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Appraisal of a Regional Electrification Project Egypt

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Projects Department
Europe, Middle East and North Africa Regional Office

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Document of the World Bank

CURRENCY EQUIVALENTS
(as of November, 1976)

Currency Unit	=	Egyptian Pound (LE)
Official Rate		
1 Egyptian Pound (LE 1)	=	US$2.56
Parallel Market Rate*		
LE 1 (or 100 milliemes)	=	US$1.50
LE 1,000	=	US$1500
LE 1,000,000	=	US$1.5 million
LE 0.67	=	US$1.00

*Unless otherwise indicated all conversions of foreign currencies to Egyptian Pounds in this report are based on the Parallel Market Rate of Exchange.

WEIGHTS AND MEASURES

1 kilowatt (kW)	=	1,000 watts (10^3W)
1 Megawatt (MW)	=	1,000 kilowatts (10^3kW)
1 kilowatt hour (kWh)	=	1,000 watt hours (10^3Wh)
1 Gigawatt hour (GWh)	=	1,000,000 kWh (10^6kWh)
1 kilometer (km)	=	1,000 meters (10^3 m)
1 kilovolt ampere (kVA)	=	1,000 volt amperes (10^3VA)
1 megavolt ampere (MVA)	=	1,000 kilovolt amperes (10^3 kVA)

GLOSSARY OF ABBREVIATIONS

MEE	-	Ministry of Electricity and Energy
GEEC	-	General Egyptian Electricity Corporation
REA	-	Rural Electrification Authority
S & P	-	Sanderson and Porter, Inc.
EEA	-	Egyptian Electricity Authority
CAO	-	Central Auditing Organization
EdF	-	Electricite de France

CONSULTANTS MENTIONED IN THE REPORT

-- Sanderson & Porter, Inc. (US), UNDP Power Sector Survey (EEA)

-- Electricite de France (France), Tariff Studies (EEA)

-- Lahmayer International, Salzgitter Consult and Deutsche Project Union, (Germany); and Harza Engineering Co. (US), Qattara Project (EEA)

-- Harza Engineering Co. (US), Rehabilitation and Expansion of Power Distribution Systems in Cairo, Alexandria and two other cities (EEA)

-- Harza Engineering Co. (US), Consultants for Regional Electrification Project (REA)

EGYPTIAN ELECTRICITY AUTHORITY

FISCAL YEAR

January 1 to December 31

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APPRAISAL OF

A REGIONAL ELECTRIFICATION PROJECT

EGYPT

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This report was prepared by Messrs. Arturo Roa (Engineer) and Peter A. Cordukes (Financial Analyst).

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SUMMARY

i. This report appraises a Regional Electrification Project for the Government of Egypt. The Project, covering about 18% of the Rural Electrification Authority's (REA) 1976-80 Five Year Program, consists of approximately 3,400 km of 11-kV distribution lines and related equipment, 230 MVA of substation and distribution transformer capacity and 100 km of 66-kV and 33-kV subtransmission lines, training and consulting services. The facilities would be located in about 32 zones in Upper and Lower Egypt. The Project is estimated to cost about US$70.6 million of which about US$50 million (71%) would be for foreign costs.

ii. A Bank loan of US$48 million is proposed to the Egyptian Electricity Authority (EEA) to cover 96% of the foreign costs of the Project. It would be made available to REA under a subsidiary agreement except for the portion to be retained by EEA for consulting services and training. The remaining costs would be financed by the Government and EEA. Execution of the subsidiary agreement would be a condition of loan effectiveness, and the Government agreed as a further condition of loan effectiveness to establish a special fund for the Project to ensure that local counterpart funds will be available when needed.

iii. This loan would be the Bank's first power loan to Egypt. In May 1976, consultants (Sanderson and Porter Inc., S & P) commenced a UNDP financed "Power Sector Survey" for the EEA under Bank supervision. A diagnostic phase report issued in November 1976 contained a number of recommendations aimed to increase EEA's efficiency and help meet Egypt's future power needs. EEA has directed S & P to assist in the implementation of the report's recommendations and agreed to engage financial consultants to assist with implementation of the recommendations on financial administration and accounting systems.

iv. The Project would improve and expand electric power distribution to about 6 million people in urban centers and villages outside Cairo and Alexandria. During appraisal 23 of the 32 zones were identified and the remaining zones were selected during negotiations. The data on the representative zones which was obtained during appraisal has been used to prepare the Project cost estimates and for evaluation of the benefits. REA has selected consultants for the Project (Harza Engineering, US), to review the rural zones for consideration of construction priority in accordance with criteria agreed with the Bank, and subsequently for detailed design and construction supervision. These same consultants are currently reviewing design and construction standards for EEA under a USAID financed contract. The Project would be constructed in the period 1978-80 by the Ministry of Electricity and Energy's three construction companies or by private local contractors under REA's supervision. REA has established a Project unit and appointed suitable staff.

v. The Project consultant is expected to develop detailed construction schedules which REA agreed to review periodically with the Bank in connection with the reporting requirements for the Project. In addition, the Bank obtained EEA and REA's agreement to implement systems to monitor the performance of the EEA system and the National Rural Electrification Plan.

vi. Disbursement would be for the c.i.f. cost of imported items and related services and for the ex-factory costs of items manufactured locally, and for the foreign exchange costs of consultants hired outside Egypt and 70% of expenditures for consultants hired locally. Contracts for equipment and materials would be awarded on the basis of international competitive bidding consistent with Bank Group Guidelines for procurement, except that contracts totalling not more than US$1.0 million for specialty items may be awarded after international shopping. Retroactive financing of expenditures for consultants' services up to $150,000 would be permitted.

vii. The Borrower, EEA, established as a Government-owned authority in early 1976, replacing the General Egyptian Electricity Corporation is responsible for operation and maintenance of the sector facilities. It is overstaffed and its training facilities are not being fully utilized. Accordingly, a training program consisting of provision of 9 man years of technical assistance, accommodation units and training materials would be financed from the loan to strengthen EEA's training activities.

viii. Load growth of the EEA system averaged 17%/a during 1974-76 and it is estimated at 13%/a in 1976-80. This growth is expected to be met from existing hydro plant at Aswan, existing thermal plant mostly in the Delta and 2100 MW of thermal generating capacity planned or under construction through 1982. Distribution facilities in most of Egypt are run-down and overloaded. A USAID financed distribution rehabilitation program is already underway in the Canal Zone, Cairo and Alexandria, and the REA program commenced in 1971 covers about 120 urban centers, 4,000 villages and 25,000 hamlets in Lower and Upper Egypt.

ix. Neither EEA nor its predecessor GEEC has earned a profit since 1972 and its financial performance is distorted by previous years adjustments, incomplete valuation of fixed assets and problems identified by the auditor's reports which have not been corrected. The financial consultants to be engaged as part of the Project are expected to help EEA overcome some of these problems. EEA's 1977-80 investment program, which will require about LE 921 million (US$1.4 billion), is expected to be financed 26% from internal sources, 26% from contributions and grants and 48% from borrowing. EEA's financial forecasts show it could achieve a 9% rate of return by 1979, as it agreed to do with USAID, if it increased electricity tariffs by about 50% above present levels. EEA agreed to submit to the Bank an acceptable plan or proposals for tariff increases, or other measures, to achieve the 9% return commencing 1979 and a formula for revaluation of its fixed assets not later than June 30, 1978. Thereafter, EEA agreed to submit to the Bank each year a suitable financial plan for achieving the 9% rate of return in the following year. Although a 9% rate of return was agreed to be a reasonable target for EEA, it may be difficult to achieve in 1979. However, the plan to be submitted at the end of 1978 would afford an opportunity for the Bank to review with EEA this target for 1979. EEA also agreed to a tariff study to be financed under the loan, using consultants, to formulate an appropriate tariff structure and rates. To ensure EEA's debt to equity ratio continues to improve and that borrowing does not exceed prudent levels, EEA agreed to obtain the Bank's consent to any borrowing it plans to undertake whenever its internal cash generation would not be sufficient to cover its debt service at least 1-1/2 times in any future year. EEA also agreed to revalue its foreign debts at the end of each year in accordance with the current rates of exchange. With respect to EEA's overdue electricity accounts, the Government agreed to take all measures on its part to enable EEA to reduce its accounts receivable to not more than the equivalent of 6 months sales by March 31, 1978, and not more than 3 months sales by December 31, 1978.

x. The Project would add the needed system reinforcements to restore adequate service and allow normal load growth. It would also provide extensions to eliminate a large backlog of long-waiting service requests. Through electrification, the Government seeks to help correct the imbalance in living conditions between Cairo and Alexandria and the smaller urban centers and rural areas. The Project is the least-cost means of meeting supply to the urban centers and villages by comparison with the alternative of isolated diesel units. Large benefits are possible, due to the fuel savings, since by 1980 the incremental fuel of the central system will be associated gas which is presently flared. The internal economic return on the Project is estimated to be at least 10.2% comprised of 12.6% for the urban centers and 4.2% for the rural zones. These returns represent minimum values since they do not take account of unquantifiable benefits expected to be obtained from the Project.

xi. Agreement having been reached on the principal issues, subject to the conditions of effectiveness, the Project is suitable for a Bank loan of US$48 million to EEA. The standard terms for Bank loans to Egypt of 20 years including 4-1/2 years grace are appropriate.

APPRAISAL OF

A REGIONAL ELECTRIFICATION PROJECT

EGYPT

I. INTRODUCTION

1.01 The Government of Egypt has requested the Bank to help finance a portion of its 1976-80 rural electrification program. The program involves the upgrading and extension of supply to about 2,000 villages and about 36 urban centers throughout Egypt. It would complete a plan formulated in 1971 by the Rural Electrification Authority (REA) estimated in 1975 to cost a total of about LE 300 million (US$450 million equivalent).

1.02 The proposed loan of US$48 million, which would be the Bank's first power loan to Egypt, would finance part of the 1978-80 portion of REA's program. The Project, which would consist of about 3,500 km of distribution lines and related facilities, is estimated to cost about US$70.6 million of which about US$50 million (71%) would be for foreign costs. The proposed loan would meet the foreign cost of equipment and materials, studies and consultant services. It would be made to the Egyptian Electricity Authority (EEA) who would retain a portion for financial services, a tariff study, a review of safety and inspection practices and training, the remainder being made available to REA who would construct the distribution facilities. Local costs and $2 million of foreign costs of installation and civil works would be met by EEA and the Government.

1.03 The Bank's active association with the energy sector in Egypt began with a sector review mission in December 1974. The mission's subsequent report prompted the appointment of consultants, Sanderson and Porter, Inc. (S & P) to carry out a "Power Sector Survey" for the Government to determine changes that might be required in EEA's institutional and organizational structure, its operations and development program to enable it to function more efficiently and meet Egypt's future power needs. This survey, which is being financed by a UNDP grant of about US$1 million, has been underway since May 1976 under Bank supervision. A diagnostic phase report was presented to EEA in November 1976. A summary of the main findings and recommendations of the report are contained in Annex 1. EEA has directed S & P to assist in the implementation of the report recommendations except those for hydro optimization and 500-kV transmission improvements which are being studied further. The study recommendations in the areas of system planning and generation maintenance are not expected before mid-1977 because specialists in these fields did not join the S & P team until well after the study commenced, due to UNDP's budget restrictions. The implementation phase of the consultants work is expected to be completed by the end of May 1978. In addition to the Power Sector Survey, the Bank is supervising the preparation of a Water Master Plan also being financed by UNDP. It is expected to optimize development and use of Egypt's water resources.

1.04 This appraisal report was prepared by P.A. Cordukes (Financial Analyst) and A. Roa (Engineer). It is based on a feasibility study prepared by REA and on information which was obtained during missions to Egypt in August 1976 for pre-appraisal, in October/November 1976 for appraisal and by a subsequent follow-up mission in February 1977. Mr. R.V. Sear (Consultant Engineer) undertook the pre-appraisal and follow-up missions and participated in the appraisal mission with the above named and Mr. G. Bergendahl (Consultant Economist). The section on training was based on a report and recommendations by Mr. E. Chittleburgh (training adviser) who visited Egypt in December 1976.

II. THE POWER AND ENERGY SECTOR

A. The Country and the Economy

2.01 Egypt, with an area of about 1 million km2, is located in the north-eastern corner of the African continent. It has a rapidly growing population (2.2%/a) of about 37 million (1975), many of whom are farmers living along the banks of the Nile river or near the Suez Canal. Most of the country is desert and less than 4% of the land is used for farming.

2.02 Economic growth since the mid-sixties has been constrained by a combination of bad harvests and heavy expenditure on defense. Since 1973 Egypt has adopted a new economic strategy aimed at increasing private business activities and encouraging private foreign capital, although most large enterprises and industry continue to be Government-owned and regulated. Recently the country has experienced substantial growth, financed almost entirely by foreign aid principally being provided by other Arab countries and the United States. This aid has been directed towards improving industrial output, reconstruction of the Canal zone and financing a large balance of payments deficit. GDP growth in real terms increased from less than 3% in 1973 to an estimated 10% in 1975. However, soaring imports, inflation in food prices (despite substantial Government subsidies) and rising population threaten continued growth.

2.03 Despite improved growth and incentives to the private sector, most of the people are poor and living standards remain low not only in rural areas but also in the overcrowded cities especially Cairo and Alexandria. Gross national product per capita was estimated at US$310 in 1975. Electricity consumption is low, per capita consumption in 1975 being only about 225 kWh per annum compared with more developed countries such as Portugal and Turkey whose per capita consumption is about 1,016 kWh and 468 kWh per annum respectively, but it exceeds that of most Northern African countries such as Algeria (154 kWh) and Morocco (183 kWh). Industrial customers account for about 60% of EEA's sales while its residential customers in Cairo and Alexandria represent only about 12% of total sales compared with 32% in Algeria and 24% in Morocco. Clearly, there is scope for increased electricity consumption for residential use as GNP and living standards improve most especially in rural areas. A key element of Government planning is aimed at decentralization of the urban population and creation of more productive opportunities in smaller towns and the rural areas. The electrification program of which the Project forms part has an important role to play in the achievement of this objective.

B. Power and Energy Resources

2.04 Egypt's principal indigenous energy resources are hydropower, natural gas and oil; there are also small non-coking coal deposits in the Sinai. No economical deposits of uranium ore have so far been discovered. Although solar energy is at present untapped, it may become an important energy source in the longer term.

2.05 With 345 MW installed capacity at the Aswan Dam and 2,100 MW at the Aswan High Dam, two-thirds of Egypt's hydropower potential has already been harnessed. Between Aswan and Cairo a further 635 MW could be developed using the 70 metres of head if existing regulation barrages were strengthened and additional ones constructed. There are also significant potential economic sites for pumped-storage schemes on the high plateau overlooking the Gulf of Suez and on plateaus bordering the Nile near Cairo and Nag Hammadi. The only other potential source of hydropower is the Qattara Project, 1/ which could have a firm capacity of about 640 MW while the depression is filling (estimated 12 years) and 340 MW thereafter, replacing water lost by evaporation. This project is being evaluated by consultants from the Federal Republic of Germany whose studies are not expected to be completed until about 1978.

2.06 Existing proven reserves of gas amount to 71.3 billion m3. They are currently being developed for new industrial consumers which include fertilizer plants in the Delta to be supplied from the Abu Madi field, cement and steel plants at Helwan and near Cairo from the Abu El Gharadek field, and a sponge iron plant near Alexandria from the Abu Qir Field. These fields have an estimated 20 year life. Gas pipeline systems are already completed from the first two fields. Delays in establishment of these industrial consumers and expected tripling of reserves by 1980, as well as an expected under-utilization of the new gas pipeline systems prompted S & P to recommend to EEA gas firing of all existing and planned thermal plant. S & P have also recommended utilization of associated gas in the Gulf of Suez, now being flared at the rate of 4 million m3 a day, for industry and power generation. It is estimated that the volume of flared gas will rise to about 12 million m3 a day by 1990. Both the associated and non-associated gas in Egypt are very clean and have virtually no sulphur.

2.07 Egypt has been virtually self-sufficient in oil production since 1963 and is becoming a significant exporter. Oil production in 1975 amounted to 11.7 million tons and domestic consumption to 8.3 million tons. Since 1973

1/ Water from the Mediterranean would be channeled to the Qattara depression, about 160 km southwest of Alexandria.

international oil companies have begun more intensive drilling, concentrating in the Gulf of Suez and the Western Desert; the Ministry of Petroleum projects crude oil production to reach 50 million tons in the early 1980s of which about 35 million tons might be exported to earn more than US$2.5 billion annually in foreign exchange, but this level of production may not be reached because the increased exploration program has met with little success.

C. The Power Sector

History

2.08 Electricity was first introduced into Egypt in 1895. Isolated diesel and some oil-fired steam units were installed in major population centers by various Government, private and municipal organizations. Supply in Cairo was in private hands until 1949 when the Government-owned Cairo Electric and Gas Department took over the responsibility from the privately owned Lebon Company. In Alexandria the assets of the Lebon Company were nationalized in 1961 and placed in the hands of a government Corporation - the Alexandria Electric and Gas Authority.

2.09 In 1964 the Ministry of Electricity and Energy (MEE) was formed to consolidate all of the electricity organizations into one state-owned organization. This was achieved in 1965 with the establishment of the General Egyptian Electricity Corporation (GEEC) to own, operate and expand the public power system. In 1971, the General Rural Electrification Authority was created to plan and supervise the construction of rural electrification projects. Early in 1976 the sector was reorganized through the establishment of four new authorities; the Egyptian Electricity Authority (EEA) replacing GEEC, the Rural Electrification Authority (REA), the Nuclear Power Plant Authority (NPPA) and Qattara Depression Authority.

Organization

2.10 The organizational structure of the sector is shown in Annex 2. Each of the four authorities is responsible to the Minister of Electricity and Energy who prescribes sector policies and is responsible for coordination with Government plans. Regulation and coordination is facilitated through the Higher Council of the Electricity Sector which includes, in addition to the MEE, the Ministers of Agriculture and Irrigation, Industry and Petroleum. Each of the authorities has a board of directors whose members are appointed by the Prime Minister upon the recommendation of the Minister of Electricity and Energy. The chairman of the respective boards is appointed by Republican Decree.

2.11 Construction work is normally performed by three MEE companies which undertake works on a competitive proposal basis for the MEE's authorities, for other Government organizations and for the private sector. They have also contracted work in neighboring countries. However, private local contractors have recently indicated interest in REA work and are expected to participate through local bidding procedures.

2.12 The EEA, which would be the borrower, is responsible for implementation, management, operation and maintenance of all power facilities throughout Egypt. Its organization is shown in Annex 3. A new law (No. 12 of 1976) was ratified by the People's Assembly on January 18, 1976, as part of the reorganization of the sector; a summary of its main provisions is contained in Annex 4. One of the key aims of the reorganization was to give the EEA more autonomy for developing its own manpower and budgetary policies, financial and accounting procedures. New by-laws were drafted accordingly and were approved by Government on April 26, 1977. The changes within the power sector appear to be similar to those being made for other Government authorities and have resulted so far in only limited reduction in Government control. The principal change for EEA has been the transfer of the Government-owned contracting companies to the MEE. Further changes may evolve gradually as EEA seeks greater autonomy and increased efficiency, a process which should commence with the implementation of its by-laws (para 2.15).

2.13 EEA's head office is in Cairo from which it co-ordinates operation and maintenance through its five zone offices for the Cairo, Alexandria, Canal, Delta and Upper Egypt zones. Each zone has its own President who serves on EEA's board of directors. The zones have freedom to develop their own internal procedures and practices but their programs, budgets and finances must be approved by the head office. Outside the Cairo and Alexandria zones, coordination of transmission, distribution and customer billing between EEA, REA and the local councils within zones is achieved through offices in each Governorate (there are 26 Governorates or administrative divisions for the whole of Egypt).

2.14 Except in Cairo and Alexandria, municipal councils buy power in bulk from EEA and bill and collect revenue from all low voltage customers, even though EEA is responsible for all operations throughout the country, including distribution. The customer billing activities of the councils are not reported to EEA, and any surplus earned from this source is retained by the councils. In September of 1976 the Higher Council of the Electricity Sector recommended to the Government formation of seven new distribution companies to take over all distribution assets, operate and maintain them, and to undertake the customer billing function. The precise form of the companies will be determined by legislation to be enacted but they are expected to be subsidiary companies of EEA. The companies to be established will encompass the same areas as EEA's existing zone offices except that Upper Egypt would be split into two, Middle Upper Egypt and High Upper Egypt, and a new northern zone would be created for the three Governorates west of Cairo and Alexandria. Since these companies will eventually own, operate and maintain the assets to be financed by the Bank loan, the Government agreed to ensure that decisions with respect to establishment of distribution companies will include provisions satisfactory to the Bank for the management, ownership, operation and maintenance of the assets, audit of the consolidated accounts of EEA, and consolidation of performance of the obligations under the financial covenants.

2.15 The EEA budgeted for more than 43,000 employees in 1976 and in 1977 expects the numbers to reach 50,000. However, these statistics include at least 3,000 ex-servicemen and young graduates who are on the payroll by Government direction but not actually fully employed by EEA in established positions. Government policy aims to avoid involuntary unemployment, a policy which all Government departments and authorities are obliged to support. Throughout the sector it is clear that there is considerable overstaffing and a severe shortage of experienced middle and top management level executives. Proposals for strengthening EEA's training activities have been made by the Bank which has reviewed sector training plans and needs (para 2.19). While the efficiency of existing staff may be upgraded by training, there is a continuing stream of qualified staff leaving Egypt to take up higher paid employment in neighbouring countries, which will continue to partially erode the training efforts. Basic salary scales are extremely low by comparison with those in most Arab countries, ranging from less than LE 200 to only about LE 2,000 (US$ equivalent $300-$3,000) per year. EEA's new by-laws (para 2.12) would give EEA the authority to increase salaries and benefits, to provide incentives for above average performance and to approve dismissal procedures where circumstances may warrant and should be effective in the longer-term, but short-term improvements will depend largely on EEA's increased training activities. Country-wide improvements will depend on the effectiveness of the Government's political and economic policies and the extent to which they are supported by foreign financial assistance to Egypt as a whole.

Existing Facilities

2.16 Since 1970, all important hydro and thermal generating stations in Egypt have operated interconnected through EEA's unified power system--see IBRD Map 12674. The system has a total installed generating capacity of 2,445 MW of hydro in the South--345 MW at the Aswan Dam station, and 2,100 MW at the High Dam station--and 1,370 MW of steam and gas-turbine units, mostly in the Delta. A 500-kV, double-circuit transmission line, 838-km long, connects the Aswan stations to the Delta Region and is the backbone of the interconnected system. Further interconnection is accomplished through 2,400 km of 220-kV and 3,550 km of 132-kV transmission. Subtransmission at 66kV (2,600 km) and 33 kV (1,600 km) supplies 11-kV, 6.6-kV, and 3-kV distribution in the entire service area. Low voltage distribution is 380/220 volts, patterned after European practices. System frequency is 50 Hz.

2.17 Excessive outages experienced during early operation of the 500-kV system moved EEA to impose unusually severe restrictions on the maximum load assigned to the hydro stations. This limitation in the power transmitted from Aswan to the large load centers in the Delta has delayed full utilization of available High Dam generation. Although load growth averaged 17%/a during 1974-76, and is estimated at 13%/a average for 1976-80, existing capacity and committed construction are ample to serve the short term needs if expected improvements in system operation are realized.

2.18 Total net generation for 1975 was 9,793 GWh, with a peak demand of 1,733 MW, and 64.5% load factor. For 1976, the estimated figures are: 11,800 GWh, 2,000 MW and 67.4% load factor. Approximately 40% of the total population has access to electricity. In the rural zones this figure is about 20%.

Training

2.19 EEA is very conscious of the need for training and is well aware of its manpower problems. For these reasons it particularly requested that the Power Sector Review give attention to its training needs. However, because of insufficient funds, this was not possible and instead the Bank undertook the task of identifying the training needs of the sector. The Bank's report is reproduced as Annex 5. EEA gives its manpower function equal status with the other three main functions in its organizational structure of finance, operations and projects (including studies and research). It has two well-equipped training centers: one in Cairo South for training and re-training of engineers and the other at the Cairo North power station for technicians and skilled workers. Both facilities are under-utilized and do not provide any training for commercial and financial staff. They also lack adequate accommodation facilities and instructors. A training program consisting of 9 man-years of technical assistance, accommodation units for 100 trainees at each of the EEA's training centers, audio-visual and other didactic materials and training for three instructor trainers at the ILO International Center for Vocational Training in Turin and expected to have a foreign exchange cost of US$1.2 million was agreed to be included as part of the Project.

Tariffs

2.20 EEA's existing tariffs (Annex 6) are based on a 1970 study by Electricite de France (EdF) which provided an appropriate basis for calculating the costs of supply. However, the current tariffs do not realistically reflect the costs of supply in economic terms because fuel is charged to EEA at subsidized prices i.e. pre-1973 prices and not at its export value or at international prices. Using international prices for fuel oil, the cost of generation per kWh from EEA's new steam plant 1/ has been estimated to be 14.4 milliemes of which 8.5 milliemes would be for fuel alone. This position will improve once the change over to associated gas firing is accomplished (para 2.06).

2.21 In 1975, EEA's average revenue per kWh sold was about 9 milliemes, barely sufficient to cover the fuel cost in new thermal plant. Industry, which consumes about 60% of electricity sold, paid on average only about 7 milliemes per kWh despite a tariff increase of 20% which was introduced in January 1975 for all consumers except municipalities and residential customers. Certain larger industrial customers are on special tariffs, the two most important being the aluminum smelter at Nag Hammadi which paid about 2.5 milliemes/kWh and the Kima fertilizer complex near Aswan whose tariff was increased from about 1.8 milliemes/kWh in 1974 to about 5.0 2/ milliemes/kWh in 1975. By 1979 these two customers are expected to account for about 36% of EEA's total sales.

1/ Sanderson & Porter - "Power Sector Survey - November 1976, P. 103, Table VII-1".

2/ A Ministerial Committee headed by the Minister of Finance reduced this rate to 3.354 milliemes per kWh for 1975 but has made no decision on the actual rates to be applied in 1976 and 1977.

The prices paid by these consumers and other industrial consumers are clearly less than the marginal cost of supply from Egypt's newest baseload steam plants. To the extent that these tariffs are below the long-run marginal costs of supply, these consumers are being subsidized through EEA. Action to correct this situation is expected to be taken by EEA following a tariff study (para 2.27).

2.22 The municipalities, who buy power in bulk from EEA at 10.5 milliemes per kWh (i.e. 9.0 milliemes/kWh for power and 1.5 milliemes/kWh for system operation and maintenance), bill all medium and low voltage consumers in the cities, towns and villages beyond Cairo and Alexandria. By law, the prices they charge may not exceed those in Cairo and Alexandria and in practice they are the same as in Cairo and Alexandria. (Where a customer's installed capacity exceeds 624 kVA, supply is provided directly by EEA which bills these consumers at its normal tariffs.) No doubt the cost of supply to rural consumers is higher than in Cairo and Alexandria but the Government is anxious to improve conditions in rural areas and has based its decision to establish a uniform tariff to low voltage residential and commercial consumers on the basis of the limited capacity of rural consumers to pay higher costs for supply.

2.23 Nearly all medium and low voltage rates are based on declining block tariffs. As consumption increases the price to the consumer is reduced, but the cost of incremental supplies may not be declining. As a result larger consumers who often can afford to pay more may in fact be paying less than the cost of supplying them. The tariff study proposed in para 2.27 is also expected to address this problem.

2.24 All consumers pay a charge for installation of a meter based on the type of service, in addition to a nominal monthly meter rental charge. Where existing lines have to be extended to supply a new consumer, that consumer pays in advance the cost of the extension, subject to a minimum charge of LE 1,000. Even at this price there are reported to be as many as 40,000 potential consumers willing to pay for supply but who cannot be connected because the distribution systems are already overloaded.

2.25 Changes in electricity prices can be secured only through a time-consuming and cumbersome process. First, EEA must determine its basic costs which are then checked by the Central Auditing Organization and the Price Planning Authority. They are then submitted to the Higher Council of the Electricity Sector, and finally approved by the Council of Ministers and issued as a Presidential decree.

2.26 In June of 1976, the Chairman of EEA set up a committee to study the costs of generation, transmission and distribution up to 1980, to recommend rate increases and to establish a fair basis for determining costs on which a tariff structure could be formulated. The committee has recommended that the cost of electricity should include:

(i) depreciation of the High Dam electrical assets and the 500-kV transmission and assets transferred to EEA by REA for operation and maintenance;

(ii) interest on all local and foreign loans; and

(iii) a 3% return on total invested capital as approved by the Council of Ministers on July 25, 1973.

Other important proposals of the committee were: consumers in the duty-free zones in Alexandria, Port Said and Suez should pay tariffs which include the international price of fuel (calculated at the parallel market rate of exchange), and local fuel and other price changes should be reflected in tariffs for all categories of consumers. Its proposals for increases in tariffs of about 10% were recently approved by EEA's board of directors and submitted to the Government for consideration.

2.27 EEA has agreed to employ consultants on terms and conditions satisfactory to the Bank to review existing tariffs and formulate an appropriate tariff structure and rates. This study, which would be financed by the Bank, would contain specific tariff rate recommendations taking into account the criteria of the EEA Committee mentioned in para 2.20. Anomalies and deficiencies in EEA's present tariff structure (paras 2.20 and 2.21) would be identified by the study. Appropriate terms of reference have been proposed to EEA by the Bank and a report is expected to be completed within 12 months after commencement of the study.

Sector Finances

2.28 Until 1976, the power sector finances of GEEC were for practical purposes part of the Government's. The GEEC budget was a part of the Government budget; any unspent funds and profits were returned to the Ministry of Finance at the end of each year. Since EEA was established it prepares its own budget for approval by its Board of Directors, which then must be ratified by the Minister of Electricity and Energy and finally approved by the People's Assembly. EEA's budget is a cash budget which is prepared only for one year. Its 5-Year Plan for investments is submitted to the Ministry of Planning for coordination with the national 5-Year Plan. The current plan for 1976-80 is still tentative and has not been ratified by the Parliament.

2.29 Day to day operation and maintenance, customer billing and accounting are controlled by the zone offices which appear to have considerable autonomy in relation to EEA's head office (para 2.13). At the head office, consolidated accounts are prepared on the basis of figures provided by the zone offices. Monthly cost reports are prepared on a cash basis but include uncontrollable costs such as overhead, depreciation and transfers. In any case they are reported to be issued too late to be effective for cost control. Customer billing and collection at the zone offices is partly computerized in Cairo and Alexandria. However, at Alexandria the transfer of records to the computer was made without provision for parallel operation. As a result the customer billing process for Alexandria as of December 1976 was several months behind. Financial consultants to be engaged by EEA (para 5.07) will look further into computerization of the customer accounting functions.

D. The Development Program

Generating Capacity

2.30 Generating capacity planned or under construction by EEA through 1982 totals 2,107.5 MW 1/ compared to an existing installed capacity of 3,815 MW. All the scheduled additions are thermal units--steam or gas turbines. Power and energy balances developed as part of the appraisal, Annexes 7 and 8, suggest some of this new capacity may be premature, particularly if due attention is paid to the increased utilization of the hydroelectric potential of the two Aswan Dams and the possibility of additional power installations in new and existing Nile barrages as recommended by S & P in the Phase I report of the UNDP Power Sector Survey.

Future Program

2.31 EEA predicts a large increase in specific new industrial loads between 1977 and 1982 as shown in Annex 9. Also, consumption by existing industrial loads is expected to increase by 900 GWh in 1976 and 180 GWh in 1977. New industrial loads in 1978 and 1979 would add 1,290 GWh each year. The next significant increase would come in 1982 when an additional 2,580 GWh per year is expected. EEA's figures appear optimistic in light of previous load projections and recent S & P findings shown in Annexes 10 and 11 respectively. Previous load forecasts are generally in agreement on a total consumption figure of approximately 20,700 GWh in 1980. They are also very close for 1985 with about 29,200 GWh. These values are below the 29,100 and 32,000 GWh figures predicted by EEA for the same years. An industry-by-industry review by S & P confirms a certain amount of over-optimism in the EEA figures. Not more than a 10% average annual increase of industrial load from 1976 to 1985 can be supported from the consultant's findings. This was the assumption for industrial load growth used in the generation and sales projections developed as part of the appraisal and shown in Annex 12. Assuming that distribution systems are improved as required, other consumption (residential, commercial, irrigation, etc.) was also assumed to grow at an average of 10%/a for the same period. The appraisal load forecast brings the figures suggested by EEA to more realistic values as supported by recent evaluation of potential industrial loads and previous projections. Annex 14 shows a detailed construction program to cover power and energy requirements to meet the needs forecast up to 1980. This program was also developed as part of the appraisal taking into account the EEA committed program. It will require an investment of LE 921 million (US$1,382 million) including escalation. Since a major objective of the Power Sector survey (para 1.03) is to improve EEA's planning capabilities, it is expected that the 1977-80 construction program will be scaled down somewhat to a program similar to that in Annex 14 deferring about US$120

1/ Sanderson & Porter - "Power Sector Survey" - November 1976, page 67, Table IV-1. (Applies to the EEA interconnected system only. Does not include several small diesel engine and gas turbine units going to isolated desert and coastal areas.)

million for at least two years, following receipt of the S & P recommendations on system planning expected about mid-1977. S & P are already taking steps in that direction (for example, an improved version of the WASP (see Annex 10) system planning program has been made available.) Improvements in utilization of hydropower production and peaking capabilities (assumed maximum capabilities were 12,000 GWh/a and 1,800 MW, respectively) are assumed in line with applicable recommendations of the Power Sector Survey Phase I report.

Transmission Program

2.32 Concurrently with the generation expansion program above, a massive program covering addition of lines and substations rated 500, 220, 132, 66 and 33-kV is under way to cover the needs of the EEA up to 1982 (about 1,600 MW incremental capacity). Additional transmission to connect future generation to be located near associated gas fields in the Gulf of Suez and to improve the Aswan-Cairo 500-kV system has also been proposed to EEA by S & P.

Distribution Program

2.33 Distribution facilities in most of Egypt are run-down and overloaded. Two major efforts are in progress to correct these deficiencies and restore adequate service. One, under EEA, covers Cairo and Alexandria and the Canal Zone. The other covers about 120 towns, 4,000 villages and 25,000 hamlets in the 80 zones of REA's National Rural Electrification Plan (Annex 13). The REA program was started in 1971 and to date some 84 towns have had their systems reinforced and expanded and 2,000 villages have been electrified in 28 zones. The remaining 52 zones are scheduled for completion during 1976-80. The Project covers about 60% of the remaining program in terms of number of zones, and 18% in terms of required investment.

III. THE PROJECT

A. Objectives

3.01 The Project would improve and expand electric power distribution facilities serving a regional population of 6 million people in about 32 zones. Through assistance for training, consultants, and studies, it would also strengthen organizational and institutional aspects of EEA and REA. In addition, proposed monitoring systems would gather and process basic statistical data to support expected improvements in EEA's and REA's planning capabilities and procedures.

B. Description

3.02 The Project, covering about 18% of REA's program for the period 1976-80, consists of approximately 3,400 km of 11-kV and 380/220 V overhead and underground distribution lines and related equipment, 230 MVA of substation and distribution transformer capacity and 100 km of 66-kV and 33-kV subtransmission lines and related facilities, training and consulting services (Annex 16). These facilities would be located in about 32 REA zones (13 urban and 19 rural) in Upper and Lower Egypt. Only the first 23 of those zones (9 urban and 14 rural) were appraised (see Annex 25, Attachment 1, and IBRD Map 12674). These zones are expected to be representative of the remainder, identified subsequently (Annex 15); however, since the Project provides for improvement in REA's planning and evaluation procedures, redefinition of the rural zones would be permitted as planning improves and detailed engineering progresses. The training component consists of audio-visual and other didactic material, 18 man-months of overseas training for Egyptian instructor-trainers, 108 man-months of technical assistance, and new dormitory-type accommodations for about 100 trainees at EEA's two training centers in Cairo. Consulting services would include about 264 man-months of engineering and studies for REA. The technical assistance component comprises 132 man-months of technical assistance for EEA to implement UNDP sector survey recommendations on financial administration and accounting, a tariff study and review of safety and inspection practices.

3.03 Rehabilitation and extension of existing distribution facilities would be done in stages. The Project would provide, initially, sufficient transformers, switchgear, cables, etc. representing 65-70% of the total installations needed to accommodate a 10-year load growth in each zone. The balance would be completed through additions as part of REA's routine program.

C. Status of Engineering

3.04 Some preliminary engineering was completed in 1971-73 by REA with the help of Soviet consultants at the start of the National Rural Electrification Plan. A great deal of the information developed then needs to be updated and upgraded. Recently, EEA engaged Harza Engineering Co. (US) to review current Egyptian distribution practices and recommend suitable planning, design and construction standards. Harza's contract, financed by USAID and originally intended to cover only Cairo, Alexandria and two provincial cities, was later amended to also include the urban areas in the Project zones.

3.05 The Project consultants would review all proposed rural zones--according to kWh consumption potential--to rank them for electrification construction priority. The consultants would then follow up with detailed design, bidding documents and specifications and construction supervision as further detailed in the Terms of Reference outlined in Annex 15. REA has elected to have Harza serve as consultants for the Project and requested retroactive financing of costs for these services incurred after May 1, 1977, not to exceed US$150,000. A contract acceptable to the Bank is under negotiation and Harza is expected to commence work on the Project before the end of May.

3.06 The ranking of the rural zones would aim at maximizing the financial and economic return on the Project. REA has included the following criteria 1/ in the terms of reference for the Project Consultants and will apply them to the selection of the remaining rural zones, and to REA's future development:

(a) Financial return should be enough to contribute to debt service within the first 10 years of operations.

(b) Internal financial rate of return, not less than 4% over a 25-year period.

(c) Average initial per capita income not less than US$50/a in the selected area.

(d) Income growth rate not less than 5%/a.

(e) Preferentially, the Project should include regions where:

- the quality of infrastructure, particularly of roads and waterways, is reasonably good;
- there is evidence of growth of output from agriculculture; and where, therefore,
- there is evidence of a growing number of productive uses in farms and agro-industries;
- there are a number of large villages, not too widely scattered;
- incomes and living standards are improving;
- there are coordinated plans for developing the regions; and
- the region is reasonably close to the central electricity supply system.

1/ (a) and (e) were taken from "Rural Electrification", World Bank publication, October 1975; others are mission recommendations.

D. Cost Estimates

3.07 The estimated cost of the Project (Annex 16) is US$70.6 million, of which US$50.0 million would be foreign exchange costs. The estimates, summarized below, do not include interest during construction, and since EEA and REA are both tax-exempt by law, taxes and duties are also excluded.

	LE Millions			US$ Millions		
	Local	Foreign	Total	Local	Foreign	Total
Overhead and Underground Transmission and Distribution	5.8	15.6	21.4	8.7	23.5	32.2
Substation equipment and Transformers	2.3	6.2	8.5	3.4	9.3	12.7
Engineering	.6	1.5	2.1	.9	2.2	3.1
Studies & Training	.8	1.5	2.3	1.2	2.2	3.4
Subtotal	9.5	24.8	34.3	14.2	37.2	51.4
Contingencies:						
Physical	1.0	2.7	3.7	1.5	4.1	5.6
Price	3.3	5.8	9.1	4.9	8.7	13.6
Total Project Cost	13.8	33.3	47.1	20.6	50.0	70.6

3.08 The estimated cost is based on REA estimates for similar work using late 1976 base prices. Project cost estimates were developed from unit costs in Annex 16. Consulting services were estimated at US$2.2 million for Project Consultants (264 man-months), US$1,092,000 for extension of the Power Sector Survey, tariff studies and review of safety and inspection practices (132 man-months), and US$648,000 for technical assistance in training (108 man-months). Physical contingency was assumed at 11% for all components. Escalation was applied in accordance with the following annual rates corresponding to expected conditions:

	1977-79	1980
Civil Works (local currency), %	12	10
Equipment & Materials (foreign currency), %	8	7

E. Financing

3.09 The proposed loan of US$48.0 million equivalent would cover 96% of the foreign exchange costs of the Project. The remaining costs would be financed by the Government and EEA. These funds are described as loans but are in fact treated as contributions would be subject to interest of 5%/a. It has been assumed that the Bank loan would be for 20 years including a 4-1/2 year period of grace. Interest during construction on the Bank loan of about US$8.0 million and the foreign exchange costs associated with the local erection contracts ($2.0 million) would be financed by the Government through EEA. The Bank loan would be guaranteed by the Government of Egypt but made to EEA who would make the proceeds available to REA under a subsidiary agreement excluding the portion for financial consultants, the tariff study, review of safety and inspection practices and training which would be disbursed to EEA. Execution of the subsidiary agreement would be a condition of loan effectiveness.

3.10 To ensure availability of adequate local counterpart funds when needed, the Government agreed as a condition of effectiveness to establish a special fund (to be replenished monthly) available to REA sufficient to meet at least three months' expenditure on the Project, as determined from time to time. In the event cost overruns occur, the Government will provide any funds needed to complete the Project.

F. Implementation

Responsibility

3.11 REA would be responsible for Project implementation, assisted by its engineering consultants. Within REA, the Project would be controlled by the pertinent divisions under the office of the Deputy Chairman for Technical Affairs through a coordinating Project Unit specifically established for the Project. REA established this unit and appointed suitable staff by means of an Administrative Resolution issued by its Chairman on April 5, 1977. At the Bank's request the Project Manager participated in the loan negotiations.

Project Monitoring and Statistical Data

3.12 The present decentralized distribution of power through municipalities has prevented collection of comprehensive statistical data on load patterns, total investment costs and operating accounts for the areas already electrified. Data of this kind is indispensable for future planning of the National Rural Electrification Plan and the overall development of electricity supply in Egypt. The Bank's recommendations with respect to monitoring the EEA system and the Project are shown in Annex 17. EEA agreed to adopt a system of indicators to monitor its technical and financial performance while REA agreed to develop a system to monitor the National Rural Electrification Plan by September 30, 1978, which would be implemented subject to any modifications requested by the Bank.

Construction Schedule

3.13 The Project facilities would be installed in the period 1978-80. As part of supervision services, the consultant proposed for the Project would develop detailed construction schedules and suitable monitoring devices including specifically critical path schedules. REA agreed that these schedules and any material modifications to them would be furnished promptly to the Bank. REA has customarily awarded installation and erection contracts to one of the three MEE construction companies. However, private local contractors have recently indicated interest in REA work and are expected to participate through local bidding procedures. REA agreed to provide the Bank with copies of the bid documents, specifications and contracts relating to the erection and installation of facilities provided under the Project.

Risks

3.14 There are no special risks involved in the implementation of this project, and because of the importance the Government attaches to rural electrification and of REA's dependence on the project to carry out a substantial part of its 1978-80 work program, the project should have a less than average risk. REA has experience with projects of this kind and its technical and managerial capabilities are being strengthened through consultants under the Project. MEE's contracting companies and private local contractors are expected to carry out the installation and erection works under the project; however, through EEA's parallel program for the improvement of the distribution systems of Cairo, Alexandria and the Canal Zone, their workload is heavy. To avoid related delays, cost increases, and other problems, EEA's consultants are studying how the capacity of the electrical contracting industry can be expanded and the efficiency of works can be improved through changes in design and construction practices. The Government is aware of the magnitude of local funds required for the project and special commitments have been obtained to ensure that shortage of local counterpart funds will not hinder project execution (para 3.10).

G. Procurement and Disbursement

3.15 The proceeds of the proposed loan would finance all of the foreign exchange cost of equipment and materials, consultants' services, studies and training required for the Project. Disbursement would be for the c.i.f. cost of imported items and related services and for the ex-factory costs of items manufactured locally, for 40% of the cost of dormitory-type facilities, and for 100% of foreign expenditures for consultants hired outside Egypt and 70% of local expenditures for consultants hired locally. The estimated disbursements from the proposed loan are shown in Annex 18. Estimated closing date is December 31, 1981. Contracts for equipment and materials would be awarded under international competitive bidding (ICB) consistent with Part A of the Bank Group "Guidelines for Procurement". A preference of 15% or applicable duties, whichever is the lesser, would be granted to Egyptian manufacturers who participate. However, because of the high manufacturing costs and heavy backlog of orders of local manufacturers, neither REA nor the Bank expect successful local bids. Retroactive financing of foreign expenditures for consultants' services up to US$150,000 is proposed (para 3.05). All funds are expected to be disbursed for the Project.

3.16 Contracting for dormitory type facilities (approximately US$1 million) would also be through ICB in accordance with procedures described in preceding paragraph. Disbursement would be against a percentage of the total contract cost (40%), representing the foreign exchange cost. Audio-visual and other didactic materials (approximately US$50,000), for the training component, and meters, relays and similar equipment requiring standardization, would be procured under "Other Procurement Procedures", Part B of the Guidelines, after inviting quotations from at least three suppliers or the manufacturers, as appropriate. Total cost of contracts awarded under Part B Procedures would not exceed US$1,000,000 equivalent.

3.17 Rational use of REA's stock would insure against delays in Project construction because of untimely deliveries. To permit this, disbursements for replenishment stock of distribution equipment and materials (e.g. poles, hardware, insulators, crossarms, distribution transformers, wire and cable, etc.) withdrawn after loan signing and used in the Project, would be permitted.

H. Environmental Impact

3.18 The work consists of rehabilitation of existing underground distribution plus extension of overhead lines in agricultural areas. Therefore, following conventional practices there would be no significant environmental impact.

IV. THE PROJECT ENTITY

A. Background

4.01 The REA will be responsible for supervising the execution of the Project. It was established in 1971 as the General Rural Electrification Authority and subsequently renamed the REA under Law 27/76 signed by the President of the Republic on March 23, 1976. Law 27 contains provisions similar to those for EEA. REA's main functions are:

(a) to study, plan and implement the Government's rural electrification program and upgrade the existing distribution networks up to and including 66 kV (except those for Cairo and Alexandria which remain EEA's responsibility);

(b) to connect new low and medium voltage consumers including local industries, irrigation and agricultural.

B. Organization and Management

4.02 REA's organization structure is shown in Annex 19. The functions of the various departments are described in Annex 20. It has about 5,000 permanent staff and engages at least another 20% on a temporary basis to meet construction needs in the field. Most of its managerial staff were formerly with EEA and there continues to be a regular interchange of staff between the two authorities. They also work closely together in the field where REA maintains a joint office with EEA in each of the 16 Governorates of Upper and Lower Egypt. Like EEA, REA is overstaffed and short of capable senior and middle level staff. REA would also expect to derive benefits from the enhanced training program (para 2.19).

C. Operations

4.03 REA records the costs of its construction works using simple hand-written cost records which show the direct cost of materials (at average cost) progressively as they are incurred. At year-end all the overheads or indirect costs are allocated to completed works or works in progress in proportion to the amount recorded for direct costs. Thus REA operates strictly on a cost recovery basis. Up to December 1975, REA had spent LE 80 million on electrification since its formation in 1971. All interest expense on loans including a 5% annual payment on Government contributions has been capitalized. So far REA has not transferred financially any completed work to EEA. From the end of 1976, REA is expected to hand over all completed work each year to EEA for operation and maintenance in accordance with recommendations of the EEA committee studying costs (para 2.26). The relevant loans and debt service obligations will be transferred to EEA with the completed fixed assets in accordance with arrangements with REA.

4.04 Prior to enacting Law 27, any funds provided by the Government in its budget for electrification in rural areas which were unspent at year end were retained by the Ministry of Finance and not transferred to REA for use in the following year. Under the new law REA may retain any unspent portion from the Government's budget for use in the next year. About 20% or LE 19 million of REA's expenditures to the end of 1975 has been financed by foreign loans of which LE 14 million were provided by Russia. Most of the foreign loans are in the form of suppliers' credits on concessionary terms.

4.05 The MEE has planned that REA should spend LE 262 million excluding interest during construction during the 1976-80 Five-Year Plan of which about 40% or LE 106 million would be for foreign costs. Firm sources of foreign financing arranged so far will provide only about LE 10 million, half of which is expected to be for equipment purchases from Russia. REA is actively seeking other foreign funds in the form of suppliers' credits and loans from bilateral sources on concessionary terms. In this context, it has requested US$25 million from the Canadian International Development Agency (CIDA). Also the Government has arranged for the provision of equipment from Finland in exchange for aluminum under a barter agreement. In addition to financing the distribution study USAID is planning to finance distribution projects in Cairo, Alexandria and two provincial cities and in the Canal Zone. The USAID financed distribution program is not being implemented under REA supervision but (as a part of Harza Engineering consulting services) by EEA. The Government is giving high priority to rural electrification, and all local costs are expected to be provided for in the Government budget. However, the availability of foreign funds will clearly determine the extent to which the REA electrification program can be achieved.

V. FINANCE

A. Past Performance and Present Position

5.01 Since REA acts only as the executing agency for rehabilitation and expansion of distribution works outside Cairo and Alexandria including that under the proposed Bank Project, the Bank has not made a detailed financial review of REA beyond identifying the adequacy of its budgeting process (para 4.03) and financial administration. Instead it has reviewed the financial position and prospects of EEA which would be the Borrower and initially responsible for ownership and operation of the Project facilities. As the EEA was only established as an independent Government-owned electricity authority in 1976, it has yet to present its first financial statements. Prior to 1976, EEA's predecessor, the GEEC, operated as a Government corporation which included the three construction companies that now report directly to the MEE. However, as the construction companies maintained their own accounts and only paid small dividends to the GEEC, the accounts of the GEEC provide an adequate guide to the electric utility sector's financial performance prior to 1976. As of February 12, 1976, EEA assumed all the GEEC's assets, liabilities, rights and obligations. The income statements and balance sheets of the GEEC for the years 1973 through 1975 are shown in Annexes 21 and 22. The accounts as of December 31, 1972 were for a period of 18 months following a change in the GEEC's fiscal year from June to December and these accounts have therefore not been shown. As the 1975 accounts were still being audited during the Bank's appraisal visit, the accounts for 1975 are preliminary.

5.02 Neither EEA nor its predecessor GEEC have earned a profit since 1972. Its financial performance is distorted by:

(a) previous years' adjustments probably arising from delays in completion of accounts by the zone offices;

(b) the use of the Government's standardized accounting system which is designed to measure production inputs and value-added for national statistical purposes;

(c) failure to separate EEA's liabilities from those of the REA and transfer completed assets to EEA;

(d) the valuation of fixed assets is not yet complete. Specifically the fixed assets forming part of the High Dam Project and associated loans are included in EEA's books at estimated values only; and

(e) problem areas identified by the GEEC's audit reports in previous years have not been corrected. As a result the GEEC's auditors have not been prepared to give an unqualified opinion on the accounts. Problems which are referred to in the auditor's reports include:

(i) lack of coordination between technical and financial departments which affects stock, work in progress, and fixed assets accounts;

(ii) the costing system does not enable control of work in progress, stock and in-transit items;

(iii) irregularities in stock records;

(iv) accounts with the zones not reconciled; and

(v) no inventory of fixed assets.

5.03 Unpaid electricity accounts at the end of 1975 1/ amounted to about LE 51 million representing almost 8 months sales; a provision for bad debts of almost LE 20 million had been made. Nearly all unpaid accounts are owed by the public sector; municipal councils, public utilities, government buildings and industrial companies. In some cases, failure to pay is due to inadequate budget provision by these organizations, in others it is due to refusal to accept the 20% rate increase which was introduced in January 1975. The Government agreed to take action to reduce the level of unpaid bills (para 5.12).

5.04 Although GEEC incurred a net loss in 1975, operating income was sufficient to provide a rate of return on average net fixed assets in service of 4.1%. If the provision for bad debts were reduced by half (i.e. LE 10 million), the rate of return would have exceeded 7%. However, the rate base, gross fixed assets in service minus depreciation, on which the rate of return was calculated, comprises fixed assets valued at historical costs and, as mentioned previously (para 5.02), in the case of the High Dam assets at an estimated value. Depreciation is based on the straight line method using rates established under the national standardized accounting system. There has been some adjustment to rates for hydro plant, transmission lines and substations since the High Dam was completed. These are now all proposed to be depreciated over 50 years (previously 40 years). Assets which remain in service after they have been fully depreciated continue to be depreciated at half rates. However,

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1/ Figures for 1976 were not completed but EEA estimated delinquent electricity accounts as of December 31, 1976 to be about LE 60 million.

the latter provisions which are held as a reserve for revaluation are small. Depreciation policies, with the exception of the provisions charged on assets which have been fully depreciated, are considered appropriate but gross fixed assets in service and depreciation should be revalued periodically to reflect price level changes and to provide an appropriate rate base for determining EEA's operating performance (para 5.06).

5.05 Since 1973, while gross fixed assets in service have grown at less than 3%/a to LE 436 million, sales have risen by 16%/a. This has been clearly a period of consolidation and little new investment due to Egypt's international problems, scarcity of funds, and adequacy of existing generating capacity. GEEC's capital structure reflects a similar trend; the debt/equity ratio was 75:25 at the end of 1975 (compared with 77:23 for 1973). The corporation's capital of LE 75.6 million has been unchanged since 1968. Most of EEA's existing long-term debt (about 88%) is owed to the Government and repayable over 12 years subject to annual interest of 5%. Foreign debts total about LE 40 million of which about LE 29 million is owed to the USSR and the remainder are short-term suppliers/export credits on soft terms. Foreign debts have not been revalued to reflect foreign exchange adjustments. Therefore, the Bank has proposed that they should be (see para 5.15).

5.06 Many of the problems described above have been diagnosed by Sanderson and Porter in their Power Sector Survey (para 1.03). Therefore the Bank suggested to EEA that the S & P team be supplemented by three additional financial consultants under a separate contract. The services of these experts would be financed under the proposed Bank loan for a period of two years at an estimated foreign cost of US$600,000. Their principal functions would be to assist EEA to:

(a) modify the national standardized accounting system to better meet the needs of EEA as an autonomous public utility authority especially for improved cost control and management information;

(b) update the fixed assets records and propose a simple formula for revaluation of EEA's fixed assets and depreciation provisions to reflect current price levels; and

(c) undertake a study of the feasibility of transferring customer billing, payroll and other high volume accounting activities to computer processing.

5.07 Accordingly, EEA agreed to employ consultants on terms and conditions satisfactory to the Bank to assist EEA in improving its financial administration and accounting systems.

B. Financing Plan

5.08 The forecast sources and applications of funds of EEA for the period 1976-80 is given in Annex 23. A condensed version for the Project construction period 1977-80 is given below:

		1977-80 Millions of LE	%
Capital Expenditure Requirements (excluding REA's program)		921	100
Sources of Funds			
Internal Cash Generation	421		
Reduction in Working Capital	19		
	440		
Less: Debt Service	(197)		
Net Internal Cash Generation		243	26
Contributions from Ministry of Housing and Reconstruction 1/		217	24
USAID Grants		19	2
Borrowing			
Proposed IBRD Loan	32		
Ministry of Finance	104		
USAID Loans	189		
Other Foreign Loans	117		
Total Borrowing		442	48
Total Sources of Funds		921	100%

5.09 It can be seen from the above table that EEA's investment program will require about LE 921 million (US$1.4 billion) which is expected to be financed 26% from internal sources, 26% from contributions and grants and 48% from borrowing. The financing plan appears to be appropriate. Arrangements for foreign financing are well advanced and seem assured but the Government may have difficulty providing its share of the total funds required because of its current critical shortage of funds and substantial commitments to other sectors of the economy. Procedures to ensure adequate provision of local currency by the Government for construction of the Project have been agreed with the Government (see para 3.10). However, the provision of funds by the Ministry of Finance for EEA's program is not likely to affect the Project which is being financed separately by REA nor is the Project specifically dependent on timely completion of plant in EEA's program. Incremental demands arising from the Project in 1980 represent a small fraction of the increase for Egypt as a whole.

C. Future Performance

5.10 EEA's future financial position has been estimated in income statements and balance sheets prepared for the years 1976-80 which are shown in

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1/ Contributions from Ministry of Housing and Reconstruction are for rehabilitation of power facilities in the Canal Zone.

Annexes 21 and 22. The assumptions used in preparing these forecasts are given in Annex 24. In the absence of a firm five-year investment plan and proper system planning, these forecasts have been assembled from data obtained from various sources within EEA.

5.11 The forecasts have been prepared on the basis that the Government and the MEE wish to establish EEA as a financially viable public authority which should attain a level of earnings which would provide some of its future expansion needs from internal sources after meeting its operating costs and debt service obligations. This supposition is supported by the Council of Ministers' decision of July 25, 1973, to include a return on total invested capital of 3% and the conclusion of the EEA committee studying costs (para 2.26) to recommend that local cost increases be reflected in EEA's cost structure and tariffs. It is further confirmed by the covenants that the Government and EEA have agreed to in the USAID loan agreement for the Helwan-Talka gas turbine project dated July 31, 1976. Under the terms of this agreement EEA have agreed to:

(a) set system-wide tariffs sufficient to produce an annual rate of return of 9% on average net fixed assets in operation, appropriately valued and revalued from time to time;

(b) attain a ratio of debt to equity no greater than 1.5 to 1; and

(c) meet the targets in (a) and (b) within three years i.e. by July 31, 1979.

5.12 Critical to EEA's future financial performance is its ability to collect overdue electricity accounts and reduce the volume of funds it has tied up in working capital (para 5.03). EEA is making concerted efforts to collect all overdue accounts. The Government has agreed to take all measures on its part to enable EEA to reduce its accounts receivables to not more than the equivalent of six months sales by March 31, 1978 and not more than three months sales by December 31, 1978. EEA is to submit to the Bank by the end of May 1977, a summary of the Government's plan and steps already undertaken to achieve the agreed targets.

5.13 If its budget estimates and forecast reduction in provisions for bad debts are achieved, in 1976 EEA could earn a rate of return of 10.5% on the existing book values of average net fixed assets in service. After 1976, net income is expected to decline rapidly again as costs increase especially salaries and wages, depreciation on new plant, and interest charges on new loans including the depreciation and charges relating to the 1971-75 construction by REA which is expected to be taken up by EEA at the end of 1976. During the period 1976-80 operating costs per unit are expected to increase by about 7%/a.

5.14 At the present time, it is not possible to assess with any accuracy the impact of revaluation of EEA's accounts (para 5.02). Neither has it been possible to quantify the savings which might be achieved by converting EEA's oil-fueled thermal plants to natural gas, improvements in the 500 kV transmission system and optimization of plant capacity at Aswan. Therefore, for the purposes of the financial forecasts tariff increases of 20% in 1978 and 22-1/2% in 1979 which would increase tariffs about 50% above present levels have been assumed. These would only be sufficient to achieve a 9% rate of return in 1979 on average net fixed assets at existing value. Tariff increases of this magnitude would in all likelihood not be sufficient to achieve a 9% return on a fully revalued assets base, (para 5.02). EEA has agreed, however, to complete the valuation of its existing assets and establish a formula acceptable to the Bank for revaluation of its existing assets by June 30, 1978. EEA has further agreed to submit to the Bank a plan or proposals by December 31, 1978, for tariff increases or other measures designed to achieve a 9% rate of return on its average net fixed assets in service after revaluation. Although EEA and the Government agreed with the Bank that a 9% financial rate of return was a reasonable target for EEA, it was felt in view of EEA's present financial position, that it may be difficult to achieve in 1979. However it was understood that the plan to be submitted at the end of 1978 would afford all parties an opportunity to exchange views on the target for 1979 and consult with USAID and other interested lending institutions which have agreed similar financial targets for EEA. Thereafter, EEA has agreed to submit to the Bank by the end of November each year a suitable financial plan for meeting the 9% rate of return in the following year. Since the rate of return is intended to measure the financial performance of the sector it would be calculated on the consolidated accounts of the EEA. These would include the accounts of distribution companies which the Government is planning to establish as EEA subsidiaries.

5.15 If the tariff increases assumed were to be adopted, EEA could expect to be able to finance about 26% of its construction requirements in the years 1977 through 1980. This would enable it to approach the debt/equity ratio target of 1.5 to 1 (60:40) proposed by USAID. The debt/equity ratio is expected to improve from 75:25 in 1975 to 67:33 in 1980. After revaluation of fixed assets, the 60:40 objective could well be achieved. More importantly from the Bank's viewpoint, the tariff increases assumed would, after 1977, provide sufficient internal cash generation annually through 1980 to cover EEA's debt service commitments more than 1-1/2 times. To ensure that EEA's debt to equity ratio continues to improve, and that its borrowing does not exceed prudent levels, EEA agreed to obtain the Bank's consent to any borrowings it plans to undertake whenever its internal cash generation is not sufficient to cover its debt service at least 1-1/2 times in any future year. In calculating amortization of long-term debt, EEA agreed that it would revalue all foreign debts at the end of each year in accordance with the current rates of exchange obtainable by the borrower.

D. Accounts and Audit

5.16 EEA prepares financial statements as of December 31 each year. The accounts are audited each year by the Government's Central Auditing Organization (CAO) whose reports are comprehensive and well documented. EEA's audited accounts are expected to be presented to the Government by the end of May each year. EEA agreed to submit its annual financial statements audited by the CAO or other independent auditors satisfactory to the Bank within six months of the end of each year and to take appropriate action each year with respect to matters identified in the auditor's report.

E. Insurance

5.17 EEA insures through a Government-owned insurance corporation to cover business risks normally covered by Government and public authorities in Egypt e.g. motor vehicles and stores and materials. It does not, however, provide insurance coverage against certain business risks normally covered by public utilities e.g. fire, machinery breakdown and public liability. The Government and EEA explained that the risks in EEA's operations are widespread and that provision is made in EEA's annual budgets to meet normal losses arising from exposure to these risks. In the event of catastrophic losses EEA, being a 100% government-owned authority, relies on the Government to meet major losses. Also, EEA agreed to undertake a review of existing safety and inspection practices for operation and maintenance of power equipment and facilities through employing consultants on terms and conditions satisfactory to the Bank.

VI. BENEFITS AND JUSTIFICATION

A. Main Benefits and Beneficiaries

Existing Conditions

6.01 Existing distribution facilities in the Project area, as well as in the rest of Egypt, are run-down and have been operating at overloads for some time. Lack of financing has prevented much needed modernization and expansion. Service is inadequate and many applications for new connections are pending in urban and rural areas for lack of distribution system capacity.

Immediate Impact of the Project

6.02 Under the present conditions no additional load growth is possible. The Project would add the needed system reinforcements to restore adequate service and allow normal load growth. It would also provide extensions to eliminate a large backlog of long-waiting service requests.

Load Forecast

6.03 Once the Project facilities begin operations, the load would resume growth along REA's estimate of 10%/a average rate on total kWh consumption. Annex 25 shows a forecast of sales generated by the Project of 1,039 GWh by 1989--compared to an estimated figure of 160 GWh in 1980--the first full year of Project operation. For the Project area, then, the average growth rate is being estimated at about 23%/a.

Beneficiaries

6.04 The Project would benefit about 6 million people. At least 30% of them would be getting electric service for the first time. The Project makes up about 20% of the National Rural Electrification Plan, a high priority program set in motion by the Government in 1971 to improve the lot of 30 million Egyptians outside Cairo and Alexandria through dependable supply of electricity for household uses, street lighting, irrigation and drinking water supply, and agro-industrial use. Abundant electricity first became available with the start-up of the Aswan High Dam hydro-electric complex and associated transmission system. Through electrification, the Government seeks to help correct the imbalance in living conditions existing between population in the two large metropolitan areas and those in smaller urban centers and rural areas. Bringing them electricity to foster industrialization and creation of jobs would reverse the present centralization trend and stem migration to the already hopelessly congested large cities.

Coordinated Development

6.05 The Project would cover 60% of the second five-year installment of the National Rural Electrification Program--effectively keeping it going-- to ensure it stays in step with other current regional health, agricultural and education programs aimed at decentralizing business, political and industrial activities; thereby inducing a more balanced national development and better distribution of income.

B. Economic Evaluation

Comparison of Supply Alternatives

6.06 As proposed, the Project would be supplied from the EEA unified power system. In the case of loads being connected to the central system for the first time, the alternative would be to supply groups of villages and hamlets from isolated diesel engine stations. To check whether the common central supply was the least-cost alternative, a remote zone located away from existing central system facilities was selected and an analysis made of the comparative costs of supply to this zone either from the central system or local, isolated units, over an assumed 25-year life of the distribution facilities. As shown in detail in Annex 26, the supply from the central system is less expensive at any of the discount rates considered (6-16%). The present worth of savings with central supply to this zone would total about LE 1.6 million at a 12% discount rate. Since the selected zone represents the least favorable situation, it follows that supply from the central system for the Project is the least-cost alternative.

Household Lighting

6.07 In newly connected households electricity will substitute for kerosene in residential lighting. An average home uses about 1/2 liter of kerosene per day for lighting purposes. The corresponding consumption of substitute electricity has been estimated at 15 kWh per household per month. A calculation was made of the resource cost savings resulting from the substitution of electricity for kerosene. At current prices for electricity LE 12.8 would be saved per household annually (a total of LE 2.1 million/a by 1989). Details are given in Annex 27. Large benefits are possible due to fuel savings since by 1980 the incremental fuel of the central system would be flared gas with a low opportunity cost, while kerosene is expensive.

Internal Economic Return

6.08 The internal economic rate of return (IER) on the Project is the discount rate which equalizes the present values of the time-streams of the attributable costs and benefits over the Project's life, assumed to be 25 years after its completion in 1980. As shown in Annex 27, the costs include the Project capital and operating costs, adjusted by shadow pricing unskilled labor and the opportunity costs of fuel. The associated benefits include revenues accruing to the municipalities--or distribution companies, as the case may be--from sales of electricity (at existing tariff rates) through the Project facilities. Where they could be quantified, resource cost savings through the substitution of electricity supplied by the Project for alternative energy sources were taken in lieu of revenues as the measure of benefits. The IER was estimated to be at least 10.2% for the urban centers and the rural zones taken together. Separate IER's were also estimated for the urban centers (at least 12.6%) and for the rural zones (at least 4.2%). These are minimum values of the rate of return since they are based mostly on sales revenues and do not take account of unquantifiable benefits such as:

- resource cost savings in irrigation and drinking water supply as present diesel-engines and other drives are replaced by electric motors

- increased productivity through additional power tools and equipment

- opportunity to promote literacy, population control and general education through specialized programs during non-daylight hours

- increased security and ease of movement after dark through street lighting.

6.09 Sensitivity tests indicate the above IER figures would be 8.8%, 11.0% and 3.2% respectively if the volume of estimated sales is reduced by 10%. Similarly, they would be 8.6%, 11.0% and 3.2% for a 10% increase in capital cost; 9.8%, 12.4% and 4.0% for a 10% decrease in resource cost savings through decrease in the price of kerosene; and 9.6%, 12.0% and 3.8% for a 10% increase in the cost of associated natural gas. The IER's are, therefore, relatively insensitive to reasonable variations in the main parameters. Tariff increases, which are not thought to significantly affect demand, would strongly influence the above figures (e.g. a 20% increase in tariffs to the Project consumers--corresponding to the tariff increases assumed in financial forecasts, para 5.14--would increase IER's to 17.8% in the urban centers and 6.8% in the rural zones).

VII. AGREEMENTS REACHED AND RECOMMENDATIONS

7.01 During negotiations, agreement was reached on the following principal issues:

(a) Government agreed to ensure that provisions with respect to establishment of distribution companies will be satisfactory to the Bank (para 2.14);

(b) EEA agreed to implement a training program (para 2.19);

(c) EEA agreed to employ consultants on terms and conditions satisfactory to the Bank to review existing tariffs and formulate an appropriate tariff structure and rates (para 2.27);

(d) The Government agreed to establish a special fund (to be replenished monthly) available to REA sufficient to meet at least 3 months' expenditures on the Project (para 3.10);

(e) EEA agreed to adopt a system of indicators to monitor its technical and financial performance while REA agreed to develop a system to monitor the National Rural Electrification Plan by September 30, 1978, which would be implemented subject to any modifications requested by the Bank (para 3.12);

(f) REA agreed to furnish to the Bank its detailed construction schedules and any material modifications to them (para 3.13);

(g) REA agreed to provide the Bank with copies of the bid documents, specifications and contracts relating to the erection and installation of facilities provided under the Project (para 3.14);

(h) EEA agreed to employ consultants on terms and conditions satisfactory to the Bank to assist EEA in improving its financial administration and accounting systems (para 5.07);

(i) Government has agreed to take all measures on its part to enable EEA to reduce its accounts receivables to not more than the equivalent of six months sales by March 31, 1978 and not more than three months sales by December 31, 1978 (para 5.12);

(j) EEA agreed to complete the valuation of its existing assets and establish a formula acceptable to the Bank for revaluation of its existing assets by June 30, 1978 (para 5.14);

(k) EEA agreed to submit to the Bank a plan or proposals by December 30, 1978 for tariff increases or other measures designed to achieve a 9% rate of return on its average net fixed assets in service after revaluation starting in 1979 (para 5.14);

(l) EEA agreed after 1978 to submit to the Bank by the end of November each year a suitable financial plan for meeting the 9% rate of return in the following year (para 5.14);

(m) EEA agreed to obtain the Bank's consent to any borrowings it plans to undertake whenever its internal cash generation is not sufficient to cover its debt service at least 1-1/2 times in any future year (para 5.15);

(n) EEA agreed that it would revalue all foreign debt at the end of each year in accordance with the current rates of exchange obtainable by the borrower (para 5.15);

(o) EEA agreed to submit its annual financial statements audited by the CAO or other independent auditors satisfactory to the Bank within 6 months of the end of each year and to take appropriate action each year with respect to matters identified in the auditors' report (para 5.16);

(p) EEA agreed to undertake a review of existing safety and inspection practices for operation and maintenance of power equipment and facilities employing consultants on terms and conditions satisfactory to the Bank (para 5.17).

7.02 The Project is suitable for a Bank loan of US$48 million to the Egyptian Electricity Authority with the guarantee of the Government of Egypt. The standard terms for Bank loans to Egypt of 20 years including 4-1/2 years of grace are appropriate. The loan could become effective within four months of loan signing; establishment of the special fund (7.01(e)) and execution of a subsidiary agreement (para 3.10) would be conditions of effectiveness.

May 24, 1977

APPRAISAL OF

A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Summary of Findings and Preliminary Recommendations of Power Sector Survey 1/ by Sanderson & Porter, Inc.

1. Introduction

1.01 The next several pages present a summary of the findings during Phase I of the Power Sector Survey. There are two, however, which are considered to be of particularly outstanding significance since they possess potentials for great benefits to Egypt's economy for years to come. One of these relates to the use of associated natural gas which is now being flared in the Gulf of Suez area and the other to the full utilization of the hydroelectric potential of the Nile. Each of these has the potential for savings of many millions of Egyptian pounds for many years in the future. Both are discussed below and in greater detail in other sections of the report.

2. Power Sector Energy Policy

2.01 Egypt's principal indigenous energy resources are hydropower, natural gas, and oil.

2.02 EEA's energy policy should be directed towards harnessing as rapidly as possible two energy sources where there now is undesirable waste - the additional hydroelectric potential of the Nile and the associated natural gas now being flared in the Gulf of Suez oil fields. Afterward other natural gas resources can be used to free more oil for export and improve Egypt's position in world trade. National planning over at least the next 20 years should be based on the use of gas resources to supply domestic needs, leaving oil available for export.

2.03 To assure optimum use of Egypt's energy resources, it is important that EEA work closely with the Ministries of Irrigation, Petroleum, and Industry. Better coordination between the Ministries and their planning groups at the working level is essential. EEA's planning staff will have to be strengthened to accomplish the needed results.

2.04 Fuel pricing policies should be examined carefully and choices of production methods between high and low energy technologies available to some industries can be of major importance to the Nation's economy.

1/ Issued November 20, 1976.

2.05 In order to assure optimum use of Egypt's alternative energy sources, marginal costs of producing and delivering electric energy should be prepared on a regular basis and supplied to other concerned Ministries for their planning purposes.

2.06 Regular inter-Ministry planning liaison with regard to the economics of supplying large prospective power system loads is needed.

2.07 There may be opportunities for beneficial international coooperation between Egypt and several other countries in North Africa and the Middle East who are involved in extensive energy resource development and use programs.

3. Organization and Management

3.01 EEA was created by Law 12 early in 1976 but the new organization has not been fully implemented because of the lack of needed by-laws. It is highly desirable that this situation be corrected as soon as possible.

3.02 EEA is over-organized in some areas and understaffed in others with a serious need for qualified personnel to whom some of the management responsibilities now assumed by a relatively small number of top officials can be delegated.

3.03 EEA management realizes the existing personnel problems but is handicapped by serious shortages of qualified personnel, losses of capable people to other organizations both within and outside Egypt, and regulations governing employment, salaries, and promotions.

3.04 It is recommended that an effective management development program be organized to assist in solving some of the existing personnel problems. EEA's top management is staffed by a highly qualified group dedicated to their responsibilities of developing the electric power resources of Egypt, but many need substantial assistance in order to relieve them of overburdening workloads now prevailing.

3.05 The total number of EEA employees is extraordinarily large in terms of the electric system as compared to electric utilities in some other countries.

3.06 A high level engineering planning group should be organized and given the responsibilities for long-range power system planning.

3.07 The Studies, Research, and Projects Sector and the Operations Sector should be reviewed in terms of responsibilities and organizational needs.

4. System Operations

4.01 The Egyptian Unified Power System includes two large hydroelectric stations and a number of oil-fired thermal stations. Immediate attention should be given to the conversion of some of the thermal plants from oil to natural gas.

4.02 Housekeeping practices should be improved at a number of stations to reduce fire and safety hazards, improve general appearance, and perhaps produce better equipment performance in some cases.

4.03 An improved program is needed for the maintenance of metering, instrumentation, and operational monitoring equipment so that information needed by operators will be available and reliable especially during times of system emergency.

4.04 Accurate automatic system frequency control is becoming an increasingly important need of the Unified Power Ssytem, and provision of such a control system is recommended.

4.05 Establishment of a strong technically oriented central relay, instrument, and meter laboratory to supplement the existing zone arrangements is recommended. It would provide specialized expert repair, rehabilitation, preventive maintenance and calibration of delicate equipment.

4.06 Some EEA Zones now hold regularly scheduled meetings at frequent intervals with representatives of major customers to discuss power supply, future requirements, or related questions. This is a commendable practice and it is recommended that it be adopted in other areas where not already used. Communication between EEA and its customers and with other governmental organizations is often a problem and concerted efforts to improve communications both internally and externally would be helpful in solving many operating problems.

4.07 Future use of the hydroelectric potential of the Aswan and High Dams probably offers one of the greatest economic opportunities available to EEA. To accomplish this requires better coordination with the Ministries of Agriculture and Irrigation and also improvements in 500-kV transmission line performance if optimum benefits are to be achieved. It is urged that these opportunities be explored promptly.

4.08 Water leaks around sector gates at the High Dam should be corrected while the loss of water is less significant than it may be in the future.

4.09 More thorough analysis of power system interruptions is recommended with a view to improving system coordination, performance, and reliability.

4.10 A number of independent small generating units are still being installed at industrial plants in Egypt. Every effort should be made to meet usual customer service requirements through service from the Unified Power System and curb the proliferation of small units.

4.11 Cooling towers now under construction at Karmouz station should be completed before the hot weather season of 1977 so that more of the plant's capacity will be usable to meet next year's load requirements.

4.12 Inventories of spare parts on hand and those needed for maintenance stock are recommended. Also special requirements to restore inoperable equipment to service should be identified in order to facilitate decisions as to whether such equipment will be returned to use or permanently retired.

4.13 Shortages of appropriate tools and maintenance equipment have been reported in some locations and an inventory of these needs is recommended.

4.14 It is suggested that each Power Station and Network Director be invited to submit a resume of outstanding needs in his area of responsibility in order that a determination of overall needs and relative priorities can be made.

5. System Planning

5.01 Appointment of a System Planning Engineer to the initial Power Sector Survey Team was delayed four-and-a-half months because of funding limitation. Consequently the System Planning aspects of the Survey largely remain to be developed later in the course of the survey work, and the corresponding section of this report is limited to general observations and comments.

5.02 A relatively large number of new generating units is already committed or anticipated in the near future. A comprehensive study of future system plans is recommended to assure adequate coordination between these unit additions and associated transmission system expansion programs.

5.03 Modifications and improvements of the 500-kV system are needed to permit reliable transmission of larger amounts of power from the High Dam to the Cairo and Lower Egypt areas. Significant fuel savings appear to be the reward for improved line performance and increased transmission capability.

5.04 EEA needs a capable engineering section to do long-range planning and develop an orderly system expansion program for meeting future load growth requirements.

5.05 An adequate load reporting and forecasting system should be developed to meet the specific needs of EEA for system planning purposes.

5.06 The option of providing hydroelectric generating facilities at the existing Nile barrages should be examined immediately. The usefulness of such capacity seems promising and any work to accomplish it should be included in the projects for rehabilitation and improvement of the existing civil works.

6. Distribution

6.01 The Power Sector Survey Team's responsibility with respect to distribution systems and problems is limited to coordination of the Power Survey with distribution studies which are to be carried out separately. Such coordination will be made with the studies planned for Cairo, Alexandria and two other provincial capitals and expected to be started in 1977.

7. Accounting and Finance

7.01 The national standard accounting system, by which EEA is now limited, should be supplemented by accounting practices adapted especially to public utility operations in order to improve cost control and management information.

7.02 The Operating Budget should be subdivided for more significant comparisons with actual results, and emphasis should be given to controllable expenses.

7.03 Headquarters should exercise stronger leadership in coordination and supervision of Zonal accounting practices, and eliminate bottlenecks delaying prompt reporting of accounting and cost data.

7.04 Financial reports should be made more useful to operating management.

7.05 Supplementary Management Information reports should be expanded to meet needs of operating management and provide performance indicators for key management functions, not limited to technical functions.

7.06 Commercial operations should recognize the need for marketing and customer relations, especially services for large industrial consumers and for prospective consumers.

7.07 Revenue analysis should be reinforced to develop more complete analysis of consumption patterns for revenue forecasting and tariff planning.

7.08 Mechanization of commercial accounting should be coordinated on system-wide basis for eventual integration with other data processing requirements in large volume.

7.09 Long overdue delinquent accounts should be settled as quickly as possible and management of collections strengthened in order to minimize delinquencies in all categories.

7.10 Cost analysis and reporting should be standardized and given higher priority, so that significant results can be made available in time for effective follow-up.

7.11 Losses of energy not billed should be analyzed at all levels and avoidable losses minimized especially at distribution levels.

7.12 Fixed asset property accounting records should be improved, possibly requiring a physical inventory for transfers of properties and determination of a base for measuring return.

7.13 Planning should be started for uniform coding and eventual computerization of large volume processing functions, already begun in several isolated cases.

7.14 Performance measurement factors should be developed as a guide for management at all levels.

8. Tariffs

8.01 The marginal cost of producing electric energy should provide the basis for establishing EEA's electricity tariffs, and the calculation of marginal cost should include not only the total costs of facilities including financing charges but should take into account also both the domestic and international prices of fuels.

8.02 Government policy is for all industry to pay the full cost of energy consumed, calculated at domestic prices. Further industries producing for export should pay a supplement to cover the full export value of fuel embodied in that part of its operations. Marginal costs are not yet fully reflected in EEA tariffs and should therefore be furnished periodically as appropriate to other concerned industries for their planning purposes. The marginal cost calculations should provide figures at both the prevailing domestic price and the export value on "opportunity cost" of the fuel. As also suggested in the Energy Resources and Policy Section, there should be regular inter-Ministry planning liaison with regard to large prospective loads, total costs of supply including transmission, conditions of service, and other relevant factors.

8.03 EEA's cost estimating guidelines require it to take into account all costs, depreciation and actual interest payments on loans, plus a return of three percent on the value of its invested capital. If assets are undervalued, the cost calculation and therefore the tariffs derived from them will not produce sufficient funds for replacement of those assets. A December 1972 study valued EEA's assets at LE 420 million, equivalent to $630 million at today's "parallel market" exchange rate. Replacement value of EEA's 3845 MW generating capacity plus transmission and distribution systems might approximate $4 billion. 1/

8.04 EEA receives residual fuel oil (and natural gas) not at oil's export price or "opportunity cost" of $60 per metric ton but at a subsidized price equivalent to $11.25 per ton at the "parallel market" exchange rate of LE 1.00 equals $1.50.

1/ This figure represents the opinion of the consultant and not necessarily that of the Bank.

8.05 An example calculation based on current estimates of costs for construction and operation of a new 2 x 150 MW steam power plant shows production costs of 2.16 U.S. cents/kWh for the higher fuel price and 1.14 cents/kWh for the lower.

8.06 EEA's average billing rate was 9 milliemes/kWh in 1975. This provides relatively low revenues in terms of replacement values or assets. Furthermore, current investments in new facilities will force tariffs upward. If EEA were required to pay the export price for its fuel oil, the tariff structure would also have to undergo a sharp increase.

8.07 While all consumer sectors are being charged rates below the marginal economic cost of producing and delivering electricity, the lowest rates and greatest disparities are in the industrial sector. Appropriate adjustments should be considered to help support the high marginal costs of new facilities being added to the UPS and to assure the financial solvency of EEA. Some of the aluminum and fertilizer operations are analyzed in Section VII of this report as examples of the need to reexamine the tariff structures and seek more equitable bases for power supply to these types of consumers.

9. Training

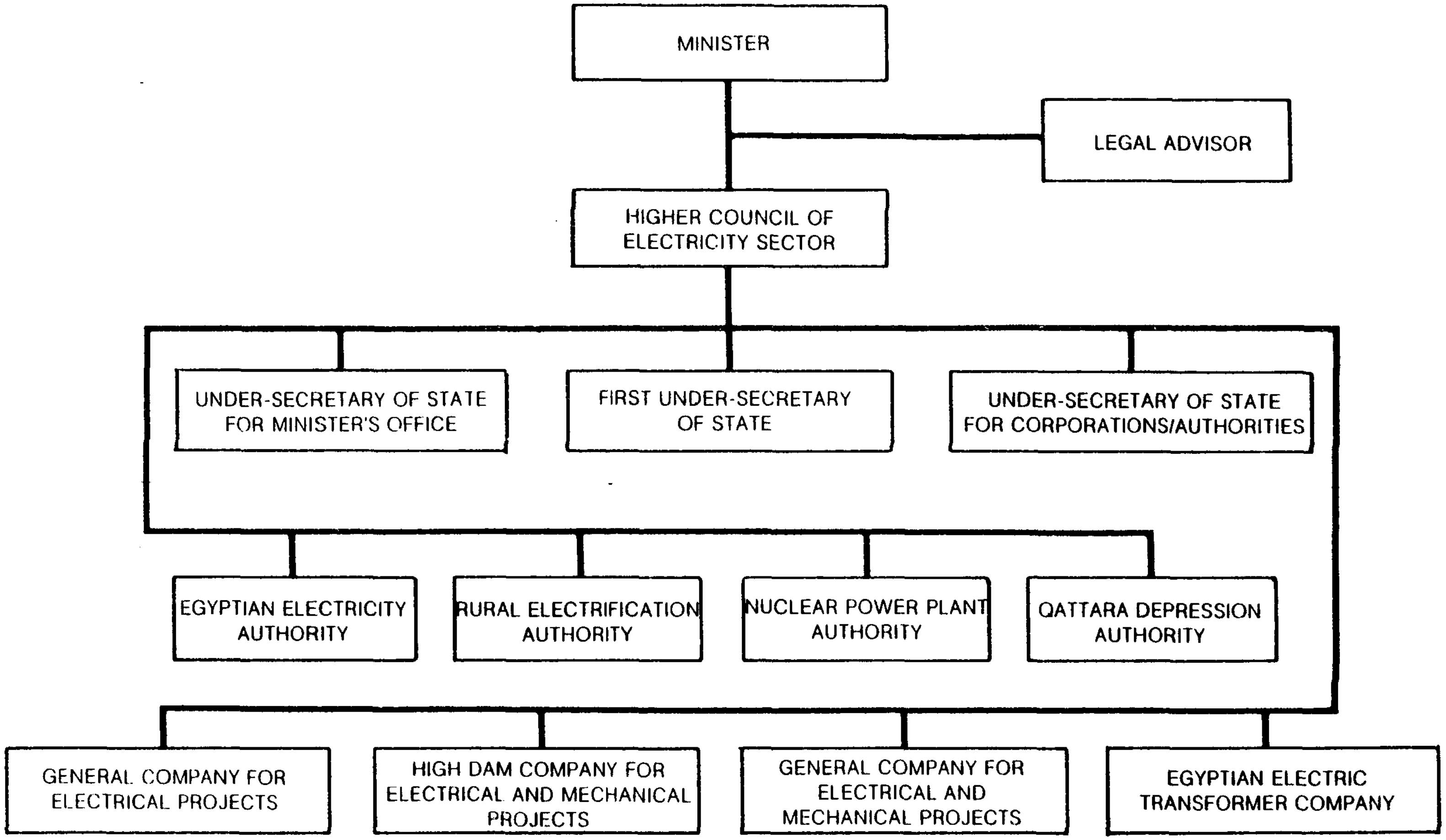
9.01 During Phase I of the Power Sector Survey, it has been impossible to accomplish any significant training of national counterparts who are upper management people with responsibilities and work loads that preclude much attention to day-to-day work of the Survey Team. It is recommended that EEA consider whether some changes in assignments are desired so that more training through work association will be possible during the remainder of the project.

9.02 It is recommended that ways be explored to better utilize the facilities of the technical training institute at Cairo South station.

9.03 It is recommended that short courses for further education and development of technical employees be organized. It appears that there are engineers within existing employee ranks who are qualified to serve as part-time instructors for courses of this nature. Along the same line, selected courses from local university curricula may offer opportunities for further development of interested employees.

ANNEX 2

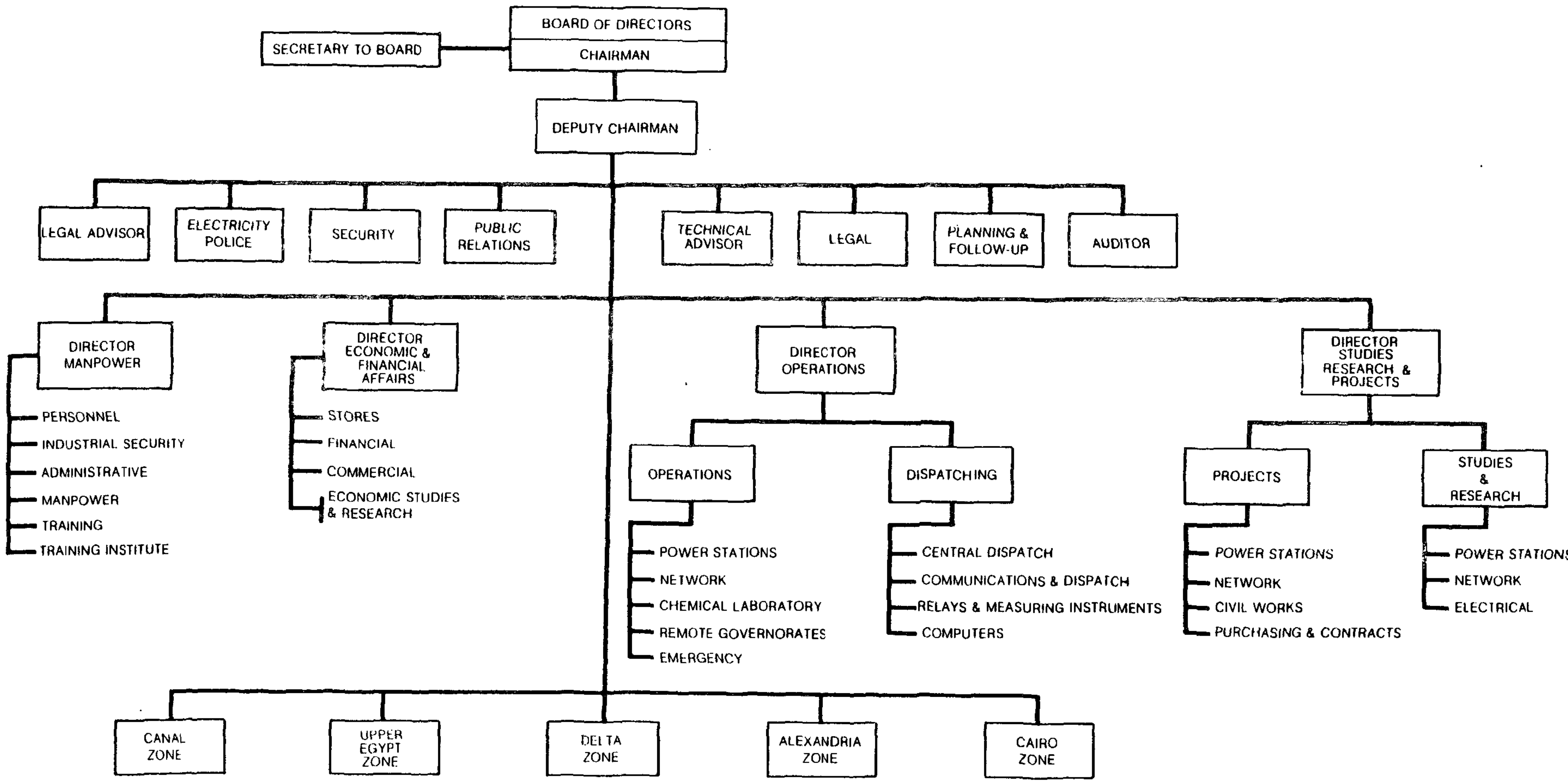
EGYPT
MINISTRY OF ELECTRICITY AND ENERGY
ORGANIZATION CHART



May 1977

World Bank—16892

EGYPT
EGYPTIAN ELECTRICITY AUTHORITY
ORGANIZATION CHART



May 1977

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Summary of Law Establishing EEA

1. Law No. 12 of 1976 establishing "The Egyptian Electric Power Authority" was ratified by the People's Assembly on January 18, 1976.

Legal Existence

2. The Authority is a legal entity affiliated with the Ministry of Electricity and Energy. Its head office is in Cairo.

Functions

3. EEA's functions are:

(a) Implementing generation, transmission and distribution Projects.
(b) Management, operation and maintenance of power stations.
(c) Regulation of loads on the main networks throughout Egypt.
(d) Distribution and sale of electric power throughout Egypt.
(e) Studies and Research.

Capital and Sources of Funds

4. The Authority's capital comprises the funds of the General Eyptian Electricity Corporation (GEEC) and funds appropriated by the State. Its revenues and sources of funds are proceeds of sales of electricity, Government subsidies, funds appropriated by the State, proceeds of works and services, Government loans, credit facilities, donations and grants.

Budget

5. The Authority has its own budget unrestricted by the laws governing preparation of the State Budget. Any budget surplus can be carried forward from year to year.

Interest Rates on Government Loans

6. The Council of Ministers sets the interest rate on Government loans.

Capacity to Contract

7. The Authority can enter into contracts with individual companies, banks and local and foreign organizations for purposes for which it was established.

Importation of Goods

8. The Authority can import its requirements without permits or restrictions by laws and regulations governing importation or foreign currency. Imports for its projects are exempt from customs duties and taxes.

Board of Directors

9. The Chairman and his salary are determined by Republican decree. Members of the Board are appointed by Order of the Prime Minister on the recommendation of the Minister of Electricty and Energy. The Board is responsible for the management of the Authority's affairs. It approves the Authority's regulatory structure and prepares electricity tariff proposals which are approved by the Higher Council of the Ministry of Electricity and Energy and the Council of Ministers.

The Board also has the discretion to:

(a) Approve the Authority's draft annual budget and balance sheet.
(b) Make budget transfers from one item to another.
(c) Lay down the Authority's internal regulations.
(d) Frame personnel allowances.
(e) Propose contracting for loans.
(f) Accept donations and grants.
(g) Review progress and financial reports.
(h) Review any items submitted by the Chairman or the Minister.

10. All the Board's resolutions are communicated to the Minister by the Chairman within 3 days. They become enforceable unless the Minister objects to them in writing within 30 days.

Chairman

11. The Chairman's duties include:

(a) Execution of the Board's resolutions.

(b) Managing the Authority.

(c) Supplying the Minister and State bodies with information they request.

(d) Representing the Authority in the courts.

Statutes

12. The Authority's statutes are to be issued within 6 months of the date of publication of this law in the official gazette. They will take into consideration:

(a) Linking wages to productivity.

(b) Maximum pay scales related to Government's civil servants.

(c) Incentive bonuses and allowances should not be greater than double the salaries set.

(d) Main principles of the social insurance scheme (Law 79 of 1975).

(e) Travelling allowances and expenses should not exceed the actual expenses incurred.

(f) Adoption of the rules of the standard accounting system.

(g) Direct operations should only be entrusted to foreign firms or international experts with the approval of the Minister.

(h) The most up-to-date supply rules.

Personnel

The GEEC personnel are transferred to the Authority without any further measure.

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Training

Introduction

1. The electric power sector has been well provided in the past with training assistance from both bilateral and multilateral sources. As a result, excellent facilities exist for the training and re-training of technical staff at all levels. However, these facilities are underutilized because of:

(a) a shortage of trained instructors;

(b) lack of living accommodation for trainees, necessitating their finding temporary accommodation in Cairo and commuting to the Training Centers; and

(c) an unwillingness, on the part of management in Zones away from Cairo, to release staff to attend training or re-training courses.

Measures are included in the Project to overcome these problems.

2. The training of financial and commercial staff has been neglected, although short orientation courses for meter readers and supervisors are conducted occasionally in EEA headquarters. There is a need to introduce regular training courses to meet the needs of the Departments of Financial and Commercial Affairs at all levels, and provisions are made in the Project to enable EEA to achieve this.

3. Finally, the future success of EEA's manpower development efforts will depend on the strength of the training organization within the EEA. At present, the key position of Director General of Training is vacant, and it is necessary to ensure that when the post is filled, the incumbent is aware of the requirements and is able to carry them out. Technical assistance is provided in the Project aimed at establishing a dynamic organization capable of meeting the training needs of the sector in the long term.

The Institute of Engineers (Cairo South)

4. This Training Center, located on the site of the Cairo South thermal generating station, was established between 1967 and 1973 through a UNDP-financed ILO project, the original objectives of which were:

(a) to establish orientation and upgrading courses for graduate engineers;

(b) to establish a pilot training program for field staff engaged in rural electrification projects; and

(c) to set up instructor-training courses.

5. During the life time of the Project, (b) and (c) were dropped, the first due to implementation problems, and the second because it became the intention to train instructors at a centralized Instructor Training Institute (ITI) in Cairo. This plan failed to materialize, when the ITI was taken over entirely for the training of military personnel, and no arrangements for instructor training were made as an alternative; an eventuality which has resulted in the present serious shortage of trained instructors mentioned in para. 1(a).

6. Excellent facilities and courses were established by the ILO team, however, in the following fields:

(a) thermal power plants and turbines;
(b) switchgear and protection;
(c) telemetering and instrumentation;
(d) transmission and distribution;
(e) load dispatching;

and the associated laboratories, workshops and classrooms are capable of handling a throughput of about 800 engineers per year for orientation and upgrading training. Because of the reasons listed in para. 1, however, only 273 engineers attended the Center during 1976.

<u>The Training Center for Mechanical/Electrical Skilled Workers and Technicians (Cairo North)</u>

7. This facility, located adjacent to the site of the Cairo North thermal generating station, was established through Russian aid in 1973. Here, too, excellent workshops, laboratory and classroom facilities exist for the training of middle and lower level technical staff in the following fields:

(a) repair and installation of transformers and electrical machines;

(b) repair and installation of substation switchgear;

(c) repair of relays and control devices;

(d) village electrification;

(e) repair of measuring instruments;

(f) jointing of underground cables;

(g) operation and repair of low and medium voltage distribution systems;

(h) water treatment;

(i) general machining, welding and sheetmetal work.

8. In spite of the fact that the facilities could take about 3,000 trainees per year, only 900 passed through during 1976, the reasons for this underutilization being the same as those affecting the Cairo South Institute. An additional problem faced by this Center, however, is the lack of spare parts for the Russian equipment, but this could be largely overcome by more forceful management of the Center, either through direct procurement or by making the more simple parts locally.

Financial, Commercial and Management Training

9. The need for the EEA to improve the effectiveness of its middle and top management, through a series of seminars and training workshops, is being taken care of through a program financed by American assistance. There remains, however, the need to introduce both short orientation courses for all new staff in the financial and commercial departments, and upgrading courses for existing staff, aimed at improving their job performance.

The Training Component of the Project

10. A total of 9 man-years of technical assistance will be provided to the EEA as follows:

(a) A Training Adviser for 3 man-years who would act in the vacant post of Director General of Training. His duties would include:

(i) advising the Inspector General of Manpower in the EEA on all matters related to recruitment, training and manpower development;

(ii) establishing links with management in the Zones to stimulate their cooperation in nominating and releasing staff to attend training courses conducted in the two Training Centers;

(iii) reviewing the suitability of existing courses against the present needs, and introducing changes, as required;

(iv) providing technical leadership to the instructional staff at the Training Centers, and particularly to the Directors of the Centers, so as to improve their managerial effectiveness;

(v) assisting the EEA in identifying a local incumbent for the post of Director General of Training, and ensuring that he is in every way capable of taking over the responsibilities on completion of the technical assistance input.

(b) An instructor Training Specialist for three years to set up and conduct training courses for EEA staff selected to be re-trained as instructors. The courses would be installed at the Cairo South Institute for Engineers, but will meet the needs for instructors at both the Training Centers, including those needed for the planned courses for financial and commercial staff.

(c) A Specialist in the training of financial and commercial staff for three years. His duties will include close liaison with management in the Zones through the Training Adviser, and with the Directors General of the Financial and Commercial Departments of the EEA, so as to accurately identify the training needs in these areas, and to prepare and conduct training courses accordingly.

11. Dormitory-type living accommodation, together with associated cafeteria and ablution facilities for 100 trainees is badly needed at both Training Centers. This would encourage managers to nominate trainees from the Zones rather than have them face the almost impossible task of finding temporary lodgings in Cairo and commuting daily to the Centers.

12. A new building would be required on the Cairo South site, and adequate space is available. At Cairo North, it would be possible to rehabilitate existing buildings and provide only minor additions.

13. There is a marked shortage of wall charts, cutaway models and other training materials in both the Centers. Funds are provided in the Project to make up this deficiency and thus improve the effectiveness of the training programs.

14. In order to ensure a continuous replacement of instructors lost by attrition or transfer within the organization, it will be necessary for selected Egyptian instructors to take over the instructor-training role when the technical assistance input ends. Provisions are made in the Project for up to 18 man-months of overseas training for these instructor-trainers.

Training Costs

15. The estimated foreign cost of the training component is as follows:

		US$
(a)	Technical Assistance	
	108 man-months at an estimated $6,000 per month	648,000
(b)	Foreign exchange component of civil works required to provide the necessary living accommodation for 100 trainees at both Training Centers (40% of total cost)	400,000
(c)	Audio visual and didactic materials	50,000
(d)	18 man-months of overseas training for Egyptian instructor-trainers at $3,000 per month	54,000
	Total	$1,152,000

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APPRAISAL OF

A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Egyptian Electricity Authority Tariffs

High Tension/Industrial Consumers

132 kV and 220 kV	-	5.072 milliemes/kWh 1/
11 kV, 33 kV and 66 kV	-	6.464 milliemes/kWh 2/

Medium Voltage/Industrial Consumers 5/

Consumers below 11-kV contracting for more than 500 kW are charged as follows:

(1) Fixed Annual Demand Charge - LE 5.62/kW

(2) Energy Charge 3/

first 1,000 hours/year	-	10.103 milliemes/kWh
next 500 " "	-	9.503 " "
" 1,000 " "	-	8.303 " "
" 1,000 " "	-	7.103 " "
" 1,500 " "	-	5.403 " "
excess over 5,000 "	-	4.603

Medium Voltage Consumers

Consumers below 11-kV contracting for between 8-kW and 500-kW.

Energy Charge only 4/

first 70,000 kWh	-	20.347 milliemes/kWh
next 100,000 kWh	-	16.647 milliemes/kWh
excess over 170,000 kWh	-	15.847 milliemes/kWh

1/ Includes a fuel factor of 1.257 milliemes/kWh) fuel factors are
2/ " " " " 1.306 " ") set arbitrarily
3/ " " " " 2.998 " ") by Government
4/ " " " " 1.947 " "

5/ Hours of demand schedule shown for energy charge apply to public sector industries; private sector have the same rates applied to lower hours of demand; ranging from 750 hours at the first step to 3,000 hours for the sixth step.

Commercial and Small Shops 6/

Consumers using a 380-volt service where installed capacity is below 625 KVA.

first 45 kWh	-	22.347 milliemes/kWh
excess over 45 kWh	-	18.947 milliemes/kWh

Residential Consumers 7/

first 45 kWh	-	16.5 milliemes/kWh
excess over 45 kWh	-	10.0 milliemes/kWh

Municipalites 8/

Bulk Supply - 9 milliemes per kWh plus 1.5 milliemes for operation and maintenance.

6/ These rates not yet being applied. Old rates which are still being applied range from:

Daylight hours (2300 to 1700)	(first 200 hours/year	16.0 milliemes/kWh
	(to over 2000 hours/year	7.7 milliemes/kWh
Night rates	(first 400 hours/year	24.1 milliemes/kWh
	(to over 1000 hours/year	11.6 milliemes/kWh

7/ Residential consumers in Cairo and Alexandria are charged a stamp tax of 5 milliemes/kWh on all consumption and a radio license fee of 2 milliemes/kWh on the first 45 kWh sold. These taxes are collected by EEA and paid to the Government.

8/ Residential consumers in the municipalities beyond Cairo and Alexandria also pay these same taxes except the radio license fee is only 1 millieme. Industrial consumers with less than 625 kVA pay a fixed rate of 15.2 milliemes/kWh.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

UNIFIED POWER SYSTEM

EGYPTIAN ELECTRICITY AUTHORITY

Installed and Available Generating Capacity and Peak Demand (1976-1985)

(MW)

	Installed Generation Number and Rating of Units	Total	Available Generating Capacity 1/ 1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
I. Steam Stations												
a. Existing												
1. Cairo West	3 x 87	261	230	230	230	230	230	230	230	230	230	230
2. Cairo South	4 x 60	240	180	180	180	180	180	180	120	120	120	120
3. Cairo North	2 x 30 + 1 x 20 + 2 x 10	100	60	60	60	30	-	-	-	-	-	-
4. Tibbin	3 x 15	45	28	28	28	28	28	28	28	-	-	-
5. Talkha	3 x 12.5 + 3 x 30	127	127	127	127	127	127	90	90	90	90	90
6. Damanhur	2 x 15 + 3 x 65	225	210	210	210	210	210	210	210	210	210	210
7. Siuf	2 x 26.5 +2 x 30	113	100	100	100	100	100	100	100	100	100	100
8. Karmouz	4 x 16	64	30	30	15	15	15	-	-	-	-	-
9. Assyout	3 x 30	90	60	60	60	60	60	60	60	60	60	60
Total Existing		1,265	1,025	1,025	1,010	980	950	898	838	810	810	810
b. Planned or Under Construction (1976-1982) 2/												
1. Kafr El Dawar	2 x 110	220		220	220	220	220	220	220	220	220	220
2. Cairo West Expansion	1 x 87	87				87	87	87	87	87	87	87
3. Abu Qir I	2 x 150	300					300	300	300	300	300	300
4. Abu Qir II	2 x 150	300					300	300	300	300	300	300
5. Suez I	2 x 150	300						300	300	300	300	300
6. Ismailia	2 x 150	300							300	300	300	300
7. Suez II	2 x 150	300									300	300
8. Plant "X"	1 x 300	300										300
New Steam		2,107		220	220	307	907	1,207	1,507	1,507	1,807	2,107
c. Total Steam Plant		3,372	1,025	1,245	1,230	1,287	1,857	2,105	2,345	2,317	2,617	2,917
II. Gas Turbine Stations												
a. Existing												
1. Mex	2 x 14	28	13	13	13	13	13	13	13	13	13	13
2. Suez	1 x 17	17	17	17	17	17	17	17	17	17	17	17
3. Ismailia	1 x 20	20	20	20	20	20	20	20	20	20	20	20
4. Port Said	2 x 20	40	40	40	40	40	40	40	40	40	40	40
Total Existing		105	90	90	90	90	90	90	90	90	90	90
b. Planned or Under Construction												
1. El Fayum	1 x 20	20	-	20	20	20	20	20	20	20	20	20
2. Abu El-Matamir	1 x 20	20	-	20	20	20	20	20	20	20	20	20
3. Cairo North	1 x 20	20	-	20	20	20	20	20	20	20	20	20
4. Helwan	4 x 30	120	-	120	120	120	120	120	120	120	120	120
5. Talkha	6 x 30	180	-		180	180	180	180	180	180	180	180
6. Plant "Y"	4 x 30	120	-	-	-	-	-	-	-	-	120	120
Total New Plant		480	-	180	360	360	360	360	360	360	480	480
c. Total Gas Turbine Plant		585	90	270	450	450	450	450	450	450	570	570
III. Hydro Stations												
a. Existing												
1. Aswan Dam	7 x 46 + 2 x 11.5	345	250	250	250	250	250	250	250	250	250	250
2. High Dam	12 x 175	2,100	1,050	1,050	1,150	1,250	1,250	1,350	1,450	1,550	1,550	1,550
Total Existing 2/		2,445	1,300	1,300	1,400	1,500	1,500	1,600	1,700	1,800	1,800	1,800
b. Planned or Under Construction 3/												
c. Total Hydro Plant		2,445	1,300	1,300	1,400	1,500	1,500	1,600	1,700	1,800	1,800	1,800
IV. Total Generating Plant			2,415	2,815	3,080	3,237	3,807	4,155	4,495	4,567	4,987	5,287
V. Peak Demand			2,000	2,200	2,470	2,800	3,130	3,350	3,600	3,900	4,200	4,500
VI. Margin (Deficit),			415	615	610	437	677	805	895	667	787	787
As Percent of Peak Demand			20.8	27.9	24.7	15.6	21.6	24.0	24.9	17.1	18.7	17.5

1/ Reduction indicates retirement of units after 25 years of service. No upgrading of existing capability through maintenance is assumed.

2/ Based on projected capability attainable with full High Dam reservoir once existing system operating limitations are overcome.

3/ A project to utilize the 70m head along the Nile between Aswan and the sea by building power stations at three existing barrages and four new barrages is at present under study by the Ministries of Electricity and Irrigation. Total additional capacity would be 635 MW and 4.7 billion kWh p.a.

SOURCES: Mission estimates from data obtained from EEA and Power Sector Survey, Phase I Diagnostic Report by Sanderson & Porter, Inc., November 1976.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

UNIFIED POWER SYSTEM

EGYPTIAN ELECTRICITY AUTHORITY

Available Generation - 1976-1985
(GWh)

DESCRIPTION	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
I. Steam Station1/										
a. Existing										
1. Cairo West	1,610	1,610	1,610	1,610	1,610	1,610	1,610	1,610	1,610	1,610
2. Cairo South	1,260	1,260	1,260	1,260	1,260	1,260	840	840	840	840
3. Cairo North	420	420	420	210						
4. Tibbin	196	196	196	196	196	196	196			
5. Talkha	889	889	889	889	889	630	630	630	630	630
6. Damanuhr	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470
7. Siuf	700	700	700	700	700	700	700	700	700	700
8. Karmouz	210	210	105	105	105					
9. Assyout	420	420	420	420	420	420	420	420	420	420
Total Existing	7,175	7,175	7,070	6,860	6,650	6,286	5,866	5,670	5,670	5,670
b. Planned or Under Construction										
1. Kafr El Davar		1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540
2. Cairo West Expansion				609	609	609	609	609	609	609
3. Abu Qir I					2,100	2,100	2,100	2,100	2,100	2,100
4. Abu Qir II						2,100	2,100	2,100	2,100	2,100
5. Suez I						2,100	2,100	2,100	2,100	2,100
6. Ismailia							2,100	2,100	2,100	2,100
7. Suez II									2,100	2,100
8. Plant "X"										2,100
Total New Steam		1,540	1,540	2,149	4,249	8,449	10,549	10,549	12,649	14,749
c. Total Steam Plant	7,175	8,715	8,610	9,009	10,899	14,735	16,415	16,219	18,319	20,419
II. Gas Turbine Stations 2/										
a. Existing										
1. Mex	39	39	39	39	39	39	39	39	39	39
2. Suez	51	51	51	51	51	51	51	51	51	51
3. Ismailia	60	60	60	60	60	60	60	60	60	60
4. Port Said	120	120	120	120	120	120	120	120	120	120
Total Existing	270	270	270	270	270	270	270	270	270	270
b. Planned or Under Construction										
1. El Fayum		60	60	60	60	60	60	60	60	60
2. Abu El Matamir		60	60	60	60	60	60	60	60	60
3. Cairo North		60	60	60	60	60	60	60	60	60
4. Helwan		360	360	360	360	360	360	360	360	360
5. Talkha				540	540	540	540	540	540	540
6. Plant "Y"									360	360
Total New Plan		540	540	1,080	1,080	1,080	1,080	1,080	1,440	1,440
c. Total Gas Turbine Plant	270	810	810	1,350	1,350	1,350	1,350	1,350	1,710	1,710
III. Hydro Stations3/										
a. Existing										
1. Aswan										
2. High Dam										
Total Existing	9,000	10,000	11,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
b. Planned or Under Construction4/										
IV. Total Available	16,445	19,525	20,420	22,359	24,249	28,085	29,765	29,569	32,029	34,129

1/ Based on 7,000 hour average yearly operation. Reduction shown to reflect scheduled retirement of old plant.
2/ Based on 3,000 hours average yearly operation.
3/ Based on projected capability attainable with full High Dam reservoir once existing system operating limitations are overcome.
4/ A project to utilize the 70m head along the Nile between Aswan and the sea by building power stations at three existing barrages and four new barrages is at present under study by the Ministries of Electricity and Irrigation. Total additional capacity would be 635 MW and 4.7 billion kWh.

SOURCE: Mission estimates from data obtained from EEA and Power Sector Survey Phase I Diagnostic Report by Sanderson & Porter, Inc. November 1976.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

EGYPTIAN ELECTRICITY AUTHORITY

Projected Daily and Annual Energy Consumption, Peak Load and Load Factors for the Years 1975-2000

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
1. Daily consumption, GWh														
1.1. Ordinary loads	18.5	21.4	23.5	25.8	28.4	31.2	34.3	37.8	41.5	45.6	50.2	79.0	108.2	148.2
1.2. Canal Area loads		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	4.8	7.6	10.4	14.2
1.3. Heavy Industrial loads, existing, under construction or contracted for:														
1.3.1. Fertilizer (KIMA)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
1.3.2. Aluminium	2.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
1.3.3. Iron & Steel	4.4	4.4	4.4	4.4	4.4	4.4	4.4		4.4	4.4	4.4	4.4	4.4	4.4
1.3.4. Oil Pipelines		3.0	3.6	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
1.4. Heavy Industrial Loads, beyond 1977				4.3	8.6	8.6	8.6	17.2	17.2	17.2	17.2	49.4	73.9	104.8
1.5. Total daily consumption	30.9	40.3	43.5	52.4	59.8	63.1	66.7	74.9	83.5	88.1	93.0	156.8	213.3	288.0
2. Annual consumption, 10^3 GWh	9.8	13.8	15.2	18.1	20.8	21.9	23.1	27.3	28.7	30.3	32.0	54.6	74.3	100.3
3. Daily Load Factor	0.733	0.819	0.806	0.824	0.817	0.809	0.800	0.806	0.800	0.798	0.799	0.780	0.780	0.780
4. Annual Load Factor	0.631	0.768	0.771	0.780	0.774	0.769	0.764	0.760	0.753	0.752	0.753	0.744	0.744	0.744
5. Maximum System Load, MW	1770	2050	2250	2650	3050	3250	3450	4100	4350	4600	4850	8380	11400	15390

SOURCE: Egyptian Electricity Authority (EEA)

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EGYPT

Comparison of Forecasts of Energy and Maximum Demand

		Egypt forecast 1/			Aoki forecast 2/	Base data used for WASP Program 3/		
	Year	Energy (GWh)	Load factor (%)	Max. demand (MW)	Energy (GWh)	Energy (GWh)	Load factor (%)	Max. demand (MW)
	1978	18,500	71.6	2,950		18,408.2	71.9	2,923
	1979	19,600	72.8	3,073		19,504.0	71.9	3,097
----Study Period----	1980	20,700	72.8	3,246	20,700	20,669.0	71.9	3,282
	1981	21,800	72.2	3,447		22,136.4	71.9	3,516
	1982	23,000	73.0	3,597		23,717.1	70.9	3,766
	1983	24,905	71.6	3,972		25,426.7	69.7	4,091
	1984	26,966	70.2	4,387		27,156.5	68.8	4,445
	1985	29,200	68.8	4,845	29,200	29,124.8	67.8	4,831
	1986	32,116	67.8	5,407		32,053.1	66.9	5,392
	1987	35,324	66.8	6,034		35,263.0	65.9	6,019
	1988	38,851	65.9	6,732		38,819.0	65.0	6,720
	1989	42,732	64.9	7,513		42,710.8	64.0	7,505
	1990	47,000	64.0	8,383	47,000	47,001.9	64.0	8,383
	1991	51,185	63.8	9,158		49,984.8	64.0	8,914
	1992	55,743	63.8	9,974		53,141.4	64.0	9,479
	1993	60,707	63.8	10,862		56,516.7	64.0	10,080
	1994	66,113	63.8	11,829		60,093.9	64.0	10,719
	1995	72,000	63.8	12,883	63,900	63,906.5	64.0	11,398
	1996	78,369	63.8	14,022		67,864.8	64.0	12,104
	1997	85,301	63.8	15,263		72,064.4	64.0	12,853
	1998	92,847	63.8	16,613		76,533.0	64.0	13,650
	1999	101,060	63.8	18,082		81,276.3	64.0	14,495
	2000	110,000	63.8	19,682	85,300	86,305.7	64.0	15,393

1/ Prepared by the General Egyptian Electricity Corporation (GEEC), forerunner of EEA.
2/ H. Aoki, Consultant.
3/ Wien Automatic System Planning Program (WASP).

SOURCE: Market Survey for Nuclear Power in Developing Countries, International Atomic Energy Agency, Vienna, September 1973.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Large Industrial Electrical Loads in Egypt, 1974-1985
(in Megawatts)

Industry	Location	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Iron & Steel													
Integrated Mill	Tebbin 1	52	64	64	64	64	64	64	64	64	64	64	64
(1.5 Mill Tons)	Tebbin 2	49	70	70	72	72	72	72	72	72	72	72	72
(" " ")	Helwan	52	62	63	63	63	63	63	63	63	63	63	63
*Sponge Iron	Alexandria							30	60	60	60	60	60
*Sponge Iron	Sadat City								20	40	40	40	40
*Electric Steel	Alexandria								40	70	100	100	100
*Electric Steel	Sadat City									.50	150	250	300
Chemical Projects													
*Nitrates	Ras Gharib								20	50	50	50	50
Fertilizer Kima	Aswan	200	200	250	250	250	250	50	50	50	50	50	50
Ferro-Silica Kima	Aswan	10	12	25	25	25	25	25	25	25	25	25	25
Urea (German Uda)	Alexandria								15	15	15	15	15
Caustic Soda	Alexandria				20	20	20	20	20	20	20	20	20
NH_3NO_3 & Urea	Talka		17	17	17	17	25	33	33	33	33	33	33
Phosphate Projects													
Mining	Esna			10	10	10	10	10	10	10	10	10	10
~~Factory elemental~~ (cancelled 340 MW)	~~Nag Hammadi~~												
Mine-Fertilizer	Abu Tartur								90	90	90	90	90
Textiles (own 50 MW)	Mahalla El Koubra												
*Aluminium Smelter (2nd Stage 150 MW not started)	Nag Hammadi		80	150	220	220	300	370	370	370	370	370	370
Petroleum Refinery	Alexandria						20	20	20	20	20	20	20
Petroleum Refinery	Alexandria							20	30	30	30	30	30
Oil Pipeline (340 km - 2x42")	Suez-Alexandria			50	130	150	150	150	150	150	150	150	150
Oil Pipeline (2x36" cancelled 100 MW)	Suez-Port Said												
Cement Expansions	Helwan							40	40	40	40	40	40
Cement Plant	Assiut				35	35	35	35	35	35	35	35	35
Cement Plant	Suez							30	30	30	30	30	30
		363	505	699	906	926	1034	1032	1257	1387	1517	1617	1667
Annual Increase			142	194	207	20	108	-2	225	130	130	100	50

Note: The asterisked projects have still to be contracted. Assuming they materialize as shown the total industrial load increase from 699 MW in 1976 to 1,667 MW in 1985 is equal to a 10% per annum growth rate. New projects will be developed but are unlikely to affect the totals above before 1980 given the 4-5 year gestation period for new industry.

SOURCE: Sanderson & Porter, Inc.,
UNDP Power Sector Survey Field Team

May 1977

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

EGYPTIAN ELECTRICITY AUTHORITY

UNIFIED POWER SYSTEM

Generation and Sales, 1974-1985
(Million kWh)

	ACTUAL		ESTIMATED	FORECAST								
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
I. Net Generation of which:	8,525	9,793	11,800	13,500	15,180	17,205	19,187	21,106	23,025	24,948	26,867	28,699
a) Combustion Turbine	47	24	10	350	420	490	670	850	1,050	1,210	1,390	1,570
b) Steam Turbine	2,351	2,980	3,700	3,150	3,760	4,715	6,517	8,256	9,975	11,738	13,477	15,129
c) Hydro	6,127	6,789	8,090	10,000	11,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
II. System (T&D) Losses	1,630	1,485	2,000	2,300	2,580	2,925	3,262	3,588	3,914	4,241	4,567	4,879
III. Sales of which:	6,895	8,308	9,800	11,200	12,600	14,280	15,925	17,518	19,111	20,707	22,300	23,820
a) Industrial	3,789	4,805	5,880	6,888	7,860	9,060	10,185	11,208	12,171	13,067	13,900	14,580
b) Other	3,106	3,503	3,920	4,312	4,740	5,220	5,740	6,310	6,940	7,640	8,400	9,240
IV. Available Generation			16,445	19,525	20,420	22,359	24,249	28,085	29,765	29,569	32,029	34,129
V. Margin (Deficit)			4,645	6,025	5,240	5,154	5,062	6,979	6,740	4,621	5,162	5,430
As percentage of required net generation			39.4	44.6	34.5	29.9	30.0	33.1	29.3	18.5	19.2	18.9

SOURCE: EEA and UNDP Power Sector Survey, Sanderson and Porter, Inc., Field Team and Mission estimates.

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ANNEX 12

APPRAISAL OF

A REGIONAL ELECTRIFICATION PROJECT

EGYPT

The National Rural Electrification Plan

Origins and Background

1. The Arab Republic of Egypt includes more than 4,000 villages in addition to many smaller farm communities (hamlets) scattered all over the country numbering about 25,000. With the completion and start-up of the Aswan High Dam hydroelectric project and associated 500, 220, and 132-kV power system facilities, enough electricity became available to serve all main load centers in the country.

The National Plan

2. To assure high quality, dependable electric service and to make electricity available to the population outside the two large metropolitan areas of Cairo and Alexandria, an ambitious 1971-75 National Rural Electrification Plan was evolved along the following lines:

- Reconstruction and strengthening of the distribution networks (11-kV and 380 volts) in about 120 urban centers.

- Extension of the 66-kV and 33-kV transmission network by a total route length of about 600 miles.

- Installation of about 52 substations rated 10-40 MVA to connect 11-kV distribution to the bulk supply system through the extended 66-kV and 33-kV subtransmission.

- Installation of new low voltage (380/220 volts) distribution networks in about 4,046 villages and 25,000 hamlets.

- Installation of 11-kV/380 volts distribution transformers with a total capacity of 1,500 MVA to supply the above networks and small motor loads for irrigation pumping and rural industries.

- Installation of new 11-kV distribution lines to feed the above mentioned distribution transformers. The total estimated length of these lines is about 8,000 miles.

Work Already Completed

3. The REA program begun initially under the 1971-75 5-Year Plan had to be scaled down because of financial constraints to about 2,000 villages and hamlets and 84 towns. REA now intends to complete the balance of the original plan during the 1976-80 5-Year Plan period.

4. During the first 5-Year Plan, REA erected 12 substations of the 52 proposed. Ten more substations are still under construction and there is enough material on hand for 14 additional installations. During the same period, 660 villages were electrified involving installation of 2,601 km of 11-kV primary mains; 2,295 km of 11-kV primary laterals; and 3,331 outdoor distribution transformers rated 11/0.4 kV in unit sizes ranging from 25 to 100 kVA, three-phase.

5. The distribution networks in 84 urban centers were rebuilt and modernized in the same time span. The work included installation of:

- Twenty-five 11-kV distribution switchboards.
- 660 transformer kiosks with a total capacity of 122.5 MVA.
- 375 km of 11-kV underground cable.
- 35 km of 11-kV overhead lines.
- 60 km of low voltage underground cable.
- 366 km of 0.4-kV overhead secondary.

In addition, several district offices, warehouses and a whole new supporting organization were established and placed in operation.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Development Program Costs, '000 LE, LE1,000 = US$ 1.50

Base Prices, end of 1975		Percent	Work in Progress on of December 31, 1975	1976	1977	1978	1979	1980	Total 1975-1980	Total 1976-1980
I) Steam Stations										
1. Kafr El Dawr 1/	LC	27	13,075	2,560	1,551				17,186	4,111
	FC	73	36,223	9,869	1,266				47,358	11,135
(start-up 1977)	T	100	49,298	12,429	2,817				64,544	15,246
2. Cairo West Extension	LC	22	265	2,130	2,120	1,155	1,550		7,220	6,955
	FC	78	2,756	8,806	11,417	2,671	563		26,213	23,457
(start-up 1979)	T	100	3,021	10,936	13,537	3,826	2,113		33,433	30,412
3. Abu Qir I	LC	21	65	1,280	3,860	6,725	6,610		18,540	18,475
(start-up early 1980)	FC	79	5,990	7,099	37,118	19,071	913		70,191	64,201
	T	100	6,055	8,379	40,978	25,796	7,523		88,731	82,676
4. Abu Qir II	LC	23		5	1,170	3,375	7,620	6,000	18,170	18,170
(start-up late 1980)	FC	77		3,900	43	29,473	22,288	6,041	61,745	61,745
	T	100		3,905	1,213	32,848	29,908	12,041	79,915	79,915
5. Suez I	LC	15			50	3,775	5,965	6,900	16,690	16,690
(start-up 1981)	FC	85				14,958	32,391	45,558	92,907	92,907
	T	100			50	18,733	38,356	52,458	109,597	109,597
6. Ismailia	LC	19				50	3,780	6,660	10,490	10,490
	FC	81					14,967	30,207	45,174	45,174
(start-up 1982)	T	100				50	18,747	36,867	55,664	55,664
7. Suez II	LC							5	5	5
(start-up 1984)	FC	100						3,900	3,900	3,900
	T	100						3,905	3,905	3,905
Subtotal Steam Plant	LC	20	13,405	5,975	8,751	15,080	25,525	19,565	88,301	74,896
	FC	80	44,969	29,674	49,844	66,173	71,122	85,706	347,488	302,519
	T	100	58,374	35,649	58,595	81,253	96,647	105,271	435,789	377,415
II. Gas Turbine Stations										
1. El Fayum	LC	37		250	750				1,000	1,000
(start-up 1977)	FC	63	171	1,536					1,707	1,536
	T	100	171	1,786	750				2,707	2,536
2. Abu El Matamir	LC	37		250	750				1,000	1,000
(start-up 1977)	FC	63	171	1,536					1,707	1,536
	T	100	171	1,786	750				2,707	2,536
3. Cairo North	LC	32	150	350	300				800	650
(start-up 1977)	FC	68	1,707						1,707	
	T	100	1,857	350	300				2,507	650
4. Talkha/Helwan	LC	25		25	3,200	9,085			12,310	12,310
(start-up 1977	FC	75		3,413	17,552	15,163			36,128	36,128
through 1979)	T	100		3,438	20,752	24,248			48,438	48,438
Subtotal Gas Turbine	LC	27	150	875	5,000	9,085			15,110	14,960
Plant	FC	73	2,049	6,485	17,552	15,163			41,249	39,200
	T	100	2,199	7,360	22,552	24,248			56,359	54,160
Total Generation	LC	21	13,555	6,850	13,751	24,165	25,525	19,565	103,411	89,856
	FC	79	47,018	36,159	67,396	81,336	71,122	85,706	388,737	341,719
	T	100	60,573	43,009	81,147	105,501	96,647	105,271	492,148	431,575
III. Transmission										
a. 220-kV Overhead Lines	LC	73	630	3,550	18,966	17,273	3,434	3,025	46,878	46,248
	FC	27	1,399	2,841	5,564	6,238	1,519	717	18,278	16,879
(Amreia-Kafr El Dawar)	T	100	2,029	6,391	24,530	23,511	4,953	3,742	65,156	63,127
(Kafr El Dawar - Abu Qir - Alexandria)										
(Damanhour-Kafr El Dawar-Alexandria)										
(Abu Qir - New Amreia)										
(Abu Qir - Dekhila)										
(Talkha - Kafr El Sheikh)										
(Kafr El Sheikh - Daiwanhour)										
(Cairo 500 - Tibbin - Wadi Hoof)										
(High Dam - Aswan)										
(Suez - Ismailia)										
(Ismailia - Port Said)										
(Zagazig - Ismailia)										
(Nag Hammadi - Abu Tartour)										
(Talkha - El Kassaley)										
(El Haram - Cairo South)										
(El Haram - Cairo West)										
(Ismailia - El Kassaby)										
(Suez - Cement)										
(Cement - Ein El Soklma)										
(Eafon - Ferrosilicon)										
(Dekhila - Side Kreir)										
b. 220-kV Underground	LC	9		10	330	550			890	890
Cables	FC	91			1,135	8,422			9,557	9,557
	T	100		10	1,465	8,972			10,447	10,447
(Cairo North - Sapteya)										
(Ciaro East - Heliopolis)										
c. 66-kV Underground	LC	45		495	1,873	4,717	1,385	1,143	9,613	9,613
Cables	FC	55		384	3,949	4,775	1,451	1,224	11,783	11,783
	T	100		879	5,822	9,492	2,836	2,367	21,396	21,396
(Cairo Zone)										
(Alexandria Zone)										
(Canal Zone)										
Subtotal	LC	59	630	4,055	21,169	22,540	4,819	4,168	57,381	56,751
	FC	41	1,399	3,225	10,648	19,435	2,970	1,941	39,618	38,219
	T	100	2,029	7,280	31,817	41,975	7,789	6,109	96,999	94,970

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Development Program Costs, '000 LE, LE1,000 = US$1.50

Base Prices, end of 1975		Percent	Work in Progress on of December 31, 1975	1976	1977	1978	1979	1980	Total 1975-1980	Total 1976-1980
IV. Substations										
a. 500-kV Primary Voltage	LC	23		500	500	1,000			2,000	2,000
	FC	77		2,560	4,266				6,826	6,826
(Nag Hammadi	T	100		3,060	4,766	1,000			8,826	8,826
b. 220-kV Primary Voltage	LC	19	500	2,620	5,286	3,380	2,330	1,025	15,141	14,641
	FC	81	4,195	3,823	15,354	22,442	16,810	700	63,324	59,129
(Saptya, 2 x 125 MVA	T)	100	4,695	6,443	20,640	25,822	19,140	1,725	78,465	73,770
(Suez	)									
(Ismailia	)									
(Cairo East, 3 x 75 MVA	)									
(Port Said	)									
(Pyramids	)									
(Amreia	)									
(Dekhila, 2 x 175 MVA	)									
(Tibbin, 2 x 125 MVA	)									
(Kafr El Sheikh, 2 x 75 MVA)										
(El Kassaby	)									
(Safaga	)									
(Abu Tartour	)									
(Cairo West Extension	)									
(Tanta Extension	)									
(Alexandria I Extension	)									
(Tahrir Badr Extension	)									
(Zagazig Extension	)									
(Amseig Extension	)									
(Wadi Hoof Extension	)									
(Heliopolis Extension	)									
(Damanhour Extension	)									
c. 132-kV Primary Voltage	LC	36	4	366	500	370	50	25	1,315	1,311
	FC	64	227	497	328	541	370	403	2,366	2,139
(Aswan	T)	100	231	863	828	911	420	428	3,681	3,450
(Assyout Cement	)									
(Ferrosilicon	)									
(Edfon Extension	)									
d. 66-kV Primary Voltage	LC	28		359	1,840	1,851	850	500	5,400	5,400
	FC	72		1,343	5,543	3,251	2,142	1,715	13 994	13,994
(Tibbin	T)	100		1,702	7,383	5,102	2,992	2,215	19,394	19,394
(Abu Qir Fertilizer	)									
(Mastorod	)									
(Substation number 100	)									
(Torrah Cement	)									
(Canal Zone substations: Fayed, Kantara, North Suez, South Suez, and Ismailia	)									
(Wardian	)									
(Mansheya	)									
(Ibrahumeya	)									
(Gleem	)									
(Ahamra	)									
(Abzakeya	)									
(Abdin	)									
(Ain El Syra	)									
(Warrak	)									
(Alamein	)									
Subtotal	LC		504	3,845	8,126	6,601	3,230	1,550	23,856	23,352
	FC		4,422	8,223	25,491	26,234	19,322	2,818	86,510	82,088
	T		4,926	12,068	33,617	32,835	22,552	4,368	110,366	105,440
V. Distribution 1/										
a. Canal Zone Rehabilitation	LC	30		345	471	315	315	114	1,560	1,560
	FC	70		805	1,100	735	730	266	3,636	3,636
	T	100		1,150	1,571	1,050	1,045	380	5,196	5,196
b. Other Rehabilitation Work	LC	40		2,600	7,960	4,210	4,210	4,210	23,190	23,190
	FC	60		3,900	11,940	6,315	6,315	6,315	34,785	34,785
	T	100		6,500	19,900	10,525	10,525	10,525	57,975	57,975
Subtotal	LC	39		2,945	8,431	4,525	4,525	4,324	24,750	24,750
	FC	61		4,705	13,040	7,050	7,045	6,581	38,421	38,421
	T	100		7,650	21,471	11,575	11,570	10,905	63,171	63,171
VI. Communications & Control Equipment	LC	18		400	300	620	100	900	2,320	2,320
	FC	82		171	2,048	3,285	3,242	1,877	10,623	10,623
	T	100		571	2,348	3,905	3,342	2,777	12,943	12,943
VII. Studies, Research, Training 2/	LC	50		275	357	357	358	358	1,705	1,705
	FC	50		275	358	358	357	357	1,705	1,705
	T	100		550	715	715	715	715	3,410	3,410
VIII. Other, Prep. Work, Dwelling, Etc.	LC	50		900	1,839	1,348	1,050	651	5,788	5,788
	FC	50		900	1,839	1,348	1,051	651	5,789	5,789
	T	100		1,800	3,678	2,696	2,101	1,302	11,577	11,577
Total Investment Plan (unescalated)	LC		14,689	19,270	53,973	60,156	39,607	31,516	219,211	204,522
	FC		52,839	53,658	120,820	139,046	105,109	99,931	571,403	518,564
	T		67,528	72,928	174,793	199,202	144,716	131,447	790,614	723,086

1/ Not including Bank Project, shown separately.
2/ Not including Studies and Training components of Bank Project.

SOURCE: Mission estimates from data supplied by EEA.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Development Program Costs, '000 LE, LE1,000 = US$1.50

Base Prices, end of 1975 Local Currency Costs	Work in Progress on of Dec. 31, '75	1976	1977	1978	1979	1980	1975-1980	1976-1980
Escalation Factor		.065	.20	.34	.51	.67		
I. Steam Stations								
1. Kafr El Dawar								
Base Cost	13,075	2,560	1,551				17,186	4,111
Price Contingency		166	310				476	476
Total Escalated LC Cost	13,075	2,726	1,861				17,662	4,587
2. Cairo West Expansion								
Base Cost	265	2,130	2,120	1,155	1,550		7,220	6,955
Price Contingency		138	424	393	790		1,745	1,745
Total Escalated LC Cost	265	2,268	2,544	1,548	2,340		8,965	8,700
3. Abu Qir I								
Base Cost	65	1,280	3,860	6,725	6,610		18,540	18,475
Price Contingency		83	772	2,286	3,371		6,512	6,512
Total Escalated LC Cost	65	1,363	4,632	9,011	9,981		25,052	24,987
4. Abu Qir II								
Base Cost		5	1,170	3,375	7,620	6,000	18,170	18,170
Price Contingency			234	1,148	3,886	4,020	9,288	9,288
Total Escalated LC Cost		5	1,404	4,523	11,506	10,020	27,458	27,458
5. Suez I								
Base Cost			50	3,775	5,965	6,900	16,690	16,690
Price Contingency			10	1,284	3,042	4,623	8,959	8,959
Total Escalated LC Cost			60	5,059	9,007	11,523	25,649	25,649
6. Ismailia								
Base Cost				50	3,780	6,660	10,490	10,490
Price Contingency				17	1,928	4,462	6,407	6,407
Total Escalated LC Cost				67	5,708	11,122	16,897	16,897
7. Suez II								
Base Cost						5	5	5
Price Contingency						3	3	3
Total Escalated LC Cost						8	8	8
Steam Plant Escalated LC Cost	13,405	6,362	10,501	20,208	38,542	32,673	121,691	108,286
II. Gas Turbine Stations								
1. El Fayum								
Base Cost		250	750				1,000	1,000
Price Contingency		16	150				166	166
Total Escalated LC Cost		266	900				1,166	1,166
2. Abu El Matamir								
Base Cost		250	750				1,000	1,000
Price Contingency		16	150				166	166
Total Escalated LC Cost		266	900				1,166	1,166
3. Cairo North								
Base Cost	150	350	300				800	650
Price Contingency		23	60				83	83
Total Escalated LC Cost	150	373	360				883	733
4. Talkha/Helwan								
Base Cost		25	3,200	9,085			12,310	12,310
Price Contingency		2	640	3,089			3,731	3,731
Total Escalated LC Cost		27	3,840	12,174			16,041	16,041
Gas Turbine Escalated LC Cost*	150	932	6,000	12,174			19,256	19,106
III. Transmission	630	4,055	21,169	22,540	4,819	4,168	57,381	56,751
IV. Substations	504	3,845	8,126	6,601	3,230	1,550	23,856	23,352
V. Distribution 1/		2,945	8,431	4,525	4,525	4,324	24,750	24,750
VI. Communications & Control Equipment		400	300	620	100	900	2,320	2,320
VII. Studies, Research & Training 2/		275	357	357	358	358	1,705	1,705
VIII. Other, Prep. Work, Dwellings		900	1,839	1,348	1,050	651	5,788	5,788
Total Base Cost (III-VIII)	1,134	12,420	40,222	35,991	14,082	11,951	115,800	114,666
Price Contingency		807	8,044	12,237	7,182	8,007	36,277	36,277
Total Escalated LC Cost (III-VIII)	1,134	13,227	48,266	48,228	21,264	19,958	152,077	150,943
Total Escalated LC Cost (Complete Development Program)	14,689	20,521	64,767	80,610	59,806	52,631	293,024	278,335

1/ Not including Bank Project, shown separately.
2/ Not including Training & Studies provided under Bank Project.

SOURCE: Mission estimates from data obtained from EEA

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Development Program Costs, '000 LE, LE1,000 = US$1.50

Base Prices, end of 1975 / Foreign Currency Costs	Work in Progress as of Dec. 31, 1975	1976	1977	1978	1979	1980	1975-1980	1976-1980
Escalation Factor		.045	.13	.22	.33	.42		
I. Steam Stations								
1. Kafr El Dawar								
Base Cost	36,223	9,869	1,266				47,358	11,135
Price Contingency		444	164				608	608
Total Escalated FC Cost	36,223	10,313	1,430				47,966	11,743
2. Cairo West Extension								
Base Cost	2,756	8,806	11,417	2,671	563		26,213	23,457
Price Contingency		396	1,484	587	186		2,653	2,653
Total Escalated FC Cost	2,756	9,202	12,901	3,258	749		28,866	26,110
3. Abu Qir I								
Base Cost	5,990	7,099	37,118	19,071	913		70,191	64,201
Price Contingency		319	4,825	4,196	301		9,641	9,641
Total Escalated FC Cost	5,990	7,418	41,943	23,267	1,214		79,832	73,842
4. Abu Qir II								
Base Cost		3,900	43	29,473	22,288	6,041	61,745	61,745
Price Contingency		176	6	6,484	7,355	2,537	16,558	16,558
Total Escalated FC Cost		4,076	49	35,957	29,643	8,578	78,303	78,303
5. Suez I								
Base Cost				14,958	32,391	45,558	92,907	92,907
Price Contingency				3,291	10,689	19,134	33,114	33,114
Total Escalated FC Cost				18,249	43,080	64,692	126,021	126,021
6. Ismailia								
Base Cost					14,967	30,207	45,174	45,174
Price Contingency					4,939	12,687	17,626	17,626
Total Escalated FC Cost					19,906	42,894	62,800	62,800
7. Suez II								
Base Cost						3,900	3,900	3,900
Price Contingency						1,638	1,638	1,638
Total Escalated FC Cost						5,538	5,538	5,538
Steam Plant Escalated FC Cost	44,969	31,009	56,323	80,731	94,592	121,702	429,326	384,357
II. Gas Turbine Stations								
1. El Fayum								
Base Cost	171	1,536					1,707	1,536
Price Contingency		69					69	69
Total Escalated FC Cost	171	1,605					1,776	1,605
2. Abu El Matamir								
Base Cost	171	1,536					1,707	1,536
Price Contingency		69					69	69
Total Escalated FC Cost	171	1,605					1,776	1,605
3. Cairo North								
Base Cost	1,707						1,707	
Price Contingency								
Total Escalated FC Cost	1,707						1,707	
4. Talkha/Helwan								
Base Cost		3,413	17,552	15,163			36,128	36,123
Price Contingency		154	2,282	3,336			5,772	5,772
Total Escalated FC Cost		3,567	19,834	18,499			41,900	41,900
Gas Turbine Escalated FC Cost:	2,049	6,777	19,834	18,499			47,159	45,110
III. Transmission	1,399	3,225	10,648	19,435	2,970	1,941	39,618	38,219
IV. Substations	4,422	8,223	25,491	26,234	19,322	2,818	86,510	82,088
V. Distribution 1/		4,705	13,040	7,050	7,045	6,581	38,421	38,421
VI. Communications & Control Equipment		171	2,048	3,285	3,242	1,877	10,623	10,623
VII. Studies, Research & Training 2/		275	358	358	357	357	1,705	1,705
VIII. Other, Prep. Work, Dwellings, etc.		900	1,839	1,348	1,051	651	5,789	5,789
Total Base Cost (III - VIII)	5,821	17,499	53,424	57,710	33,987	14,225	182,666	176,845
Price Contingency		787	6,945	12,696	11,216	5,974	37,618	37,618
Escalated Cost (III - VIII)	5,821	18,286	60,369	70,406	45,203	20,199	220,284	214,463
Total Escalated FC Cost (Complete Development Program)	52,839	56,072	136,526	169,636	139,795	141,901	696,769	643,930

1/ Not including Bank Project, shown separately.
2/ Not including Training and Studies part of Bank Project.

SOURCE: Mission estimates from data obtained from EEA.

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Summary of Escalated Development Program Costs, '000 LE, LE1.000 = US$1.50

Base prices, end of 1975		Percent	Work in Progress as of Dec. 31, 1975	1976	1977	1978	1979	1980	1975-1980	1976-1980
I. Steam Stations	LC	22	13,405	6,362	10,501	20,208	38,542	32,673	121,691	108,286
	FC	78	44,969	31,009	56,323	80,731	94,592	121,702	429,326	384,357
	T	100	58,374	37,371	66,824	100,939	133,134	154,375	551,017	492,643
II. Gas Turbine Stations	LC	29	150	932	6,000	12,174			19,256	19,106
	FC	71	2,049	6,777	19,834	18,499			47,159	45,110
	T	100	2,199	7,709	25,834	30,673			66,415	64,216
III. Transmission; Substations, Distribution; Communication and Controls; Studies, Research and Training; and	LC	41	1,134	13,227	48,266	48,228	21,264	19,958	152,077	150,943
Others; Prep. Work,	FC	59	5,821	18,286	60,369	70,406	45,203	20,199	220,284	214,463
Dwellings, etc.	T	100	6,955	31,513	108,635	118,634	66,467	40,157	372,361	365,406
Total Program Escalated	LC	30	14,689	20,521	64,767	80,610	59,806	52,631	293,024	278,335
Costs	FC	70	52,839	56,072	136,526	169,636	139,795	141,901	696,769	643,930
	T	100	67,528	76,593	201,293	250,246	199,601	194,532	989,793	922,265

SOURCE: EEA

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Consulting Services for Rehabilitation and Expansion of Distribution Networks

Terms of Reference

I. INTRODUCTION

1.01 In Egypt, the Ministry of Electricity and Energy is responsible for the power subsector through the Rural Electrification Authority (REA), the Egyptian Electricity Authority (EEA), and two other agencies.

1.02 These Terms of Reference outline the purpose and scope of Consulting Services required by the Rural Electrification Authority for a Regional Electrification Project. The Project is part of the second five-year installment (1976-80) of the National Rural Electrification Plan started in 1971 by the REA. It would provide additional distribution capacity to accommodate load growth up to 1982, compatible with longer-range system development.

II. GENERAL

2.01 The National Rural Electrification Plan covers 80 REA-zones including about 120 towns, 4,000 villages, and 25,000 hamlets. During the first five years of the Plan (1971-75), 84 towns have had their systems reinforced and expanded and 2,000 villages have been electrified, completing altogether 28 zones. The remaining 52 zones are scheduled for completion during 1976-1980.

2.02 The Regional Electrification Project consists of approximately 3,400 km of 11 kV and 380/220 V overhead and underground distribution, 230 MVA of substation and distribution transformer capacity and 100 km of 66 and 33-kV subtransmission. These facilities would be located in Project areas proposed by REA (Attachment 1). All engineering will be according to the new standards and practices being developed by EEA with USAID financing. Harza Engineering Company (US) have been retained by EEA to develop guidelines to rehabilitate and expand subtransmission and distribution in Cairo, Alexandria and eleven provincial cities. The Project's urban centers are included in Harza's work. Attachment 2 details further the work assigned to Harza.

III. OBJECTIVE

3.01 The Consultants would assist REA to prepare bid documents and specifications and complete engineering designs based on material quantities and cost estimates developed during Project appraisal. The Consultants would also assist REA in ranking rural zones for consideration of construction priority, and establishing adequate data gathering and processing systems to monitor and evaluate the results of the National Rural Electrification Plan.

IV. SCOPE OF WORK

4.01 The Consultant's services will include:

(a) Review REA plans, engineering designs and materials and equipment specifications applying to the Project, and modify them as necessary to conform with the Harza recommendations accepted by REA. Sufficient distribution capacity is to be provided in each Project area to accommodate load growth to 1982, compatible with longer-range system development.

(b) Review REA bid documents and suggest revisions to take account of procedures outlined in World Bank procurement guidelines.

(c) Confirm selection of Project areas applying evaluation procedure given in Attachment 3.

(d) Rank the rest of the rural zones in the overall REA Plan, starting with the six remaining after (c) above, for consideration of future electrification priority. Ranking should aim at maximizing the financial and economic return on the Plan in accordance with guidelines set out in Attachment 4.

(e) Assist REA in establishing an information system to monitor the performance of the National Rural Electrification Plan as suggested in Attachment 5.

(f) Assist REA in bid evaluation and award of contracts for equipment and materials.

(g) Assist REA in Project management and construction supervision, particularly in the preparation and monitoring of construction, schedules and related progress reporting in accordance with World Bank requirements.

(h) Assist REA in inspecting and testing of equipment and materials at the factories.

(i) Assist REA in acceptance testing and commissioning of completed facilities.

(j) Assist REA in preparation of Project Completion Report to fulfill World Bank requirements.

V. CONTRACT PERFORMANCE

5.01 The Consultants shall work under the general direction of REA through a counterpart Project unit specifically established for this Project. REA shall also assist the Consultant to obtain copies of all studies and reports required for the performance of the Consultants' services.

5.02 The Consultant shall submit a quarterly report to the REA not later than the 15th of the following month. The quarterly reports shall contain information on the Consultants' activities, listing all personnel employed on the Project during the quarter and the functions they performed. The report shall indicate progress during the quarter toward achieving contract objectives, point out any difficulties or impediments, and recommend suitable remedies.

5.03 As part of Project management and supervision services, the Consultant shall develop detailed construction schedules and suitable monitoring devices including specifically critical path schedules. The Consultant shall review these schedules periodically in connection with quarterly reports and recommend steps to ensure keeping the Project on schedule.

5.04 Within nine months of the effective date of the Consultant's contract, the Consultant shall submit to REA a report on the balance of the National Rural Electrification Plan recommending an electrification construction program. The program would establish construction priorities in order of economic merit as detailed in Attachment 4.

5.05 Within a year after start of construction the consultant shall submit to REA recommendations for the establishment of an information system to gather and process data to evaluate the performance of the National Rural Electrification Plan.

5.06 Within three months of completion of construction the Consultant shall submit to REA a report summarizing the Project's history, construction costs, results achieved, problems encountered, and lessons learned which may be useful to REA.

VI. TIMING

6.01 These services are expected to be required over a period of three years, starting in May 1977 with work on the preliminary designs to confirm quantities of materials and equipment required, and ending in May 1980, after testing and placing in commercial operation of major facilities being procured and installed under the Project. The facilities to be installed in the urban centers should be completed first, the rural zones would follow.

VII. PAYMENTS

7.01 Payments for the foreign currency portion of the cost of these services are expected to be made from proceeds of a World Bank loan for which EEA has made an application. Local currency costs will be paid in Egyptian Pounds by the Rural Electrification Authority.

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Project Areas Proposed by REA

1. (a) Urban Centers

1. Damietta
2. El Mahalla
3. Tanta
4. El Mansoura
5. Fowa
6. El Fayum
7. El Miniah
8. Assiut
9. Aswan
10. Sohag
11. Kafr El Sheikh
12. Ras El Bar
13. Kafr El Dawar

2. Rural Zones

1. El Hussenieh
2. Talkha
3. Shirbin
4. El Mosalas
5. Rashid
6. El Mahrousa
7. El Wasta
8. Awlad Tuk
9. El Aakab
10. Kafr Saad
11. Kotour
12. Manfalut
13. Dairut
14. Akhmin
15. Disuq
16. Kafr El Zayat
17. Mallawi
18. El Senbillawian
19. Biala
20. Fakous
21. Hosh Eissa
22. El Fashn
23. Abnoub
24. Menia El Kamn
25. Kom Hamada

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Scope of Work Assigned to Harza Under EEA's Contract Financed by USAID

Harza's services shall be the following:

1. Review of all pertinent diagrams, plans and report on the existing subtransmission and distribution systems in Cairo, Alexandria and 11 provincial cities, together with all available information on planned rehabilitation and expansion of the systems.

2. Review and analysis of base data and methodology employed to project and forecast future loads--domestic, commercial, industrial and public--as to magnitude and location within the study areas.

3. Review and analysis of currently used system planning policies, approaches, techniques and standards, construction and maintenance methods and practices, and equipment types and specifications.

4. Examination and analysis of the systems shall include but not be limited to the following aspects and features:

   a. Determine adequacy of existing 66 kV and 33 kV subtransmission systems, using load flow, short circuit and stability studies as required.

   b. Determine adequacy of existing distribution system voltage for the primary voltage in longer range development.

   c. Determine the feasibility of adapting existing 33 kV to distribution.

   d. Determine present distribution losses.

   e. Determine appropriateness of substation sizing, length of primary feeders and degree of interconnection to ensure reliability with economy.

   f. Determine relative economics of the existing practice of using kiosks (distribution transformers and primary and secondary switching in single enclosure).

   g. Develop concept for single phase distribution facilities.

5. Become familiar, through field inspection and review of pertinent reports, with the physical condition and service performance of the existing subtransmission and distribution systems.

6. Review and assess the existing capability and capacity of the EEA, REA and others relative to accomplishment of rehabilitation and system expansion work; and a similar assessment of existing capabilities relative to system maintenance and repair.

7. Prepare and submit to the EEA, not later than four months after the effective date of this contract, 1/ a report presenting findings, analyses, conclusions and recommendations relative to rehabilitation and expansion of the systems in the study areas. The report shall set forth these policies, procedures, methods, techniques, standards, practices and equipment types recommended for use in planning the subject systems rehabilitation and expansion. Alternatives to existing policies, procedures, practices and equipment shall be recommended in the interest of system economy, efficiency and reliability as required. The report shall form the basis for Consultant/EEA discussions and subsequent decisions by the EEA regarding the policies, procedures and practices to be employed in system rehabilitation and expansion planning.

1/ Contract was signed February 8, 1977. Expected effective date is no later than April 1, 1977.

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Project Areas Evaluation Procedure

1. All urban centers listed in Attachment 1, page 1, have been selected for the Project and need no further evaluation.

2. The Consultant shall test the first 14 rural zones against the following selection criteria (additional suitable criteria may also be used, as suggested by the Consultants):

(i) Financial return should be enough to contribute to debt service within the first 10 years of operation.

(ii) Internal financial rate of return, not less than 4% over a 25-year period.

(iii) Average initial per capita income, not less than US$50/a.

(iv) Income growth rate, not less than 5%/a.

(v) The zones selected should preferably have the following features:

- adequate infrastructure, particularly roads and waterways;
- growing agricultural output; and, therefore,
- increasing number of potential productive uses for electricity in farms and agro-industries;
- a number of large villages, not too widely scattered;
- improving living standards;
- concurrent coordinated plans for regional development, for instance, health, education, irrigation, drainage, roads; and
- reasonable access to central system electricity supply.

3. Rural zones not confirmed in the preceding step would be replaced with zones further down the list. Additional zones would also be included to bring up to 19 the total of selected rural zones.

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Guidelines for Defining an Electrification Construction Program for Balance of REA's National Rural Electrification Plan

The Consultant shall rank the balance of REA's National Electrification Plan applying criteria suggested in Annex 4 (para 2) and the methodology given below:

(a) Collect the following information on a cross-section of zones already electrified (say a representative sample of at least 10):

(i) The growth in number of consumers and of demand (kWh and kW) and revenue per customer (including, if possible, statistical analysis of individual consumer growth) since each zone was electrified. Consumers are to be classified as follows:

Residential
Commercial
Government and Municipal
Public Lighting
Industrial
Irrigation
Other

(ii) The growth of total demand (kWh and kW) and revenues.

(iii) The uses to which electricity is put by each category of consumers, indicating types and numbers of appliances installed.

(iv) The costs of supply in as much detail as possible including actual costs of lines and substations, etc., costs of generation, operation and maintenance.

(v) How revenues and costs have changed over time (e.g. is load factor per consumer category and overall improving? Have investment costs per consumer been decreasing or increasing over time?)

(vi) Types and number of dwellings, numbers connected to "networks".

(vii) Trends in socio-economic factors such as:

population growth
migratory flow
household incomes (giving the range as well as the average)
average number of people per dwelling.

(viii) Details of other infrastructure (e.g. roads, water supply, schools, health centers).

(ix) Details of any new economic activities (commercial, industrial or agricultural) which have developed since the electrification of the zone.

(x) Comparative costs of electricity and electricity appliances and equipment, on the one hand, and of substantive energy sources and equipment on the other, particularly for non-domestic uses. Taxes and credit facilities for the various energy sources and types of equipment (electric and non-electric) should also be considered in this context.

(xi) The projected demand (kWh and kW), revenues and costs over the next 15-20 years, and justification of the projections.

(xii) Policies and charges for connecting new consumers of each consumer category.

(b) Analyze data statistically to establish trends and correlations for load forecasting and cost-benefit analysis in connection with REA's National Rural Electrification Plan.

(c) Collect the following information for the remaining zones in REA's National Rural Electrification Plan.

(i) Size of population and growth rate.

(ii) Household incomes (average and range).

(iii) Number and types of dwellings.

(iv) Average number of people per dwelling.

(v) Main economic activities (agricultural, industrial, commercial).

(vi) Details of existing infrastructure (roads, water-supply, schools, health centers, etc.).

(vii) Existing fuels used and their costs.

(viii) Major identifiable electricity loads (e.g. irrigation, drinking-water supply, agro-industries) for (a) existing, and (b) prospective new operations (taking account of any Government development plans for the area).

(d) Preliminary 15-20 year forecasts of demand (kWh and kW) and revenues shall be prepared for each of the zones, not yet fixing dates for electrification. The forecasts shall be based on the analysis of the data for existing electrified zones and the information collected on the new zones, together with any other information judged relevant (e.g. relating to rural electrification developments in other comparable countries). A full justification for the forecasts should be given, including details of the methodology adopted.

(e) The next step is to determine the least-cost means of meeting the forecast demand in each zone. The main alternatives to be considered are:

(i) public supplies from the main grid;

(ii) the same, but with alternative network layouts, equipment capacities and expansion plans; and

(iii) local generation (e.g. by diesel sets) serving local distribution networks.

The comparison of the feasible technical alternatives should be made over an appropriate period of time (at least 20 years), using DCF methods. The time-streams of costs should cover the following items:

- Running costs (related to kWh sales): mainly, fuel and variable costs of maintenance. Fuel should be costed at its economic value, which may differ from its internal price (e.g. the economic value of diesel or fuel oil is its export value).

- Capacity costs (related to kW peak demand): generators, local distribution networks and, in the case of public supplies from the grid, transmission and subtransmission capacity.

- Fixed overheads: mainly distribution.

Taxes should be deducted from inputs subject to taxation, and subsidies should be added back. Shadow prices should be used in valuing foreign exchange costs and unskilled labor, it is suggested that foreign exchange should be valued at the parallel market rate and unskilled labor at 50% of its money value. The use of 10% discount rate for the basic comparison is suggested, although the sensitivity of the results to higher and lower rates (e.g. from 6% to 16%) should be tested. The effects of varying the assumptions on load forecast, capital and fuel costs, and value of foreign exchange should also be tested.

(f) The final stage in the economic analysis is the calculation of the present worth of the net benefits for each zone by discounting the time-streams of costs and benefits (over a period of at least 20 years) at an appropriate discount rate (10% is suggested, with sensitivity testing over a range of 6-16%). The relevant costs are operating, maintenance, and capacity costs for generation, transmission, and distribution, as already determined for the least-cost analysis. The benefits comprise:

(i) Direct benefits in the form of the projected revenues from forecast electricity sales including any fiscal charges or other taxes.

(ii) Surplus benefits to non-household consumers (agro- and other industries, farms, commerce). These may be in the form of resource cost-savings through the substitution of publicly supplied electricity for other energy sources, (valued at their economic costs e.g. diesel oil or kerosene at its export value) or extra output resulting from the use of electricity.

(iii) Any extra Government tax revenues e.g. from taxes on electricity consumption included in the prices charged to consumers or through increased sales of electrical appliances, if these are taxed (less any reduction in tax revenues through reduced use of electricity substitutes).

(iv) Any other identifiable, but non-quantifiable benefits (e.g. social benefits).

Again, the sensitivity of the economic rate of return to varying the assumptions on capital and running costs, load forecast and value of foreign exchange should be tested.

(g) An electrification construction program shall then be defined taking into account the forecast electricity requirements (applying suitable diversity factors), costs and benefits and ranking the zones in rough merit order for electrification. This ranking should be based on the criteria suggested in Attachment 3 and the results of the economic analysis but it may be necessary in some cases to strike a balance between financial, technical, economic and possibly organization considerations in scheduling the zones to be electrified. However, any deviations from the strict economic merit order should be specifically justified.

(h) A report ranking the zones should be submitted to REA not later than nine months after the effective date of the Consultant's contract.

Guidelines for Monitoring the National Rural Electrification Program

General

1. REA's National Rural Electrification Program is the first major step in rural electrification in Egypt. It is essential that a monitoring system be developed to gather extensive data during the execution of the second five-year plan (1976-80) in order that the experience gained can be used in REA's continuing program.

2. These guidelines have been prepared to serve as the basis for discussions in the development by REA and its consultants of an appropriate monitoring system.

3. It would seem desirable that the data system be designed to collect the information on a geographical basis using the power system configuration, i.e., data would be gathered for each village, then village data would be totalled by distribution substations, and finally substation data would be totalled by bulk supply point or possibly by Rural Zones. The loads connected directly to 11-kV feeders would be grouped with the feeder village loads. This would readily permit comparing system area inputs with sales, developing average supply costs, etc. However, the finally selected system would depend on REA's particular requirements. Similarly, it is obvious that the monitoring system should be designed for computer use in view of the volume of detailed data and the desirability of processing it for various purposes.

Load Data

4. To provide data on rate of load development for different regions under varying economic conditions as the villages are electrified the following data should be collected by village (data should also be collected for the villages already electrified, to the extent possible):

(i) The growth in number of consumers, demand (kWh and kW) and revenue per consumer (including, if possible, statistical analysis of individual consumer growth) since each village was electrified. Consumers would be classified as follows:

Residential
Commercial
Government and Municipal
Public Lighting
Industrial
Irrigation
Other

(ii) The growth of total village demand (kWh and kW) and revenues.

(iii) The uses to which electricity is put by each category of consumers, indicating information on the types and numbers of appliances installed.

(iv) Information on taxes paid by consumers as part of the electricity bills.

(v) How revenues change over time (e.g.: does the load factor per consumer category and overall improve)?

(vi) Types and number of dwellings and the numbers connected to "networks".

(vii) Trends in socio-economic factors such as:

Population growth
migratory flow
household incomes (giving the range as well as the average)
average number of people per dwelling

(viii) Details of village infrastructure (e.g. roads, water supply, schools, health centers).

(ix) Details of any new economic activities (commercial, industrial or agricultural) which have developed since the electrification of the village.

(x) The projected demand (kWh and kW), revenue and costs over the next 15-20 years, and justification of the projections.

Cost Data

5. A costing system should be developed so that the following data can be compiled:

(i) Statistical information on transformers, feeder lengths, capacities, etc.

(ii) 66, 33 and 11-kV facility costs by substation, area, line feeder, etc. giving the investment costs for specific load areas.

(iii) Individual village distribution costs and average connection costs for the various consumer categories.

(iv) Purchased power costs for the various areas.

(v) Operating and maintenance costs prorated by village and by other block load.

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Development of Project Cost Estimates

Materials and Labor	Base Price Late 1976 (LE)	Estimated Project Quantities	-----Appraisal Base Cost----- LE '000 1/ Local	Foreign	Total
1. 63-kV Overhead Lines, per km.					
(single-circuit steel tower construction)					
-240/40 Sq. mm ACSR	15,000	56	227	613	840
-120/21 Sq. mm ACSR	13,000	20	70	190	260
2. 33-kV Overhead Lines, per km.					
(single-circuit steel tower construction)					
-120/21 Sq. mm ACSR	1,000	23	62	168	230
3. Distribution Substations		7	1,314	3,551	4,865
(including land, fences & steel structures)					
-10 MVA, 66/11 kV, per unit					
- HV Switchgear	156,000				
- Main Transformer	122,000				
- LV Switchgear	132,000				
- Control and Protection	102,000				
- Auxiliary Equipment	104,000				
- Cables	37,000				
- Spare Parts and Maintenance Tools	42,000				
Total Per Unit	695,000				
4. Distribution Substations		2	246	664	910
(including land, fences & steel structures)					
-10 MVA, 33/11 kV, per unit					
- HV Switchgear	75,000				
- Main Transformer	100,000				
- LV Switchgear	65,000				
- Control and Protection	100,000				
- Auxiliary Equipment	38,000				
- Cables	27,000				
- Spare Parts and Maintenance Tools	50,000				
Total Per Unit	455,000				
5. 11-kV Distribution Switchboards, per unit	60,000	21	336	924	1,260
6. 11-kV Primary Mains and Laterals					
- Underground cable, per km					
- 3 x 240 Sq. mm, Al	12,800	118	408	1,102	1,510
- 3 x 185 Sq. mm, Al (submarine cable)	12,000	3	10	26	36
- 3 x 150 Sq. mm, Al	11,200	237	716	1,938	2,654
- 3 x 120 Sq. mm, Al (submarine cable)	12,000	1	4	8	12
- 3 x 70 Sq. mm, Al	8,000	252	544	1,472	2,016
- Overhead lines, per km					
- 150/25 Sq. mm, ACSR	3,500	459	434	1,172	1,606
- 95/15 Sq. mm, ACSR	3,000	422	342	924	1,266
7. Distribution Transformers, 11,000 - 380/220 V					
3-Phase, per unit, rated:					
- 500 kVA (Kiosk)	7,500	148	300	810	1,110
- 250 kVA (Kiosk)	5,000	148	200	540	740
- 160 kVA	4,000	58	63	169	232
- 100 kVA	3,000	118	95	259	354
- 63 kVA	1,800	96	47	126	173
- 25 kVA	750	104	20	58	78
8. 380/220-V Secondaries					
3-Phase, 4-wire construction					
- Underground cable, per km	7,000	126	238	644	882
- Overhead lines, per km	5,000	1,777	2,412	6,473	8,885
Total			8,088	21,831	29,919
Consultants			629	1,465	2,094
Studies			340	728	1,068
Training			400	733	1,133
Total Base Cost			9,457	24,757	34,214

1/ LE1.000 = US$1.50.

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Development of Project Costs, '000 LE, LE1.000 = US$1.50

Base Prices, late 1976		Percent	1978	1979	1980	1978-1980
1) Overhead and Underground Transmission and Distribution	LC	27	1,692	2,983	1,128	5,803
	FC	73	4,563	8,048	3,043	15,654
	T	100	6,255	11,031	4,171	21,457
2) Substations Equipment and Transformers	LC	27	665	1,178	442	2,285
	FC	73	1,796	3,184	1,197	6,177
	T	100	2,461	4,362	1,639	8,462
3) Engineering Services	LC	30	189	314	126	629
	FC	70	440	732	293	1,465
	T	100	629	1,046	419	2,094
4) Studies and Training	LC	34	340	200	200	740
	FC	66	661	333	467	1,461
	T	100	1,001	533	667	2,201
Total Base Cost, Unescalated	LC	28	2,886	4,675	1,896	9,457
	FC	72	7,460	12,297	5,000	24,757
	T	100	10,346	16,972	6,896	34,214

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Development of Project Costs, '000 LE, LE1.000 = US$1.50

Base Prices, late 1976	1978	1979	1980	1978-1980
Local Currency				
1) Overhead and Underground Transmission and Distribution	1,692	2,983	1,128	5,803
2) Substation Equipment and Transformers	665	1,178	442	2,285
3) Engineering Services	189	314	126	629
4) Studies and Training	340	200	200	740
Total Base Cost	2,886	4,675	1,896	9,457
Physical Contingency	379	467	190	1,036
Subtotal	3,265	5,142	2,086	10,493
Escalation Factor	.1872	.3297	.4751	
Price Contingency	611	1,695	991	3,297
Total Escalated LC Cost	3,876	6,837	3,077	13,790

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Development of Project Costs, '000 LE, LE1.000 = US$1.50

Base Prices, late 1976

Foreign Currency	1978	1979	1980	1978-1980
1) Overhead and Underground Transmission and Distribution	4,563	8,048	3,043	15,654
2) Substation Equipment and Transformers	1,796	3,184	1,197	6,177
3) Engineering Services	440	732	293	1,465
4) Studies and Training	661	333	467	1,461
Total Base Cost	7,460	12,297	5,000	24,757
Physical Contingency	980	1,230	500	2,710
Subtotal	8,440	13,527	5,500	27,467
Escalation Factor	.12	.22	.31	
Price Contingency	1,013	2,976	1,815	5,804
Total Escalated FC Cost	9,453	16,503	7,315	33,271

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Summarized Project Cost Estimate, '000 LE, LE1.000 = US$1.50

	LE Thousands			US$ Thousands		
	Local	Foreign	Total	Local	Foreign	Total
1) Overhead and Underground Transmission and Distribution	5,803	15,654	21,457	8,705	23,481	32,186
2) Substation Equipment and Transformers	2,285	6,177	8,462	3,427	9,266	12,693
3) Engineering Services	629	1,465	2,094	944	2,198	3,142
4) Studies and Training	740	1,461	2,201	1,110	2,192	3,302
Subtotal	9,457	24,757	34,214	14,186	37,137	51,323
Contingencies						
Physical	1,036	2,710	3,746	1,554	4,065	5,619
Price	3 297	5,804	9,101	4,946	8,706	13,652
Total Project Cost	13,790	33,271	47,061	20,686	49,908	70,594

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A. EEA Monitoring Indicators

1. The following system performance indicators should be periodically determined and evaluated against the suggested target as shown:

(a) Unit availability. The ratio in percent of the number of hours per year each generating unit in all hydro and thermal stations is available for dispatch to the total number of hours in the year, 8,760 hours.

(b) Mamixum effective system capability. The total MW rating of all operational generating stations as a function of water and unit availability. This figure should be reported on an annual basis for the period of the year including the system one-hour peak load for the year. Figures for the current year, the previous year and the following year estimates should be reported together.

(c) Reserve margin. The ratio in percent of the maximum effective system capability to the corresponding one-hour peak demand during the year as shown in Annex 7. This figure should be no less than 15%. It should be reported on the same basis as the maximum effective system capability.

(d) Annual system losses, transmission and distribution. The ratio in percent of the total annual kWh sales as recorded at the meters of the ultimate consumers, to the total annual net system generation as recorded at the outgoing bus to the step up substations. This figure is shown as 17% in the generation and sales forecast of Annex 12. It should be no higher than 10-12%.

2. The following additional self-defining indices should also be determined and reported on an annual basis:

(a) Generating capacity utilization. The ratio in percent of hours run over total hours of unit availability.

(b) Net station heat rates. Average Btu (or Kcal) per kWh of net generation. Thermal stations, station-by-station and overall.

(c) Plant factor, percent, based on nameplate rating. All stations.

(d) Peak demand on station, MW (60 minutes) (net).

(e) Net continuous plant capability. With limiting condition, if any, fully described.

(f) Gross plant investment per kW of peak load.

(g) Gross production plant investment per kW of peak load.

(h) Gross transmission and distribution plant investment per kW of peak load.

(i) Annual residential and rural use in kWh per connection.

(j) Total annual sales per consumer separated according to tariff classifications.

(k) Total number of connection per tariff classification.

(l) Connections per 100 population in urban and rural areas.

3. For the Aswan and High Dam installations, the following should also be reported each year.

(a) Installed generating capacity - generator nameplate - MW.

(b) Net generation, million kWh.

(c) Plant factor, percent, based on nameplate rating.

(d) Net peak demand on plant, MW (60 minutes).

(e) Capability under most favorable operating conditions - MW.

(f) Capability under most adverse operating conditions - MW.

(g) Monthly status of High Dam reservoir:

(i) Storage or pondage from maximum draw-down, million cubic meters.

(ii) gross head (pond evaluation minus tailwater evaluation) meters.

(iii) cubic meters second per kW - Full station load.

4. The following financial indicators should be calculated and submitted with the EEA Annual Financial Report to the Bank;

(a) Operating Performance - rate of return on average net fixed assets in service i.e.: operating income as a percentage of the average net fixed assets for the current and the preceding year.

(b) Operating Efficiency - average cost per kWh sold.

(c) Efficiency of Collections - average number of days electricity accounts are outstanding.

(d) Debt Service Coverage - number of times gross debt service including interest during construction is covered by internal cash generation i.e. net income plus depreciation.

(e) Debt/Equity ratio - ratio of long-term debt including the portion due for repayment in one year to equity including retained earnings and any revaluation surplus.

(f) Staffing - number of employees per MW of installed plant.

B. Guidelines for Monitoring the National Rural Electrification Program

General

5. REA's National Rural Electrification Program is the first major step in rural electrification in Egypt. It is essential that a monitoring system be developed to gather extensive data during the execution of the second five-year plan (1976-1980) in order that the experience gained can be used in REA's continuing program.

6. These guidelines have been prepared to serve as the basis for discussions in the development by REA and its consultants of an appropriate monitoring system.

7. It would seem desirable that the data system be designed to collect the information on a geographical basis using the power system configuration, i.e., data would be gathered for each village, then village data would be totalled by distribution substations, and finally substation data would be totalled by bulk supply point or possibly by Rural Zones. The loads connected directly to 11-kV feeders would be grouped with the feeder village loads. This would readily permit comparing system area inputs with sales, developing average supply costs, etc. However, the finally selected system would depend on REA's particular requirements. Similarly, it is obvious that the monitoring system should be designed for computer use in view of the volume of detailed data and the desirability of processing it for various purposes.

Load Data

8. To provide data on rate of load development for different regions under varying ecnomic conditions, as the villages are electrified the following data should be collected by village (data should also be collected for the villages already electrified, to the extent possible);

(i) The growth in number of consumers, demand (kWh and kW) and revenue per consumer (including, if possible, statistical analysis of individual consumer growth) since each village was electrified. Consumers would be classified as follows:

Residential
Commercial
Government and Municipal
Public Lighting
Industrial
Irrigation
Other

(ii) The growth of total village demand (kWh and kW) and revenues.

(iii) The uses to which electricity is put by each category of consumers, indicating information on the types and numbers of appliances installed.

(iv) Information on taxes paid by consumers as part of the electricity bills.

(v) How revenues change over time (e.g.: does the load factor per consumer category and overall improve)?

(vi) Types and number of dwellings and the numbers connected to "networks".

(vii) Trends in socio-economic factors such as:

Population growth
migratory flow
household incomes (giving the range as well as the average)
average number of people per dwelling

(viii) Details of village infrastructure (e.g. roads, water supply, schools, health centers).

(ix) Details of any new economic activities (commercial, industrial or agricultural) which have developed since the electrification of the village.

(x) The projected demand (kWh and kW), revenue and costs over the next 15-20 years, and justification of the projections.

Cost Data

9. A costing system should be developed so that the following data can be compiled:

(i) Statistical information on transformers, feeder lengths, capacities, etc.

(ii) 66, 33 and 11-kV facility costs by substation, area, line feeder, etc. giving the investment costs for specific load areas.

(iii) Individual village distribution costs and average connection costs for the various consumer categories.

(iv) Purchased power costs for the various areas.

(v) Operating and maintenance costs prorated by village and by other block load.

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Estimated Schedule of Disbursements

(Assumed date of effectiveness October 14, 1977)

Bank Fiscal Year and Quarter	Cumulative Disbursements at end of Quarter
1978	US$ Millions
December 31, 1977	1
March 31, 1978	3
June 30, 1978	8
1979	
September 30, 1978	13
December 31, 1978	18
March 31, 1979	25
June 30, 1979	32
1980	
September 30, 1979	37
December 31, 1979	42
March 31, 1980	45
June 30, 1980	46
1981	
September 30, 1980	47
December 31, 1980	48

Source: Mission estimates

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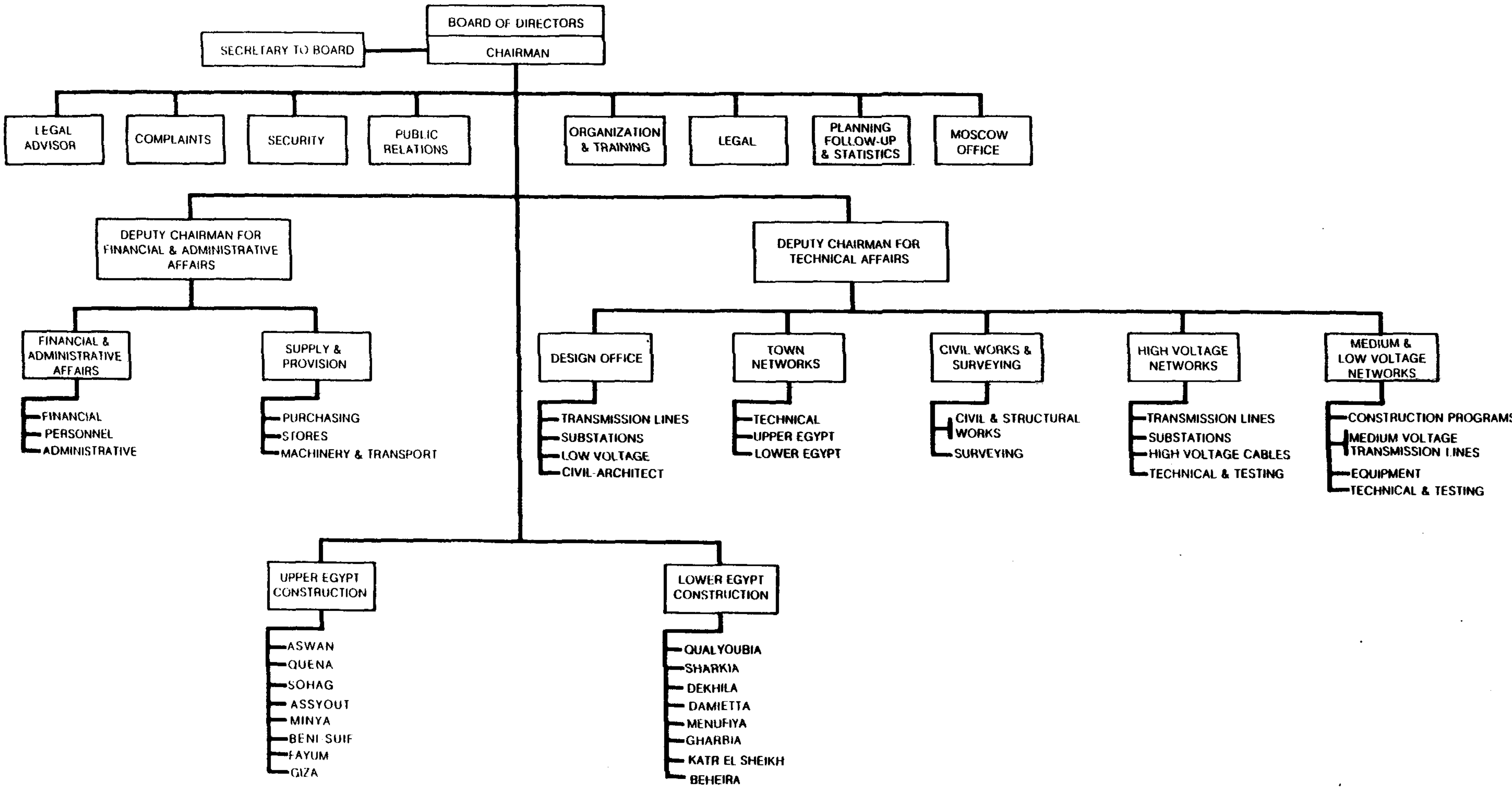
EGYPT
RURAL ELECTRIFICATION AUTHORITY
ORGANIZATION CHART



World Bank – 16893

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Functions of REA Departments

Board of Directors: The Board of Directors is responsible for:

a. Setting major policies.

b. Issuing internal regulations.

c. Approving annual budgets and financial statements.

d. Following up on reports and execution of programs.

Financial and Administrative Affairs Department. This Department is responsible for personnel, purchasing, stores, transport and other financial and administrative matters through two inspectorates. One inspectorate supervises the activities of three Directorates---purchasing, stores and transport. The other has only two Directorates---financial and administration. This Department prepares general cost estimates for all projects. It is also responsible for preparation of the annual budget of REA. It also reviews and approves all expenses.

Technical Affairs Department. This Department is responsible for all technial activities within REA. It is divided into five inspectorates:

a. The Inspectorate for Medium and Low Voltage Networks engineers and specifies equipment and materials for use in medium and low tension work -- 11-kV and below. It also follows up technical aspects and progress of project execution.

b. The Inspectorate for High Voltage Networks supervises high voltage projects - 33-kV and above - including preparation of programs, specifications, participation in adjudications, selection of equipment, field supervision, testing of equipment and certification of contractors' invoices for payment.

c. The Inspectorate for Civil Works and Surveying is responsible for preparation of survey maps for lines, substations, villages and towns. It also surveys routes to prepare line profiles and assist in negotiations of right-of-ways. This Inspectorate also supervises execution of civil works for electrical installations, buildings, warehouses, and housing requirements of the Authority.

d. <u>The Inspectorate for Rehabilitation of Networks</u> undertakes studies for improving electricity supply to cities and towns. It prepares bidding documents and specifications and participates in the procurement of equipment and materials. It also supervises the installation and construction work, prepares reports related thereto, witnesses equipment tests and certifies payment to contractors.

e. <u>The Inspectorate for Design</u> is responsible for studies, planning and engineering of electrical projects, including preparation of bidding documents, specifications and drawings, staking sheets and substation layouts. It also does all civil works design required for REA Projects.

f. <u>Field Support Departments for Upper and Lower Egypt</u>. These two Departments are responsible for ensuring timely delivery of equipment and materials to construction crews in the field. They are responsible for transportation, storage, and all other required onsite facilities and logistics. In addition, they follow up on construction progress and report accordingly. There are 16 Directorates in the two Departments, each Directorate is responsible for one Governorate. Upper level personnel in these two Departments double as EEA supervisors for Operation and Maintenance activities in their respective districts.

APPRAISAL OF A REGIONAL ELECTRIFICATON PROJECT

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EGYPTIAN ELECTRICITY AUTHORITY

Income Statements for the Years Ending December 31, 1973-80
(Thousands of LE)

	ACTUAL			FORECAST				
	1973	1974	1975	1976	1977	1978	1979	1980
Sales of Electricity - GWh	6,178	6,895	8,308	9,800	11,200	12,600	14,280	15,925
Average Revenue per kWh Sold (milliemes)	7.49	[illegible]	8.94	8.94	8.84	10.66	13.18	13.27
Operating Revenues								
Sales of Electricity	46,292	50,121	74,303	87,612	99,008	134,316	188,210	211,325
Connection and Maintenance Charges	2,709	2,378	3,725	5,359	7,084	8,217	9,427	10,724
Other Operating Revenues 1/	1,655	1,953	1,869	2,205	2,514	2,816	3,154	3,532
Total Operating Revenues	50,656	54,452	79,897	95,176	108,606	145,349	200,791	225,581
Operating Expenses								
Fuel and Lubricants	6,765	7,135	9,344	11,173	12,760	14,478	16,803	21,801
Salaries and Wages	12,150	13,862	16,421	17,596	21,115	23,226	25,549	28,104
Purchase of Materials and Services	6,143	5,847	9,873	4,232	8,879	13,506	16,612	17,797
Other Operating Expenses	2,268	7,228	18,187	6,178	7,243	8,398	9,651	11,011
Depreciation	12,066	13,604	13,531	17,380	25,667	32,815	41,307	43,628
Total Operating Expenses	39,392	47,676	67,356	56,559	75,664	92,423	109,922	122,341
Operating Income	11,264	6,776	12,541	38,617	32,942	52,926	90,869	103,240
Non-Operating Income (Loss) 2/	(1,709)	(1,611)	(316)	(366)	(455)	(586)	(548)	(492)
Gross Income	9,555	5,165	12,225	38,251	32,487	52,340	90,321	102,748
Interest								
Gross Interest	9,555	8,421	16,869	18,835	28,096	36,104	44,272	49,634
Less: Interest Charged to Construction	-	-	-	(4,158)	(7,603)	(9,502)	(13,144)	(13,272)
Net Interest Expense	9,555	8,421	16,869	14,677	20,493	26,602	31,128	36,362
Net Income	-	(3,256)	(4,644)	23,574	11,994	25,738	59,193	66,386
Average Net Fixed Assets in Service	312,015	307,715	304,929	368,358	556,717	784,728	1,008,340	1,146,082
Operating Income as a % Thereof	3.61	2.20	4.11	10.48	5.92	6.75	9.01	9.01

1/ Includes meter rentals, sales of scrap, and revaluation of stocks, sales of gas and distilled water.
2/ Includes income and expense adjustments for previous years, dividends from associated companies, compensation awarded against contractors or consumers, and proceeds of sale of assets.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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EGYPTIAN ELECTRICITY AUTHORITY

Balance Sheets as of December 31, 1973-80
(Thousands of LE)

	ACTUAL			FORECAST				
	1973	1974	1975	1976	1977	1978	1979	1980
Assets								
Fixed Assets								
Gross Fixed Assets in Service	414,932	421,921	435,801	579,341	855,566	1,093,844	1,376,912	1,454,264
Less: Accumulated Depreciation	(104,081)	(117,342)	(130,523)	(147,903)	(173,570)	(206,385)	(247,692)	(291,320)
Net Fixed Assets in Service	310,851	304,579	305,278	431,438	681,996	887,459	1,129,220	1,162,944
Work in Progress	36,347	50,011	69,466	111,324	130,287	221,806	224,978	359,960
Total Fixed Assets	347,198	354,590	374,744	542,762	812,283	1,109,265	1,354,198	1,558,904
Investments	1,914	2,177	2,248	276	276	276	276	276
Long-Term Receivables	5,626	5,506	5,778	419	419	419	419	419
Current Assets								
Cash	12,368	9,603	14,859	28,784	27,313	44,708	42,526	30,523
Inventories	25,212	32,221	44,798	49,905	54,019	58,469	62,870	67,490
Accounts Receivable	59,093	63,970	88,221	95,993	49,506	33,579	47,052	52,830
Total Current Assets	96,673	105,794	147,878	174,682	130,838	136,756	152,448	150,843
Total Assets	451,411	468,067	530,648	718,139	943,816	1,246,716	1,507,341	1,710,442
Liabilities								
Capital and Reserves								
Capital	75,617	75,617	75,617	75,617	75,617	75,617	75,617	75,617
Reserves	7,421	11,455	31,336	32,503	113,425	168,480	221,319	268,165
Legal Reserves	13,622	10,244	15,522	15,522	15,522	15,522	15,522	15,522
Retained Earnings		(3,256)	(7,900)	15,674	27,668	53,406	112,599	178,985
Total Capital and Reserves	96,660	94,060	114,575	139,316	232,232	313,025	425,057	538,289
Long-Term Debt								
Total Long-Term Debt	329,334	322,292	347,060	495,470	641,992	846,192	1,006,411	1,094,009
Less: Debt Due Within 1 Year	NA	(13,221)	(19,768)	(19,439)	(19,711)	(21,480)	(22,080)	(24,166)
Net Long-Term Debt	329,334	309,071	327,292	476,031	622,281	824,712	984,331	1,069,843
Current Liabilities								
Current Portion of Long-Term Debt	NA	13,221	19,768	19,439	19,711	21,480	22,080	24,166
Accounts Payable and Deferred Liabilities	21,206	47,007	63,981	77,415	62,823	79,715	67,054	68,311
Consumers' Deposits	4,211	4,708	5,032	5,938	6,769	7,784	8,819	9,833
Total Current Liabilities	25,417	64,936	88,781	102,792	89,303	108,979	97,953	102,310
Total Liabilities	451,411	468,067	530,648	718,139	943,816	1,246,716	1,507,341	1,710,442
Ratios								
Debt/Equity Ratio	77:23	77:23	75:25	78:22	73:27	73:27	70:30	67:33
Current Ratio	3.8	1.6	1.7	1.7	1.5	1.3	1.6	1.5

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ANNEX 22

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

EGYPTIAN ELECTRICITY AUTHORITY

Forecast Sources and Applications of Funds 1976-80
(Thousands of LE)

	1976	1977	1978	1979	1980	TOTAL 1976-80
Sources of Funds						
Internal Cash Generation						
Gross Income	38,251	32,487	52,340	90,321	102,748	316,147
Depreciation	17,380	25,667	32,815	41,307	43,628	160,797
Total Internal Cash Generation	55,631	58,154	85,155	131,628	146,376	476,944
External Sources						
Contributions from Ministry of Housing & Reconstruction		63,080	54,055	52,839	46,846	216,820
US AID Grants	1,167	17,842	1,000			20,009
Borrowings						
Proposed IBRD Loan		667	11,339	16,008	3,986	32,000
Ministry of Finance	30,401	21,812	74,587	7,563		134,363
US AID Loans		18,973	42,996	69,624	58,080	189,673
Other Foreign Loans	33,130	38,884	36,279	31,017	11,068	150,378
Total Borrowings	63,531	80,336	165,201	124,212	72,483	505,763
Total Sources of Funds	120,329	219,412	305,411	308,679	266,356	1,220,187
Applications of Funds						
Construction Requirements (incl. Interest Charged to Construction)	80,751	208,896	259,748	212,745	207,804	969,944
Proposed Regional Electrification Project 1/	-	667	11,339	16,008	3,986	32,000
	80,751	209,563	271,087	228,753	211,790	1,001.944
Debt Service						
Amortization	19,768	19,439	19,711	21,480	22,080	102,478
Interest (Net)	14,677	20,493	26,602	31,128	36,362	129,262
Total Net Debt Service	34,445	39,932	46,313	52,608	58,442	231,740
Net Change in Working Capital	5,133	(30,083)	(11,989)	27,318	(3,876)	(13,497)
Total Applications of Funds	120,329	219,412	305,411	308,679	266,356	1,220,187
Times Gross Annual Debt Service Covered by Internal Cash Generation	1.6	1.2	1.5	2.0	2.0	1.7

1/ Foreign cost only being amount of proposed Bank loan.

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ANNEX 23

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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EGYPTIAN ELECTRICITY AUTHORITY

Notes and Assumptions for Financial Forecasts

A. Income Statement

1. Sales of Electricity have been based on information furnished by EEA which was subsequently modified by the Bank. We have assumed annual kWh sales growth of 18% in 1976, 14.3% in 1977, 12.5% in 1978, 13.3% in 1979 and 11.5% in 1980. Average revenue per unit sold for forecast years has been based on estimates by customer category prepared by EEA's commercial department. Tariffs are assumed to be unchanged through 1977 and increased thereafter by 20% in 1978 and 22.5% in 1979.

2. Connection and Maintenance Charges were assumed to increase by the same percentages as annual kWh sales of electricity. Maintenance charges were based on forecast sales to Municipalities in kWhs at 1.5 milliemes per kWh.

3. Other Operating Revenues were assumed to increase by the same percentages as annual kWh sales of electricity.

4. Fuel and Lubricants were based on estimates of generation from steam units and gas turbines using fuel prices and heat rates as follows:

(1) Fuel Prices:

Diesel fuel - LE 24.60 ton (gas turbines)
Fuel oil - LE 7.50 ton (steam turbines)

(2) Heat Rates:

Gas turbines -	15,475 Btu = 1 kWh	
Steam turbines -	14,500 Btu = 1 kWh	(1976)
	14,000 Btu = 1 kWh	(1977)
	13,000 Btu = 1 kWh	(1978)
	12,000 Btu = 1 kWh	(1979)
	11,000 Btu = 1 kWh	(1980)

5. Salaries and Wages in 1976 were based on EEA's budget estimate and thereafter escalated by 20% in 1977, and 10% in each of 1978, 1979 and 1980. No specific increases in staff were assumed since EEA is considered to be overstaffed now.

6. Purchase of Materials and Services and Other Operating Expenses were based on estimates furnished about October 1976 by EEA to the Kuwait Fund for Arab Economic Development. An escalation factor of 10%/a was added to the EEA estimates.

7. Depreciation. Gross fixed assets in service at the beginning of each year were depreciated at an average annual rate of 3%/a.

8. Non-Operating Income (Loss) represents the balance of non-operating revenues and expenses as estimated by EEA in the October 1976 forecasts for the Kuwait Fund.

9. Interest was calculated at the rate of 5%/a on all loans from the Ministry of Finance including funds provided to REA for rural electrification. Interest on all existing foreign loans was based on EEA's actual calculations. All new borrowing including USAID, suppliers' credits and Ministry of Finance loans were assumed to be at an average interest rate of 5%/a (it is expected that some of these funds e.g. USAID will be provided as grants and others, particularly those obtained from neighboring OPEC countries, will be on low interest terms). Interest at the rate of 5%/a was added to construction costs of all generating plant until it was commissioned. The same interest rate was added to the progressive costs of rural electrification assets under construction through December 1976; these assets were planned to be handed over financially to EEA as of December 1976.

B. Balance Sheet

10. Gross Fixed Assets in Service are valued at historical cost. They do not reflect the findings of a committee which reviewed the valuation of EEA's assets following acquisition of electricity assets after completion of the High Dam in 1970. If the recommendations in the committee's report are adopted they would increase the valuation of gross fixed assets in service by about LE 22 million or 5%.

11. Inventories were based on EEA's October 1976 estimates subject to 10%/a escalation.

12. Accounts Receivables. EEA's estimate for 1976 was accepted for the Bank's forecast. Thereafter, it was assumed EEA would reduce the level of outstandings to the equivalent of three months sales by the end of 1978.

13. Reserves were increased each year by contributions received from the Ministry of Housing and Reconstruction and grants by USAID.

14. Accounts Payable and Deferred Liabilities were estimated each year on the basis of three months of annual capital expenditures and cash operating expenses.

15. Consumers' Deposits were increased by the same precentages as kWh sales of electricity.

C. Sources and Applications of Funds

16. Contributions from the Ministry of Housing and Reconstruction were based on EEA's 5-Year Plan estimates.

17. USAID Grant was for $30 million for power distribution equipment for Suez cities. Disbursement was based on USAID estimates furnished to the Bank.

18. Borrowings. All foreign borrowings were converted to Egyptian pounds using the parallel market rate of exchange of LE 1 = US$1.50. EEA's planned borrowing program was adjusted to meet the needs of the construction program which was revised by the Bank. The 1976 borrowing program was taken from EEA's 1976 budget estimates, and that for the years 1977 through 1980 from information prepared by EEA from their 5-Year Plan estimates.

19. Construction Requirements were based on EEA's estimates and escalated using the Bank's February 1976 guidelines for price contingencies i.e.

	1976	1977-79	1980
Equipment	9	8	7
Civil Works	13	12	10

The foreign costs of all construction were adjusted to the parallel market rate of exchange which is now being used by EEA for recording purposes. (The official rate of exchange is still used by Government for its 5-Year Plan projections).

20. Amortization of Long-Term Debt. Ministry of Finance loans were assumed repayable over 12 years after 3 years' grace. Amortization of USAID loans was assumed to commence after the expiration of the 10 years' grace period i.e. after 1980. Amortization of other existing foreign loans was based on EEA's calculations. Other future foreign loans were all assumed to be repayable after expiration of grace periods i.e. after 1980. Loans for rural electrification were assumed to be non-repayable in accordance with present Government policy except for the proposed Bank loan which is expected to have a 4-1/2 year grace period. Therefore amortization on the Bank loan would not commence until about December 1981.

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Project Load Forecast

The Load

1. The Project is part of the second installment (1976-80) of REA's National Rural Electrification Plan to rehabilitate and expand service in urban areas and rural zones (Attachment 1) serving five different categories of consumers; namely:

   a. large-scale medium voltage industrial consumers;

   b. small-scale medium voltage industrial consumers;

   c. public agencies and enterprises, including street lighting;

   d. commercial and small shops; and

   e. residential consumers.

2. Existing distribution already serves an estimated 72% of the population available in the project area -- 80% in the urban centers and fringes and 60% in the rural zones (a detailed breakdown is given in Attachment 2). These facilities have long been neglected in the past due to lack of financing and are for the most part overloaded. No significant additional load can be accommodated until after additonal system capacity is placed in service to upgrade the existing system thereby allowing resumption of normal, unrestricted load growth and extension of service to new consumers.

Load Growth

3. The main immediate increase in consumption is assumed to come from commercial and residential loads. However, in 5-10 years the Project area may attract large blocks of irrigation loads and large industrial units. Although the Project will not be totally completed until 1980, some incremental load was assumed starting in 1978 as the completed portions of the Project are progressively energized. In the absence of hard statistical data, the mission assumed reasonable average consumption figures for 1976 as the starting point for the load forecast, based on REA's estimates (Attachment 1) and in line with historic trend samples (Attachments 3 and 4) and data obtained elsewhere in the world for loads at a comparable stage of development (Attachment 5). The figures were 100/kWh/household/month for the urban centers and fringes, and 50 kWh/household/month for the rural zones.

4. Also in line with REA planning criteria, tables I - V of this Annex show the figures resulting from a 10%/a growth rate applied to overall kWh consumption. On that basis average Project load growth rate was about 23%/a.

5. At the above rate the distribution facilities were loaded to capacity by 1989. At a 20% faster rate of load growth full system capacity would be reached two years earlier, while a 20% lower rate of load growth would not load up the facilities fully until 1992, three years later than the main projection.

6. Because of lack of sufficient statistical information the load projections developed here are at best estimates only. Sensitivity tests for ± 10 variations in kWh sales were applied in Annex 27 to allow for uncertainty.

Table I

Nine Urban Centers and Fringes

Population Estimates

Year	Population, '000: Total 1/	Population, '000: with access to service	Population, '000: with service	Households, '000: with access to service 2/	Households, '000: with service
1976	2,288	1,830	1,647	366	329
1977	2,345	1,830	1,647	366	329 3/
1978	2,404	1,923	1,731	384	334 4/
1979	2,464	1,971	1,774	394	345
1980	2,526	2,021	1,819	404	364
1981	2,589	2,071	1,864	414	373
1982	2,653	2,122	1,910	424	382
1983	2,720	2,176	1,958	435	392
1984	2,788	2,230	2,007	446	401
1985	2,857	2,286	2,057	457	411
1986	2,929	2,343	2,109	468	422
1987	3,002	2,402	2,162	480	432
1988	3,077	2,462	2,216	492	443
1989-2004	3,154	2,523	2,271	505	454

1/ Average growth rate, 2.5%/a.
2/ At average of five persons per household.
3/ No increase assumed until after Project facilities first become available in 1978.
4/ Only 30% of total assumed potential customers connected the first year.

SOURCE: Mission estimates from REA data.

Table II

Nine Urban Centers and Fringes

Load Projection

Year	----Sales, million kWh---- Total Sales 1/	Incremental	-------Peak Demand, MW------- Total Peak Demand	Incremental
1976	395 2/		121	
1977	395 3/		121	
1978	407 4/	12	122	1
1979	445	40	130	9
1980	525	130	150	29
1981	578	183	161	40
1982	635	240	173	52
1983	699	304	186	65
1984	769	374	200	79
1985	846	451	215	94
1986	931	536	231	110
1987	1,024	629	249	128
1988	1,126	731	268	147
1989-2004	1,239	844	289	168

1/ Assumed increasing at 10%/a. average starting in 1978.
2/ At an average of 100 kWh per household per month.
3/ No growth assumed until Project facilities first are available.
4/ Initially, only portion (30%) of available load is expected to materialize.

SOURCE: Mission estimates from REA data.

Table III

Fourteen Rural Zones

Population Estimates

Year	Population, '000 Total 1/	Population, '000 with access to service	Population, '000 with service	Households, '000 with access to service 2/	Households, '000 with service
1976	1,507	904	633	151	106
1977	1,545	904	633	151	106 3/
1978	1,583	950	665	158	108 4/
1979	1,623	974	682	162	111
1980	1,663	998	699	166	117
1981	1,705	1,023	716	170	119
1982	1,748	1,049	734	175	122
1983	1,791	1,075	752	179	125
1984	1,836	1,102	771	184	128
1985	1,882	1,129	790	188	132
1986	1,929	1,157	810	193	135
1987	1,977	1,186	830	198	138
1988	2,027	1,216	851	203	142
1989-2004	2,077	1,246	872	208	145

1/ Average rate of growth, 2.5%/a.
2/ At an average of six persons per household.
3/ No increase assumed until after Project facilities first become available in 1978.
4/ Only 30% of total assumed potential customers connected the first year.

SOURCE: Mission estimates baded on REA data.

Table IV

Fourteen Rural Zones

Load Projection

Year	Sales, million kWh: Total Sales 1/	Sales, million kWh: Incremental	Peak Demand, MW: Total Peak Demand	Peak Demand, MW: Incremental
1976	91 2/		38	
1977	91 3/		38	
1978	94 4/	3	40	2
1979	102	11	43	5
1980	121	30	46	8
1981	133	42	49	11
1982	146	55	52	14
1983	161	70	55	17
1984	177	86	59	21
1985	195	104	63	25
1986	214	123	68	30
1987	236	145	73	35
1988	260	169	78	40
1989-2004	286	195	84	46

1/ Assumed increasing at 10%/a. average starting in 1978.
2/ At an average of 50 kWh per household per month.
3/ No growth assumed until Project facilities first are available.
4/ Initially only a portion (30%) of available load is expected to materialize.

SOURCE: Mission estimates from REA data.

Table V

Total Project

Project Load

Year	Sales, million kWh	Peak Demand, MW
1976		
1977		
1978	15	3
1979	61	14
1980	160	37
1981	225	51
1982	295	66
1983	374	82
1984	460	100
1985	555	119
1986	659	140
1987	774	163
1988	900	187
1989-2004	1,039	214 1/

1/ Maximum load capacity of distribution facilities.

SOURCE: Mission estimates from REA data.

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Estimated Population and Annual Consumption per Capita, 1976

	Population	kWh/Capita	Total Consumption Million kWh
A. Nine Urban Centers and Fringes			
1. Damietta			
a. Town	110,499	200	22.1
b. Fringes	78,370	100	7.8
2. El Mahalla			
a. Town	288,413	200	57.7
b. Fringes	47,249	100	4.7
3. Tanta			
a. Town	294,372	225	66.2
b. Fringes	117,340	100	11.7
4. El Mansoura			
a. Town	245,068	200	49.0
b. Fringes	102,808	100	10.2
5. Fuwa (Fowa) 1/			
a. Town	35,237	200	7.0
b. Fringes	67,921	100	6.8
6. El Fayum			
a. Town	171.028	100	17.1
b. Fringes	11,648	100	1.2
7. El Minya (El Miniah) 1/			
a. Town	144,102	100	14.4
b. Fringes	89,999	100	9.0
8. Assyout (Assiut) 1/			
a. Town	197,064	100	19.7
b. Fringes	110,108	100	11.0
9. Aswan			
a. Town	163,320	150	16.3
b. Fringes	13,784	100	1.4
TOTAL	2,288,330	146	333.3
B. Fourteen Rural Zones			
1. El Hosaneyah (El Hussinieh) 1/	116,843	100	11.7
2. Talkha	102,103	100	10.2
3. Shirbin	132,008	100	13.2
4. El Mousalas (El Mosalas) 1/	46,570	100	4.7
5. Rashid	79,972	100	8.0
6. El Mahrousa	80,572	100	8.0
7. El Wasta	51,579	100	5.2
8. Awlad Touk (Awlad Tuk) 1/	84,855	100	8.5
9. El Aakab	74,518	100	7.5
10. Kafr Saad	53,351	100	5.3
11. Kotour	153,624	100	15.4
12. Manfalut	143,632	100	14.4
13. Dairut	191,756	100	19.2
14. Akhmin	195,203	100	19.5
TOTAL	1,506,586	100	150.8

1/ New Spelling.

SOURCE: Rural Electrification Authority (REA)

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Project Description and Population Affected

	Rehabilitation of Existing Services				Extension of Service and New Consumers				Total Population 1/	Percent Served Now	Percent New Services
	Cities	Villages	Hamlets	Population	Cities	Villages	Hamlets	Population			
a) Urban Centers and Fringes	9	85	-	1,830,664	-	83	230	457,666	2,288,330	80	20
b) Rural Zones	12	105	-	903,952	-	159	706	602,634	1,506,586	60	40
	21	190		2,734,616		242	936	1,060,300	3,794,916	72	28

1/ 1976 estimate.

SOURCE: Mission estimates from data supplied by REA.

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Population and Sales of Electricity
for Five Towns in Lower Egypt, 1972-1975

TOWN	1972	1973	1974	1975
1. Damietta				
Population	100,111	102,613	105,178	107,807
Sales, million kWh	16.8	18.6	20.7	26.1
kWh/Capita	168	181	198	242
2. El Mahalla				
Population	261,303	267,835	274,530	281,393
Sales, million kWh	25.2	27.6	29.6	35.8
kWh/Capita	96	103	108	127
3. Tanta				
Population	266,702	273,369	280,203	287,208
Sales, million kWh	43.9	43.6	52.4	60.0
kWh/Capita	165	159	187	209
4. El Mansoura				
Population	222,031	227,581	233,270	239,101
Sales, million kWh	41.3	37	33.7	38.4
kWh/Capita	186	162	144	161
5. Fuwa (Fowa) 1/				
Population	35,547	36,435	37,345	38,276
Sales, million kWh	3.0	3.6	39	4.0
kWh/Capita	84	99	104	104
TOTALS:				
Population	885,694	907,833	930,526	953,787
Sales, million kWh	130.2	130.4	140.3	164.3
kWh/Capita	147	144	151	172

1/ New Spelling.
SOURCE: Rural Electrification Authority (REA)

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Brief Sampling of Electricity Consumption in Rural Zones, 1972-1975

Menufiya Governorate, 95% Electrified

	1972	1973	1974	1975	1976	Remarks
Menshat						
No. of Customers	12	17	26	35		3 small shops.
Total kWh	2,188	9,872	6,513	14,457		
kWh/household	182	580	250	413		
El Sokaria						
No. of customers	119	119	119	119		2 small shops.
Total kWh	18,875	43,104	40,532	43,878		
kWh/household	158	362	341	368		
Shoubra bass						
No. of customers	21	151	183	207	243	39 small shops and one
Total kWh	31,168	45,356	107,667	117,667		8-500 KW load in 1976.
kWh/household	1,481	432	588	553		
Betibs						
No. of customers	262	262	262	262		1 small shop.
Total kWh	63,969	113,450	96,718	109,810		
kWh/household	244	433	369	419		
TOTALS						
No. of customers	414	549	590	623		
Total kWh	116,200	211,782	251,782	285,812		
kWh/household	281	386	426	459		

SOURCE: Rural Electrification Authority (REA)

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Level and Growth of Consumer Demand in Urban and Rural Areas for Various Countries 1/

	Demand per consumer, kilowatt-hour per year 2/		Annual rate of growth of demand	
	Rural	Urban	Rural (%)	Urban (%)
Costa Rica	1,900	6,000	20	10
El Salvador	1,000	4,000	20	10
Ethiopia	800	2,000	40	15
India	1,000	n.a.	15	10
Thailand	200	4,000	12-20	22

1/ Estimates--the data are purely illustrative and are not averages.
2/ Rural data are for selected areas; urban data are for capital cities except for Thailand, which is an average.

SOURCE: "Rural Electrification", a World Bank Publication, October 1975, Table 8, page 25.

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Comparison of Supply Alternatives

General

1. This Annex reviews the least cost source of supply for the proposed Project. As presently planned by the REA all the Project loads would be connected to the EEA unified power system. The only reasonable alternative to central system supply would be diesel engine generating sets supplying each Rural Zone or group of Zones.

2. To check the proposed central supply solution, an analysis was made of the costs of supplying the Zone of El Aakab over a period of 25 years, the assumed useful life of the distribution facilities. Al Aakab Zone includes the village of El Aakab in addition to two other villages and 22 hamlets in the immediate vicinity. The Zone is located some 22 km due North from Aswan in an area of extreme rural poverty. It is electrically and physically remote from the central system, has no electric service at present and represents the least favorable situation for central system supply among the rural zones. In the proposed Project the El Aakab Zone would be fed from Aswan over a 33-kV line and a 33/11-kV stepdown substation.

3. The two alternatives compared were:

   a. A 22-km long 33-kV line to tap the existing bulk supply system at Aswan and supply El Aakab Zone through a distribution substation rated 10 MVA, 33/11-kV; and

   b. a diesel engine generating station at the village of El Aakab located approximately at the same point in the system as the distribution substation above. The 11-kV distribution system for the Zone would, therefore, be identical in both cases and need not be considered further.

Load Projections

4. The Zone load was projected using the same procedure applied to the combined 14 Rural Zones in Annex 25. However, since there is no service in El Aakab at present, the potential, instead of actual load for 1976, was estimated and used as the starting point. The load was assumed to grow thereafter up to the maximum load-carrying capability of the distribution system at the annual rates of growth for population and load proposed by REA - 2.5% and 20%, respectively. The resulting load projection is shown in Attachment 1.

5. Peak demand is seen growing from 1500 kW in 1980 -- the first year of operation -- to 3559 kW in 1989. Sales rise from 5.4 to 12.9 million kWh during the same period. For the purpose of the analysis, load was assumed to cease growing after 1989 and sales were considered constant from then on to 2004, the end of the 25-year study period.

Cost of Central System Supply

6. The costs of the 33-kV transmissison line and the 33/11-kV substation were taken from the unit costs in Annex 16.

22 km of single circuit 33-kV line	220,000
El Aakab substation 10 MVA, 33/11-kV	455,000
Direct Cost	675,000
Engineering, 7%	47,000
Subtotal	722,000
Physical Contingency, 10%	72,200
Total Cost	794,000

7. For reasons of standardized purchasing practices in REA calling for specific modular sizes, the substation rating was chosen as 10 MVA and the 33-kV line dimensioned accordingly. However, only half of that capacity is needed for El Aakab Zone alone to adequately take care of the projected load. Therefore, only half of the total costs above was allocated to the Zone in the analysis.

8. Operation and maintenance (O&M) of the central system facilities was taken as .4 millimes/kWh for generation and .2 milliemes/kWh for transmission.

9. The incremental sources of generation will be steam and combustion turbine stations in a 80/20 ratio as currently planned (Annexes 7 and 8). All generation will be fueled by associated gas gathered, transmitted and processed for this purpose instead of continuing the present wasteful practice of flaring it at the wellhead. Generation was assumed as being produced by a composite station having a net station heat rate (NSHR) of 11,347 Btu/kWh resulting from 80% steam and 20% combustion turbine with NSHR's of 10,315 and 15,475 Btu/kWh, respectively. The economic cost of fuel was assumed at US$20/ton (50¢ per million Btu) as has been established by the consultant for the UNDP Power Sector survey resulting in a fuel cost of 3.78 milliemes/kWh.

10. The estimated capital costs of generation are 165 LE/kW for combustion turbines and 323 LE/kW for steam-turbine stations based on non-escalated,

early 1976 prices, but including physical contingencies. The estimated transmission was taken as 60 LE/kW. Allowing for 10% peak load loss and 15% reserve margin the effective cost per kW of generation becomes 368 LE/kW. The existing generation and transmission facilities together with the sizeable expansion underway will provide ample excess capacity to accommodate the incremental load contributed by Al Aakab Zone. On the other hand, when additional system capacity is installed starting in 1982 and 1984, for transmission and generation, respectively, the incremental investment required will be allocated proportionally. This has the effect of deferring up to the above dates the incremental investment costs of central system supply in the transmission and generation cost streams.

11. Transmission losses up to and including the El Aakab distribution substation were taken as 7%.

12. A summary of central system supply costs is shown in Attachment 2.

Cost of Diesel Engine Generation

13. The diesel engine station would be equipped with 3-1,000 kW units initially, followed by two more additional units of the same size as required to meet the load growth up to 1989. The size of the station remains constant from then on to the end of the study through timely scheduling of replacements. Useful plant life remaining at the end of the study period is taken into account in the cost stream as credit for salvage value. The cost of diesel units was taken as 300 LE/kW and useful engine life as 10 years. Diesel fuel was priced at US$114.40/ton representing its export value as reported in Phase I of the UNPD Power Sector Survey. Fuel cost of generation was calculated taking NSHR as 10,428 Btu/kWh. Generation O&M costs were taken as 2.7 milliemes/kWh.

14. The cost of supply with diesel engine generators is considerably higher as shown in Attachment 3, due mainly to the high cost of fuel.

Comparison of Alternatives

15. The cost comparison summarized in Attachment 4 shows that the central system supply is the least cost alternative at any discount rates considered (6 to 16%). The present worth of savings with central system supply for the Zone of El Aakab over a period of 25 years would be LE 1,620,979 at 12% discount rate.

16. Since the sample zone selected is the most remote from the bulk supply system in terms of distance and load, it follows that central system supply would yield similar or greater savings for other Rural Zones in the Project, and that supplying the Project from the central system is the least cost alternative.

Irrigation Pumping Load

17. Undoubtedly one of the most important future loads for the Project facilities in the Rural Zones will be irrigation pumping now powered with diesel engines or animal drive (bullocks) depending on the size of the installation. The larger pumps are driven by diesel engines burning light distillate #2 at US$114.40 a ton, while bullocks drive small (1-1/2-3 HP) low-lift units spread out all over the countryside. Although there were no statistics readily available to make even a superficial comparative evaluation, the findings of the above analysis would strongly suggest considerable economic advantages in favor of electric drive -- at least for the larger pumps -- on the basis of fuel cost differential alone.

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Comparison of Alternative Load Projection for El Aakab Zone

	1976	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1. Load Projection											
Population, '000	74,518	82,254	84,310	86,418	88,578	90,793	93,062	95,389	97,774	100,218	102,724
Sales, kWh x 10^3	3,726	5,455	6,001	6,601	7,261	7,987	8,786	9,664	10,631	11,694	12,863
kWh/capita	50	66	71	76	82	88	94	101	109	117	125
Average W/capita	5.7	7.5	8.1	8.7	9.4	10.0	10.7	11.5	12.4	13.4	14.3
Peak W/capita	46	60	65	70	75	80	86	92	99	107	114
Aggregate Peak, kW	3,428	4,935	5,480	6,049	6,643	7,263	8,003	8,776	9,680	10,723	11,710
Diversified Peak Demand, kW 1/	1,042	1,500	1,666	1,839	2,019	2,208	2,432	2,667	2,942	3,259	3,559
2. Required Generating Capacity, kW											
a. Diesel Engine Sets											
- Installed Capacity											
3 x 1,000		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
1 x 1,000					1,000	1,000	1,000	1,000	1,000	1,000	1,000
1 x 1,000										1,000	1,000
		3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,000	5,000	5,000
- From Power		2,000	2,000	2,000	3,000	3,000	3,000	3,000	3,000	4,000	4,000
b. Central System 2/		1,898	2,107	2,326	2,554	2,793	3,076	3,374	3,721	4,123	4,502

1/ Diversity factor: 3.29.
2/ Including allowance for 10 percent peak load loss and 15 percent reserve.

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Comparison of Supply Alternatives, Central System Supply Cost, LE

Year	Incremental Generation					Incremental Transmission		
	kW 1/	kWh 2/	Capital 3/	O & M 4/	Fuel 5/	Capital 6/	O & M 7/	Total Cost
1978						119,000		119,000
1979						198,000		198,000
1980	1,898	6,572		2,629	24,842	80,000	1,212	108,683
1981	209	7,230		2,892	27,329		1,334	31,555
1982	219	7,953	162,553	3,181	30,062	110,340	1,467	307,603
1983	228	8,748	406,382	3,499	33,007	10,800	1,613	455,361
1984	239	9,623	243,829	3,849	36,375	11,340	1,775	297,168
1985	283	10,586	82,353	4,234	40,015	13,440	1,952	141,994
1986	298	11,463	86,718	4,657	44,010	14,100	2,148	151,633
1987	347	12,808	100,977	5,123	48,414	16,500	2,362	173,376
1988	402	14,089	116,982	5,636	53,290	19,020	2,599	197,572
1989	379	15,498	110,289	6,199	58,582	18,000	2,858	195,928
1990 - 2004		15,498		6,199	58,582		2,858	67,639

1/ Includes 10 percent peak load loss and 15 percent reserve margin.
2/ Includes 17 percent system (T & D) losses.
3/ At LE 368/kW including peak load loss (10%) and reserve margin (15%).
4/ At .4 milliemes/kWh.
5/ At 3.78 milliemes/kWh.
6/ Includes Substransmission and Distribution Substation capacity.
7/ At .2 milliemes/kWh.

ANNEX 26
Attachment 3

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Comparison of Supply Alternatives Isolated Generation (Diesel Engine Sets) Supply Costs, LE

Year	Generation: Capital 1/	Generation: O & M 2/	Generation: Fuel 3/	Total Costs: Isolated Generation	Total Costs: Central Supply	Cost of Isolated Generation in excess of Central Supply
1978					119,000	-119,000
1979	600,000			600,000	198,000	402,000
1980	300,000	16,365	120,493	436,858	108,683	328,175
1981		18,003	132,560	150,563	31,555	119,008
1982		19,803	145,780	165,583	145,050	205,330
1983	300,000	21,783	160,372	428,155	48,979	379,176
1984		23,961	176,415	200,376	866,102	-665,726
1985		26,358	194,069	220,427	141,994	78,433
1986		28,992	214,465	243,457	151,633	91,824
1987		31,895	234,823	266,716	173,376	93,340
1988	300,000	35,082	258,301	593,383	197,527	395,856
1989	600,000	28,589	284,125	922,714	195,928	726,786
1990	300,000	28,589	284,125	622,714	67,639	555,075
1991		28,589	284,125	322,714	67,639	255,075
1992		28,589	284,125	322,714	67,639	255,075
1993	300,000	28,589	284,125	622,714	67,639	555,075
1994		28,589	284,125	322,714	67,639	255,075
1995		28,589	284,125	322,714	67,639	255,075
1996		28,589	284,125	322,714	67,639	255,075
1997		28,589	284,125	322,714	67,639	255,075
1998	300,000	28,589	284,125	622,714	67,639	555,075
1999	600,000	28,589	284,125	922,714	67,639	855,075
2000	300,000	28,589	284,125	622,714	67,639	555,075
2001		28,589	284,125	322,714	67,639	255,075
2002		28,589	284,125	322,714	67,639	255,075
2003	300,000	28,589	284,125	622,714	67,639	555,075
2004	-840,000 4/	28,589	284,125	-517,286	67,639	-449,647

1/ At 300 LE/kW.
2/ At 2.7 millieme/kWh.
3/ At 19.88 milliemes/kWh -- fuel at $114.40/ton and NSHR of 10,428 Btu/kWh Generation includes 10 percent distribution losses.
4/ Salvage value.

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Comparison of Supply Alternatives Present Value Summary

Discount Rate Percent	----Present Value of Costs, LE '000---- Central System	Isolated Supply	Savings with Central System Supply
6	2,074,195	5,152,519	3,078,324
8	1,819,172	4,257,278	2,438,106
10	1,615,392	3,584,646	1,060,254
12	1,449,668	3,070,647	1,620,979
14	1,312,788	2,671,408	1,358,620
16	1,198,180	2,356,430	1,158,250

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APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Internal Economic Rate of Return

1. The internal economic rate of return (IER) on the Project is the discount rate which equalizes the present values of the time streams of the attributable costs and benefits over the Project's life. The period adopted for the calculation was 1978-2004, on the assumption that the Project would have an economic life of 25 years after being totally completed and energized starting in 1980. The relevant costs and benefits are the incremental costs and benefits to the economy resulting from the Project, to the extent that these can be identified, as described below.

A. Costs

2. The incremental costs attributable to the Project comprise the following:

Project Costs

3. These are the non-escalated capital costs and the operating and maintenance (O&M) costs of the Project at 1976 prices, adjusted for shadow pricing of unskilled labor, which was valued at 50% of its financial cost in view of the high unemployment and underemployment in Egypt.

Generation and Transmission Costs

4. The EEA will incur additional capital, O&M and fuel expenses in order to meet the additonal load resulting from the Project. At first, the existing generation and transmission facilities together with the massive expansion program already underway will provide enough excess capacity to accommodate the incremental load contributed by the Project. Later on, however, additional capital expense will be incurred to provide the capacity allocated to meet the Project loads. The planned system expansion program and associated costs are shown in Annex 14.

5. The incremental cost of transmission is 60 LE/kW of subtransmission and distribution substations, 90 LE/kW and of generation 165 LE/kW and 323 LE/kW for gas turbine and steam turbine stations, respectively. Allowing for 10% peak load loss and 15% reserve margin the effective cost per kW of incremental generation becomes 368 LE/kW for a composite unit as defined below.

6. System transmission and distribution losses (T&D) were taken as 17%. Incremental generation would come from new steam and gas turbine plants in an 80/20 ratio. Therefore, fuel expense would be based on a composite net station

heat rate (NSHR) of 11,347 Btu/kWh resulting from proportional contributions of the steam units with a NSHR of 10,315 Btu/kWh and the gas turbine units with an NSHR or 15,475 Btu/kWh.

7. All incremental generation would be fueled by natural gas produced in association with petroleum. Up to now this gas has been wastefully flared at the wellhead. However, the consultants for the UNDP Power Sector Survey reported recently that EEA is definitely planning to use associated gas in the future for power generation in addition to the other industrial uses being considered.

8. Fuel expense was calculated using the economic value of flared gas established by the consultant as US$20/ton (50¢/million Btu), see Attachment 1. The economic value is the opportunity cost of flared gas as measured by its value in applications other than when burned as fuel. These other uses could be feedstock for production of petrochemicals, or export as liquified natural gas. Recent studies made for Saudi Arabia give the economic value of flared associated gas as ranging from 22-40 US¢ per million Btu delivered, appropriately processed for boiler firing. The higher, more up-to-date value suggested by the Power Survey consultant was adopted as being more realistic and more directly applicable to Egypt. Nevertheless, the effects of assuming higher and lower fuel costs were also tested.

9. Generation O&M costs were taken as .4 milliemes/kWh and transmission O&M costs as .2 milliemes/kWh. Distribution O&M expense including administration, billing and collection was taken as 2 milliemes/kWh in line with information supplied by REA.

B. Benefits

10. The benefits attributable to the Project comprise the following:

(a) revenues accruing to the municipalities or distribution companies from the sale of electricity through the Project facilities. To avoid double counting, revenues from sales where the benefits were measured by the resource cost-savings through substitution of electricity ((b) below) were appropriately deducted;

(b) resource cost-savings to the economy, to the extent that these could be quantified, through the substitution of electricity supplied by the Project for alternative energy sources; and

(c) connection charges received by the municipalities or distribution companies from new customers supplied by the Project.

These are considered in turn below.

Revenues from Sales of Power

11. The Project includes the installation of facilities for electrification and rehabilitation of nine urban areas and fourteen rural zones to serve five different categories of consumers; namely:

(a) Large-scale medium voltage industrial consumers.

(b) Small-scale medium voltage industrial consumers.

(c) Public agencies and enterprises, including street lighting.

(d) Commercial and small shops.

(e) Residential consumers.

The main increase in consumption is assumed to come from the commercial and residential consumers. However, in 5-10 years the areas may attract electric irrigation and larger industrial units.

12. The forecasting of revenues from the Project is based on (a) an estimate of the price level of electric energy, and (b) an estimate of the amount of kilowatthours sold at the price level. The sales forecasts for the Project assume that the price level is fixed to that of the year 1976. As almost 100% of the sales attributable to the Project will come from commercial and residential consumers, their rates are the relevant ones. They are: 1/

(a) The first 45 kWh are billed at no more than 22.5 milliemes/kWh (including 1 millieme tax for radio and television and 5 milliemes fiscal tax).

(b) The excess over 45 kWh per month are billed at 15.0 milliemes/kWh (including 5 milliemes fiscal tax).

13. Given this price level and the assumptions made for kWh consumption per household (Annex 25), an average price of 20 milliemes was assumed as revenue per kWh sold through the Project.

Resource Cost Savings

14. Some of the consumption will result from the substitution of electricity for other sources of energy, resulting in corresponding resource cost

---

1/ There exists certain rates for commercial and small shops (22.347 milliemes/kWh for 0-45 kWh/month and 18.947 milliemes/kWh for more than 45 kWh/month). however, they have never been applied.

savings. It was not possible to identify all these cases of substitution and quantify the resulting cost savings but reasonably reliable estimates could be made in the case of electricity supplied to new customers for household lighting. In this case it was found that the resource cost savings exceeded the value of the corresponding power revenues, the excess representing surplus benefits from the point of view of the economy. The resource cost savings were calculated as described below, and the net benefit - after deducting the value of the corresponding power revenue - attributable to the substitution was taken as the measure of benefits, rather than the power revenues themselves. For this purpose, household lighting was assumed to consume an average of 15 kWh per household per month, a figure consistent with the expected average consumption in newly connected households.

15. The alternative to electricity for household lighting in the newly connected homes is kerosene. A non-electrified house uses about 1/2 liter of kerosene a day for lighting, equivalent to four US gallons per month. (Brief field sampling by the mission revealed villagers near El Aakab spend LE 0.90 per month per household for kerosene--the cost of about 9 US gallons at current domestic prices. The extra 5 gallons must be used for cooking.) The opportunity cost of kerosene is taken at its foreign exchange value, currently US$150.70 per ton (LE 0.3417 per US gallon) as reported in the UNDP Power Sector Survey Phase I Report (see Attachment 2). It is reasonable to expect this will be a long-term value of kerosene. In any case sensitivity tests were made to investigate the effects of lower kerosene prices. The resulting annual fuel cost saving per household is calculated for the period of the study as shown in Attachments 3 and 4.

Connection Charges

16. Connection charges have been used previously just to cover the costs of connecting each single consumer to the distribution network. These charges have been about LE 3 per consumer per year. It seems reasonable to assume that the revenues from these charges will continue to cover the corresponding costs. Consequently, both of these items have been left out when calculating the internal rate of return of the Project.

Cost and Benefit Streams

17. The annual cost and benefit streams resulting from the above calculations are shown in Attachments 5, 6 and 7 to this Annex.

Internal Economic Rate of Return

18. As shown in Attachment 5, a comparison of the costs and benefits described above results in an internal economic rate of return (IER) on the whole project of not less than 10.2%. For the urban centers and rural zones taken separately, the IER's are 12.6% and 4.2% respectively (Attachments 6 and

7). The sensitivity of the IER's obtained above was tested for variations in assumptions regarding the main variables in the calculation, i.e. volume of sales, capital costs, value of associated gas and value of kerosene fuel. Attachment 8 shows that if the volume of sales falls 10% less than the main load projection, the IER for the urban centers falls to 11.0% and to 3.2% for the rural zones. With an increase of 10% in capital costs, the IER for the urban centers decreases to 11.0% and to 3.2% for the rural zones. For associated gas costs 10% higher, the IER becomes 12.0% for the urban centers and 3.8% for the rural zones. With 10% lower value of kerosene, the resulting IER is 12.4% for the urban centers and 4.0% for the rural zones. Similarly, a 10% increase in estimated sales raised the expected IER's to 11.4%, 14.4% and 5.2% for the overall Project, the urban centers and the rural zones, respectively. Tariff increases of 20%, which it is not thought would have a significant effect on demand, would improve the resulting IER's to 17.8% for the urban centers and 6.8% in the rural zones. However, as shown above the calculated IER's in all cases are relatively insensitive to probable variations in other key parameters.

Unquantifiable Benefits

19. Possible resource cost savings through substitution of electricity for diesel engine drives in irrigation pumping and drinking water supply would increase the benefits attributable to the Project in the rural zones. Large irrigation components of load generally favor the economics of electrification projects in rural regions. The additional benefits should be further investigated when better statistics are put together by REA.

20. Other tangible benefits not readily quantifiable are:

- Increased labor manhours made available because residential illumination from electric lamps allows additional incentive to do more cooking, laundry, repair works and social functions during non-daylight hours.

- Increased productivity due to usage of electric power tools and equipment in commercial establishments.

- Increased labor manhours made available on a "per household" basis from large potable water supply pumping installations. The time required each day per household to obtain drinking water and water for sanitation requirements will be saved by each household.

21. Other less tangible benefits from the Project in the areas to be newly electrified area:

- Increased quality of home life through use of electric light illumination and electric appliances for convenience.

- Increased availability for educational radio and television programs to promote literacy and general education.

- Increase stree illumination to increase security and ease of movement after dark.

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Notes on Associated Natural Gas

Energy Economics and Tariffs

1. The Egyptian General Petroleum Corporation (EGPC) estimates of the reserves of the three gas fields being tapped by pipeline systems to serve Alexandria, Cairo and the Delta total 62 billion m3, sufficient for 20 years production at 9 million m3 per day. Other gas fields have been located in the Delta, and EGPC projects that by 1980 the total gas field reserves will be increased to nearly 300 billion m3. This volume of gas would allow the intertying of the three existing pipeline systems and the replacement of oil as boiler fuel not only in the three strations near Alexandria now being constructed for gas firing, Abu kir (600 MW), Damanhour (225 MW) and Kfr El Dawar (220 MW), but also in the two major Cairo stations, Cairo South (240 MW) and Cairo West (348 MW).

2. Discussions in the Ministry of Petroleum indicated that they would welcome an immediate request from the Ministry of Electricity for a gas supply to the Cairo South station which is adjacent to the just completed and underutilized pipeline from the Abu El Gharadek gas field. The request should state the cost and earlier possible date for gas firing conversion, and the years of gas supply required to justify the conversion. A simple economic justification can utilize the $40/ton differential between the price of gas $20 from abu El Gharadek) and the export value of the fuel oil replaced ($60/ton). The added gas consumption of Cairo South will allow full utilization of the Abu El Gharadek gas system and the LPG stripping plant during the next five years while planned new gas consuming industries are bieng constructed. Even before that date the opening of new Delta gas fields should allow continued gas firing of not only Cairo South but Cairo West.

3. EGPC's estimate of associated gas flaring volumes in the Gulf of Suez oil fields near Ras Gharib indicate that the equivalent of 1.4 million tons of oil is being flared this year and is projected by EGPC to rise to 3.6 million tos in 1980 and 4.2 million tons in 1990, declining rapidly thereafter unless new fields are found. As noted in our September Progress Report plans should be made now to utilize these large volumes of wasted gas as soon as possible at Ras Gharib in industry and in a major electric generating station.

Source: Sanderson & Porter, Inc., Field Team, UNDP Power Sector Survey, November 1976 monthly report.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Egyptian Petroleum Prices
(September 1976)

	Domestic Price/Ton LE	Domestic Price/Ton US$* Equiv.	Export Price, US$/Ton	Export Price as a % Domestic
Crude Oil				
General Petroleum Company (Gharib)	11.90	17.90	67.50	380
Oriental Company	5.50	8.30	81.20	980
Gupco (Morgan, July, Ramadan)	6.90	10.40	81.40	780
Wepco (Western Desert)	9.10	13.70	81.20	590
Products				
L.P.G.	52.00	78.00	165.00	210
Regular Gasoline	86.80	130.20	257.60	200
Premium Gasoline	112.00	168.00	286.30	170
Naphtha	25.70	38.50	122.30	320
Kerosine	31.50	47.30	150.70	320
Gas Oil	80.00	120.00	115.30	96
Diesel Oil	24.60	36.90	114.40	310
Residual Fuel Oil	7.50	11.30	62.70	550
Lube Oil	250.00	375.00	1,040.10	280
Bitumen	17.00	25.50	55.90	220

* Estimated at the Parallel market exchange rate of £1.00 = US$1.50

Source: Egyptian General Petroleum Corporation.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Resource Cost Savings, Household Lighting, Urban Centers and Fringes

Year	------Population, '000------		Served Households 1/, '000		Kerosene Saved 2/	Electricity Used 3/	Net Resource Cost Savings
	with access to electricity	with service	Total	new Connections	LE '000	Price LE '000	LE '000
1978	1,923	1,731	334	5	82	18	64
1979	1,971	1,774	345	16	262	58	204
1980	2,021	1,819	364	35	574	126	448
1981	2,071	1,864	373	44	722	158	564
1982	2,122	1,910	382	53	869	191	678
1983	2,176	1,958	392	63	1,033	227	806
1984	2,230	2,007	401	72	1,181	259	922
1985	2,286	2,057	411	82	1,345	295	1,050
1986	2,343	2,109	422	93	1,525	335	1,190
1987	2,402	2,162	432	103	1,689	371	1,318
1988	2,462	2,216	443	114	1,870	410	1,460
1989 - 2004	2,523	2,271	454	125	2,050	450	1,600

1/ At five persons average population per served household.
2/ At half liter per household per day average consumption for household lighting and US$150.70 per ton export price of kerosene.
3/ At 15 kWh per household per month average use of electricity for lighting and 20 milliemes per kWh sold.

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Resource Cost Savings, Household Lighting, Rural Zones

Year	Population, '000 with access to electricity	Population, '000 with service	Served Households 1/, '000 Total	Served Households 1/, '000 new Connections	Kerosene Saved 2/ LE '000	Electricity Used 3/ Price LE '000	Net Resource Cost Savings LE '000
1978	950	665	108	2	33	7	26
1979	974	682	111	5	82	18	64
1980	998	699	117	11	180	40	140
1981	1,023	716	119	13	213	47	166
1982	1,049	734	122	16	262	58	204
1983	1,075	752	125	19	312	68	244
1984	1,102	771	128	22	361	79	282
1985	1,129	790	132	26	426	94	332
1986	1,157	810	135	29	476	104	372
1987	1,186	830	138	32	525	115	410
1988	1,216	851	142	36	590	130	460
1989 to 2004	1,246	872	145	39	640	140	500

1/ At six persons average population per served household.

2/ At half liter per household per day average consumption for household lighting and US$150.70 per ton export price of kerosene.

3/ At 15 kWh per household per month average use of electricity for lighting and 20 milliemes per kWh sold.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Internal Economic Rate of Return Cost and Benefit Streams

Total Project*

Year	Project Load: Sales Million kWh	Project Load: Peak Demand MW	Incremental System MW	Incremental Investment LE'000: Transmission	Incremental Investment LE'000: Subtransmission & Dist. Subs. 2/	Incremental Investment LE'000: Generation 3/	Incremental Operating Cost LE'000: Generation 4/ Transm. O & M	Incremental Operating Cost LE'000: Fuel 5/	Project Costs LE'000: Capital	Project Costs LE'000: O & M 6/	Total Cost LE'000	Project Benefits LE'000: Sales 7/ Revenue	Project Benefits LE'000: Resource Cost Savings Household Lighting 8/	Total Benefits LE'000	Net Benefits LE'000
1978	15	3	3		177		10	68	5,215	30	5,500	300	90	390	- 5,110
1979	61	14	11		266		44	276	8,695	122	9,403	1,220	268	1,488	- 7,915
1980	160	37	13		266		116	729	3,478	320	4,909	3,200	588	3,788	- 1,121
1981	225	51	14	1,950	2,571		163	1,027		450	6,161	4,500	730	5,230	- 931
1982	295	66	15	1,950	2,571	7,245	213	1,341	7,466	590	21,376	5,900	882	6,782	- 14,594
1983	374	82	16	946	1,418	18,124	270	1,701		748	23,207	7,480	1,050	8,530	- 14,677
1984	460	100	18	1,064	1,596	10,874	333	2,098		920	16,885	9,200	1,204	10,404	- 6,481
1985	555	119	19	1,123	1,684	6,887	401	2,524		1,110	13,729	11,100	1,382	12,482	- 1,247
1986	659	140	21	1,241	1,862	7,612	477	3,001	7,467	1,318	22,978	13,180	1,562	14,742	- 8,236
1987	774	163	22	1,359	2,039	8,278	560	3,527		1,548	17,311	15,480	1,728	17,208	- 103
1988	900	187	24	1,418	2,128	8,700	651	4,101		1,800	18,798	18,000	1,920	19,920	1,122
1989	1,039	214	27	1,596	2,394	9,787	751	4,732		2,078	21,338	20,780	2,100	22,880	1,542
1990-2004	1,039	214					751	4,732		2,078	7,561	20,780	2,100	22,880	15,319

INTERNAL ECONOMIC RATE OF RETURN: 10.150 +/- 0.050%

1/ At LE 60/kW.
2/ At LE 90/kW.
3/ At LE 368/kW including peak load loss (10%) and reserve margin (15%).
4/ Generation at 0.4 milliemes/kWh and transmission at 0.2 milliemes/kWh.
5/ Fuel at economic cost of associated natural gas at present being flared at the wellhead, US$20.00/Ton.
6/ At 2 milliemes/kWh including billing, collecting and administration.
7/ At 20 milliemes average revenue per kWh sold.
8/ See Attachments 3 and 4.

* Includes only nine urban certers and fourteen rural zones originally identified.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Internal Economic Rate of Return, Nine Urban Centers, Cost and Benefit Streams

Year	Project Load: Sales Million kWh	Project Load: Peak Demand MW	Incremental System MW	Incremental Investment LE'000: Transmission 1/	Incremental Investment LE'000: Subtransmission & Dist. Subs. 2/	Incremental Investment LE'000: Generation 3/	Incremental Operating Cost LE'000: Generation 4/ Transm. O & M	Incremental Operating Cost LE'000: Fuel 5/	Project Costs LE'000: Capital	Project Costs LE'000: O & M 6/	Total Cost LE'000	Project Benefits LE'000: Sales 7/ Revenue	Project Benefits LE'000: Resource Cost Savings Household Lighting 8/	Total Benefits LE'000	Net Benefits LE'000
1978	407	1	1				8	53	2,815	24	2,900	240	64	304	- 2,596
1979	445	9	8				36	227	4,692	100	5,055	1,000	204	1,204	- 3,851
1980	525	29	20				94	593	1,876	260	2,823	2,600	448	3,048	225
1981	578	40	11	1,537	2,305		132	834		366	5,174	3,660	564	4,224	- 950
1982	635	52	12	1,537	2,305	5,727	173	1,092	3,194	480	14,508	4,800	678	5,478	- 9,030
1983	699	65	13	768	1,152	14,318	220	1,383		608	18,449	6,080	806	6,886	- 11,563
1984	769	79	14	827	1,241	8,591	271	1,705		748	13,383	7,480	922	8,402	- 4,981
1985	846	94	15	886	1,330	5,437	326	2,052		902	10,933	9,020	1,050	10,070	- 863
1986	931	110	16	946	1,418	5,800	388	2,442	3,194	1,072	15,260	10,720	1,190	11,910	- 3,350
1987	1,024	128	18	1,064	1,596	6,525	455	2,865		1,258	13,763	12,528	1,318	13,846	- 83
1988	1,126	147	19	1,123	1,684	6,887	529	3,330		1,462	15,015	14,620	1,460	16,080	1,065
1989	1,239	168	21	1,241	1,862	7,612	610	3,844		1,688	16,857	16,880	1,600	18,480	1,623
1990-2004	1,239	168					610	3,844		1,688	6,142	16,880	1,600	18,480	12,338

INTERNAL ECONOMIC RATE OF RETURN: 12.650 +/- 0.050%

1/ At LE 60/kW.
2/ At LE 90/kW.
3/ At LE 368/kW including peak load loss (10%) and reserve margin (15%).
4/ Generation at 0.4 milliemes/kWh and transmission at 0.2 milliemes/kWh.
5/ Fuel at economic cost of associated natural gas at present being flared at the wellhead, US$20.00/Ton.
6/ At 2 milliemes/kWh including billing, collecting and administration.
7/ At 20 milliemes average revenue per kWh sold.
8/ See Attachment 3.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

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Internal Economic Rate of Return, Fourteen Rural Zones, Cost and Benefit Streams

Year	Project Load: Sales Million kWh	Project Load: Peak Demand MW	Incremental System MW	Incremental Investment LE'000: Transmission 1/	Incremental Investment LE'000: Subtransmission & Dist. Subs. 2/	Incremental Investment LE'000: Generation 3/	Incremental Operating Costs LE'000: Generation Transm. O & M 4/	Incremental Operating Costs LE'000: Fuel 5/	Project Costs LE'000: Capital	Project Costs LE'000: O & M 6/	Total Cost LE'000	Project Benefits LE'000: Sales Revenue 7/	Project Benefits LE'000: Resource Cost Savings 8/	Total Benefit LE'000	Net Benefit LE'000
1978	3	2	2		177		2	15	2,522	6	2,722	60	26	86	- 2,636
1979	11	5	3		266		8	49	4,206	22	4,551	220	64	284	- 4,267
1980	30	8	3		266		22	136	1,682	60	2,166	600	140	740	- 1,426
1981	42	11	3	414	266		31	193		84	988	840	166	1,006	18
1982	55	14	3	414	266	1,522	40	249	4,446	110	7,047	1,100	204	304	- 5,743
1983	70	17	3	177	266	3,806	50	318		140	4,757	1,400	244	1,644	- 3,113
1984	86	21	4	236	355	2,284	62	393		172	3,502	1,720	282	2,002	- 1,500
1985	104	25'	4	236	355	1,450	75	472		208	2,796	2,080	332	2,412	- 384
1986	123	30	5	296	443	1,812	89	559	4,447	246	7,892	2,460	372	2,832	- 5,060
1987	145	35	5	296	443	1,812	105	662		290	3,608	2,900	410	3,310	- 298
1988	169	40	5	296	443	1,812	122	771		338	3,782	3,380	460	3,840	58
1989	195	46	6	355	532	2,175	141	888		390	4,481	3,900	500	4,400	- 81
1990-2004	195	46					141	888		390	1,419	3,900	500	4,400	2,981

INTERNAL ECONOMIC RATE OF RETURN: 4.250 +/- 0.050%

1/ At LE 60/kW.
2/ At LE 90/kW.
3/ At LE 368/kW including peak load loss (10%) and reserve margin (15%).
4/ Generation at 0.4 milliemes/kWh and transmission at 0.2 milliemes/kWh.
5/ Fuel at economic cost of associated natural gas at present being flared at the wellhead, US$20.00/Ton.
6/ At 2 milliemes/kWh including billing, collecting and administration.
7/ At 20 milliemes average revenue per kWh sold.
8/ See Attachment 4.

APPRAISAL OF A REGIONAL ELECTRIFICATION PROJECT

EGYPT

Internal Economic Rate of Return
Sensitivity Analysis

	Total Project Urban Centers and Rural Zones Together %	Urban Centers Only %	Rural Zones Only %
Base Case	10.2	12.6	4.2
20% Tariff Increase	14.2	17.8	6.8
Kerosene			
a. 10% higher	10.4	13.0	4.4
b. 10% lower	9.8	12.4	4.0
Capital Costs			
a. 10% higher	8.6	11.0	3.2
b. 10% lower	12.0	14.8	5.6
Sales			
a. 10% higher	11.4	14.4	5.2
b. 10% lower	8.8	11.0	3.2
Fuel Costs			
a. 10% higher	9.6	12.0	3.8
b. 10% lower	10.6	13.2	4.6

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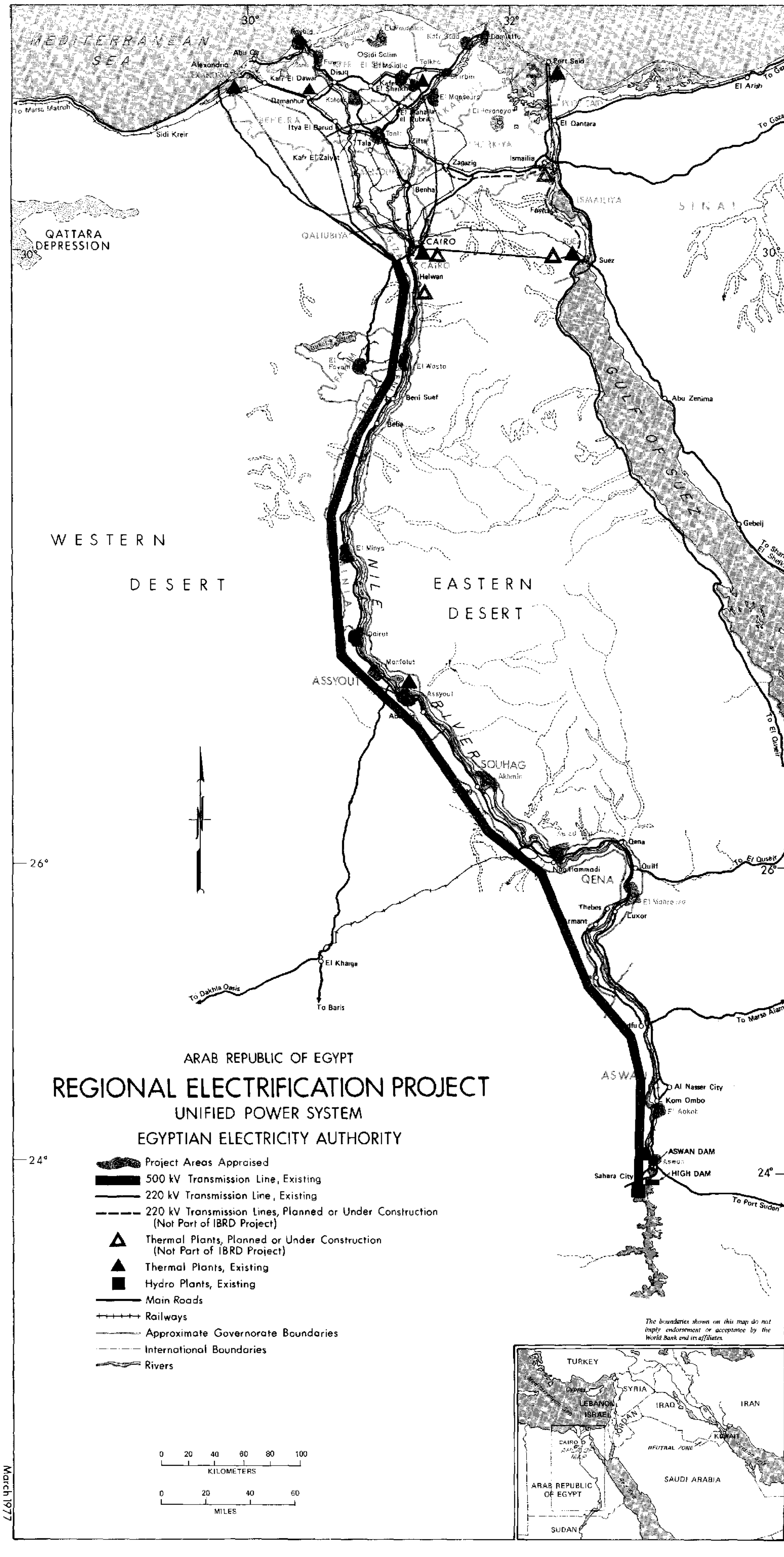

ARAB REPUBLIC OF EGYPT
REGIONAL ELECTRIFICATION PROJECT
UNIFIED POWER SYSTEM
EGYPTIAN ELECTRICITY AUTHORITY
Project Areas Appraised
500 kV Transmission Line, Existing
220 kV Transmission Line, Existing
220 kV Transmission Lines, Planned or Under Construction (Not Part of IBRD Project)
Thermal Plants, Planned or Under Construction (Not Part of IBRD Project)
Thermal Plants, Existing
Hydro Plants, Existing
Main Roads
Railways
Approximate Governorate Boundaries
International Boundaries
Rivers
0 20 40 60 80 100
KILOMETERS
0 20 40 60
MILES
The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates.
MEDITERRANEAN SEA
QATTARA DEPRESSION
WESTERN DESERT
EASTERN DESERT
SINAI
GULF OF SUEZ
NILE RIVER
Alexandria
Abu Qir
Rosetta
Kafr El Dawar
Damanhur
Damietta
Port Said
El Arish
To Gaza
El Qantara
Ismailia
Zagazig
Benha
Tanta
El Mansoura
Sidi Kreir
To Marsa Matruh
CAIRO
Helwan
Suez
El Fayoum
El Wasta
Beni Suef
Abu Zenima
Gebeil
To Sharm El Sheikh
El Minya
Dairut
Manfalut
Assyout
ASSYOUT
SOUHAG
Akhmim
Qena
Nag Hammadi
QENA
Thebes
Luxor
Armant
Quift
To El Quseir
El Kharga
To Dakhla Oasis
To Baris
To Marsa Alam
Al Nasser City
Kom Ombo
ASWAN DAM
HIGH DAM
Sahara City
To Port Sudan
To El Quseir
30°
32°
26°
24°
TURKEY
SYRIA
LEBANON
ISRAEL
JORDAN
IRAQ
IRAN
KUWAIT
NEUTRAL ZONE
SAUDI ARABIA
ARAB REPUBLIC OF EGYPT
SUDAN
CAIRO
March 1977
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