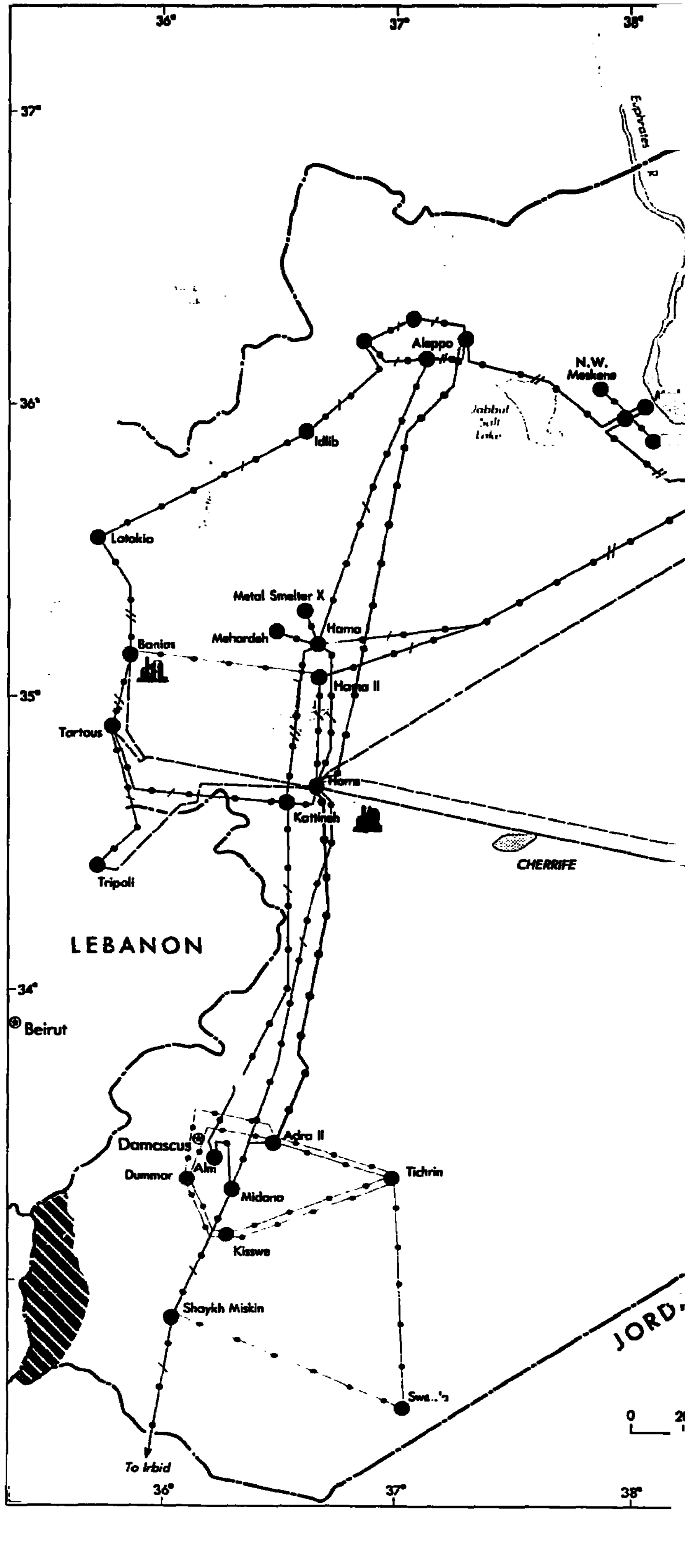
	Steam						Gas turbine				Tichreen			Nuclear Plant	
	1987	1988	1989	1990	1991	1992	1987	1988	1989	1990	1992	1993	Total	1993/94	Total
1985	6.1						9.5						15.6		15.6
1986	12.2	15.0					47.2	17.5					91.9		91.9
1987	24.4	30.0	12.4				26.3	47.5	20.2				160.8	105.6	266.4
1988	12.2	60.0	29.8	28.5				15.0	51.0	21.3			217.8	105.6	323.4
1989	6.1	30.0	59.6	47.0	41.5				26.8	56.2	12.0		279.2	158.4	439.6
1990		15.0	29.8	84.0	93.0	9.0				17.5	24.0	12.0	284.3	158.4	442.7
1991			12.4	37.0	166.0	18.0					48.0	24.0	305.4	158.4	463.8
1992				18.5	83.0	36.0					48.0	48.0	233.5	158.4	391.9
1993					41.5	18.0					72.0	48.0	179.5	105.6	285.1
1994						9.0					36.0	72.0	117.0	105.6	222.6
1995												36.0	36.0		36.0
	61.0	150.0	144.0	215.0	425.0	90.0	83.0	80.0	98.0	95.0	240.0	240.0	1,921.0	1,056.0	2,977.0
Present Value at 10%													1,143.0	637.9	1,780.9

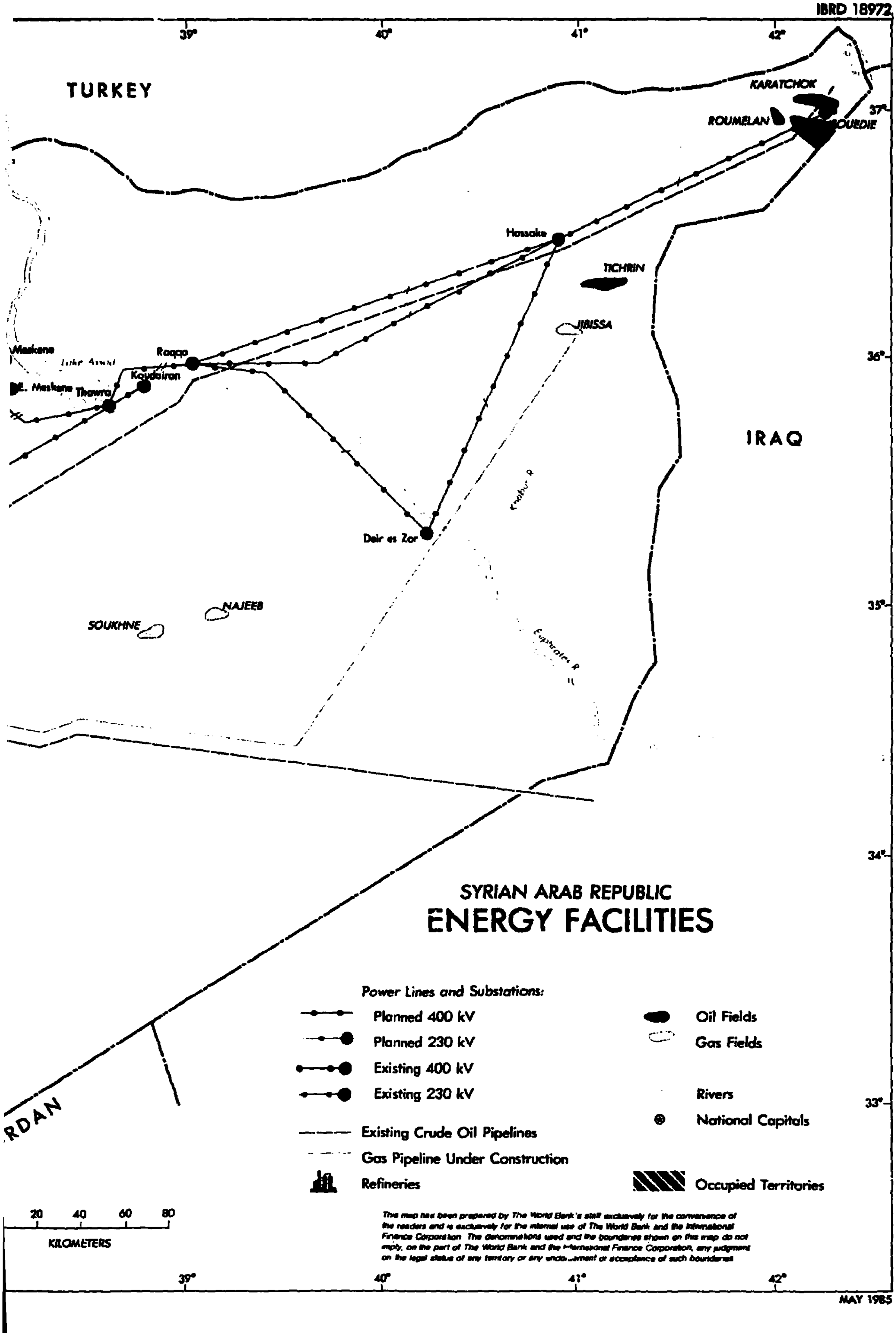
a/ Pricing and Commissioning Schedule

		Cost		Commissioning	
		MW	US$/MW	Alt 1	Alt 2
Hydro					
Tichreen		4x100 = 400	1,200	1992/93	
Steam					
Mehardeh	3	150	350	3-1987	3-87
	4	150	350	6-87	6-87
Banias	3	170	350	12-87	12-87
	4	170	350	3-88	3-88
Al Rabil	1	200	550	3-89	3-89
	2	200	550	9-89	9-89
	3	200	550	3-90	3-91
	4	200	550	1-91	3-92
Location A	1	400	550	1-91	3-93
	2	400	550	6-91	3-96
Nuclear assumed beyond horizon					
Gas turbines planned:					
Souedie		150	250	1-87	1-87
Jbisa		150	250	1-89	1-89
Homs		300	550	1-88	1-88
Additional required		200	550	1-90	1-91
		3,660			

2/ Assumed Expenditures Schedule:

Year	Steam	Gas Turbines	Tichreen	Nuclear
1	10	15	5	10
2	20	75	10	10
3	40	10	20	15
4	20		20	15
5	10		20	15
6			15	15
7				10
8				10


36°
37°
38°
Euphrates R
Aleppo
N.W. Meskene
Jabbul Salt Lake
Idlib
Latakia
Metal Smelter X
Mehardeh
Hama
Banias
Hama II
Tartous
Homs
Kattinah
CHERRIFE
Tripoli
LEBANON
34°
35°
Beirut
Damascus
Adra II
Alm
Dummar
Midano
Tichrin
Kisswe
Shaykh Miskin
JORD
0
20
To Irbid


IBRD 18972
39°
40°
41°
42°
37°
36°
35°
34°
33°
TURKEY
IRAQ
RDAN
KARATCHOK
ROUMELAN
SOUEDIE
Hassake
TICHRIN
JIBISSA
Meskene
Raqqa
Koudairan
E. Meskene
Thawra
Deir es Zor
NAJEEB
SOUKHNE
Euphrates R.
SYRIAN ARAB REPUBLIC
ENERGY FACILITIES
Power Lines and Substations:
Planned 400 kV
Planned 230 kV
Existing 400 kV
Existing 230 kV
Existing Crude Oil Pipelines
Gas Pipeline Under Construction
Refineries
Oil Fields
Gas Fields
Rivers
National Capitals
Occupied Territories
20
40
60
80
KILOMETERS
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MAY 1985