PD-AAU-910
ISN-50959

# A.I.D. EVALUATION SUMMARY: PART I

A. REPORTING A.I.D. UNIT:

USAID/EGYPT

ES#: 87-3

B. WAS EVALUATION SCHEDULED IN CURRENT FY EVALUATION PLAN?
yes X slipped __ ad hoc __

C. EVALUATION TIMING
interim __ final __
ex post __ other X

D. ACTIVITY EVALUATED:

USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

Includes two separate reports:
- Egypt: Review of USAID's Electricity Sector Projects, March 1987
- Egypt's Energy Problem, November 1986

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| E. ACTION DECISIONS APPROVED BY THE MISSION DIRECTOR | OFFICER RESPONSIBLE | COMPLETION DATE |
|---|---|---|
| 1. Prepare Project Amendment, if Concept Paper is approved, to incorporate additional rehabilitation activities in the Aswan High Dam Runner Replacement Project (263-0160). | J. Hunt, DR/UAD | 8/87 |
| 2. Prepare a list of feasibility studies for PD&S funding, to help USAID identify new power projects in the event a second round of major energy price increases takes place later this year. This list should emphasize priority rehabilitation and conservation activities. Mission management should approve this list, prior to seeking EEA and MPIC agreement on use of PD&S funds for these studies. | J. Hunt, DR/UAD | 6/87 |
| 3. Explore with the World Bank if it is useful for USAID to finance a Cost-of-Service and Rate Design Study for EEA. Finalize Scope of Work and proceed with this study, if appropriate. | J. Hunt, DR/UAD<br>C. Richter, PPP/E | 9/87 |

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DATE OF MISSION REVIEW OF EVALUATION: May 19, 1987

G. CLEARANCE/APPROVAL OF EVALUATION SUMMARY AND ACTION DECISIONS:

| Technical Office/Directorate | Program/Evaluation Office | Deputy Director |
|---|---|---|
| J. Hunt, DR/UAD | S. Conly, PPP/P | G. Laudato, DD |
| H. Hasan, DR/UAD | C. Richter, PPP/E | |
| F. Zobrist, AD/DR | J. Ryan, PPP/P | |
| | V. Molldrem, PPP/P | |
| | J. Conly, AD/PPP (A) | |

Approved:

Arthur M. Handley, DIR (A)

7/8/87
Date

H. ATTACHMENTS:

1. EGYPT: REVIEW OF USAID'S ELECTRICITY SECTOR PROJECTS, prepared by USAID/Egypt, DR/ID staff, March 1987

2. EGYPT'S ENERGY PROBLEM, prepared by Charles Richter, USAID/Egypt, PPP/E, November 1986

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I. COMMENTS BY MISSION:

1. The Assessment Approach:

This in-house assessment of USAID's assistance to the power sector in Egypt consists of two separate studies - a review of project-level achievements and issues prepared by USAID's office of Infrastructure Development (DR/ID), and an analysis of economic and policy issues prepared by a Mission economist. This two-pronged approach makes sense; in recent years USAID has conditioned assistance in the power sector to progress on energy tariffs, but historically, implementation of USAID power sector projects and dialogue on energy pricing issues have been conducted in relative isolation from each other.

The two reports are, however, complementary. The paper on electricity projects is an insightful review of U.S. assistance to the power sector, and provides valuable guidance for implementation of future power projects. However, the contribution of USAID-financed power plants cannot be considered in isolation from the economic problems in the energy sector. Although the DR/ID paper states that power projects have had a positive economic impact, this is not well substantiated. The paper on energy pricing issues provides the macro-economic perspective from which to view the impacts and issues associated with USAID assistance to the power sector.

2. USAID Strategy and Recent Economic Developments:

USAID's 1989 CDSS views "correct" energy pricing as vital to eliminating economic distortions. It states that USAID will not finance any further physical improvements in the sector (rehabilitation or new generation) in the absence of significant price increases. However, in anticipation of price increases, USAID is prepared to finance planning and feasibility work. Given existing inefficiencies - system losses are very high - any future USAID assistance will take a "least cost" approach, emphasizing rehabilitation, conservation, training and planning.

The prospects for price reform have brightened since the two Assessment reports were prepared. As part of the agreement recently reached with the IMF, the GOE announced major energy price increases in May, including a 29% increase in electricity tariffs. Additional tariff increases are expected later this year, as part of GOE efforts to strengthen the reform program.

If prices are significantly increased again this year, USAID should be prepared to respond positively to GOE requests for additional assistance in the sector. USAID anticipates, however, that if prices are significantly increased, the World Bank will become the major player in the power sector. The Bank considers energy price reforms to be the cornerstone of economic reform, and appears ready to provide a major infusion of funds to the sector under a reform scenario.

3. Identifying New Project Opportunities:

As a result of the recent announcement of energy price increases, the Mission reversed a previous decision not to finance additional rehabilitation needs of the Aswan High Dam power plant. The Mission has budgeted $40 million from the FY 87 OYB for this activity, and is moving ahead with the design of an Amendment to the Aswan High Dam Runner Replacement Project. (The DR/ID paper gave this activity high priority.)

Mission review of the assessment focused on what, if any, further design work USAID should be doing in the power sector. USAID decided that the timing was right to move ahead with preliminary design work, and agreed that USAID staff would prepare a "short-list" of feasibility studies needed to define new projects in the sector. This pre-design agenda should reflect USAID's stated priorities in the areas of rehabilitation and conservation. Once this agenda has been reviewed and approved by Mission management, USAID will seek MPIC approval for PD&S funding for this pre-design work.

USAID's decision to proceed with feasibility studies should not be confused with a commitment to undertake new projects in the sector. The latter will occur only if the GOE undertakes significant new tariff reform. We are willing to fund feasibility work because we are optimistic that this will occur.

Activities suggested by DR/ID for possible future USAID funding included a Cost-of Service and Rate Design Study for EEA. USAID is willing, in principle, to fund this type of study. However, since the Bank has informally indicated plans to conduct such a study, USAID efforts in this area should be coordinated with the Bank.

4. Institutional Issues:

USAID has been very successful in constructing new power plants and training EEA personnel to operate them. USAID efforts to improve the efficient management of the power system - e.g., the National Energy Control Center and Urban Electric Distribution projects - appear to have had a lesser degree of success. EEA is, by reputation, one of the better run public sector organizations; nevertheless, in designing future projects - particularly rehabilitation and conservation efforts - USAID needs to identify organizational changes necessary to fully realize the benefits of such projects.

J. ABSTRACT:

1. EGYPT: REVIEW OF USAID's ELECTRICITY SECTOR PROJECTS

Since 1975, USAID has provided over $1 billion to expand and to improve electrical power systems in Egypt. This in-house review of USAID electricity sector projects is part of a power sector assessment conducted in late 1986. It identifies lessons of past experience and priorities for future assistance. (A companion piece examines economic and pricing issues, on which policy dialogue in the energy sector has increasingly focused.) The review of USAID electricity sector projects draws the following conclusions and lessons learned:

- USAID has successfully constructed a number of new generation facilities. The one exception is the Ismailia power plant, which has had a history of operating problems. USAID-financed projects have significantly expanded EEA generation capacity. To-date, USAID projects have added 1977 MW, or about 24% of total existing capacity; they will add a further 555 MW by 1990. Completed plants appear to be operated effectively at planned production levels, and to be more efficient than older EEA plants. Revenues generated by USAID-financed plants are estimated to cover their operating costs.

- Training activities under USAID projects have significantly upgraded EEA capability to operate modern, more efficient technologies. However, USAID projects to improve overall power system efficiency - the Urban Electric Distribution Project and the National Energy Control Center - have not fully achieved their intended objectives, owing to institutional constraints.

- Increased funds are required to complete rehabilitation activities under the Aswan High Dam Project. Additional technical assistance may also be necessary to ensure full utilization of the computerized National Energy Control Center.

- Turnkey contracts have been effective in procuring standardized packages. Greater client control has been needed, however, in procurements of "customized" products and construction of large, multi-donor power plants.

- Since distribution projects are essentially institutional development activities, future distribution activities must be tailored to individual distribution companies if they are to be successful.

The following are key recommendations for future USAID assistance to the sector:

- USAID should give highest priority to activities to improve the efficiency and reliability of the power system and to rehabilitate existing generating facilities. USAID should consider financing such activities even in the absence of tariff reform.

- If progress on the tariff front is satisfactory, USAID should also consider further assistance for the development of new nuclear, traditional and renewable electrical energy plants, to replace existing facilities as they become obsolete, and to meet future demand.

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2. EGYPT'S ENERGY PROBLEM

This paper, prepared in-house by USAID/Egypt in November 1986 as part of a power sector assessment, describes the economic issues related to energy pricing policies in Egypt, makes recommendations for price reforms, and explores the potential impact of these reforms on future demand. (A companion piece reviews USAID's experience with power sector projects.) The paper makes the following, key points:

- Virtually all energy products in Egypt are heavily subsidized. The domestic prices of fuel oil, electricity and natural gas are all less than 20% below the economic prices of these products. The total cost of these implicit subsidies is huge - about LE 4.7 billion annually, or the equivalent of 13% of GDP. The largest implicit subsidies - about LE 2.8 billion - go to electricity.

- Implicit energy subsidies in Egypt have major economic impacts. They encourage overconsumption, inefficiency and waste, and contribute to low industrial productivity. They have significant opportunity costs; eliminating subsidies could permit the export of additional petroleum products worth LE 1.6 billion.

- The GOE has been slow to raise energy tariffs. Tariffs have actually declined in relative terms in recent years. For example, electricity prices increased 50% from 1974-84, while wholesale prices tripled.

- The GOE should immediately institute major increases in the prices of all energy products. Domestic prices should be raised to economic price levels in six subsequent annual increments. Diffusion of price increases over six years would minimize economic disruptions, and the GOE could cushion the impact on the poorest residential consumers.

- Demand for electricity is projected to increase far more slowly from 1986-1992 under the reform scenario suggested above, than without reforms. An economic simulation suggests that total demand for electricity would increase 5.7% under a reform scenario, compared to 42% without tariff reforms.

- According to this simulation, price reforms would significantly increase EEA revenues; additional revenues generated are estimated to increase to LE 2.6 billion in 1991/92. Price increases for other energy products would further augment GOE revenues and foreign exchange earnings. Increased revenues could be used to assist Egyptian industry in adjusting to new economic conditions, and to protect low-income groups from the adverse effects of reforms.

- If GDP continued to grow at 5% or more per year, substantial additional capacity would be needed after 1992 under a reform scenario. Replacement of aging equipment may well be a high priority, in view of the long lead time required by new energy investments and anticipated future increases in demand.

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K. EVALUATION COSTS

| 1. Evaluation Team Members Name/Affiliation | Contract # OR TDY Days | Contract Cost OR TDY Cost (US $) | Source of Funds |
|---|---|---|---|
| Timothy Hamman, USAID/Egypt, & other USAID/DR/ID staff | NA | NA | NA |
| Charles Richter, USAID/Egypt | | | |

2. Mission Staff Person Days 70 3. Grantee/Staff Person Days NA

A.I.D. EVALUATION SUMMARY, PART II
L. SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

## USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

### 1. EGYPT: REVIEW OF USAID'S ELECTRICITY SECTOR PROJECTS

INTRODUCTION: Since 1975, USAID has provided over $1.0 billion in project and commodity assistance for expansion and rehabilitation of power generation and distribution systems in Egypt. This in-house assessment of USAID assistance to the power sector focuses on project-level achievements and issues, and identifies lessons learned and areas for future USAID assistance.

### I. PROJECT ACHIEVEMENTS AND IMPLEMENTATION ISSUES:

Overall, USAID power sector projects have been successfully implemented. Implementation problems have plagued some projects, but for the most part these have been resolved. The experience of individual projects is summarized below.

- The Electric Power Distribution Project (263-0001) provided commodity assistance for reconstruction of war-damaged power distribution systems in the Canal Cities. It achieved its objectives without major delays, and contributed to the reemergence of residential, commercial and industrial activity in the Canal Zone.

- The Helwan-Talkha Gas Turbines Project (263-0008), completed in 1980, built 2 gas turbine generating plants with 312 MW in generating capacity. The project was contracted on a turnkey basis, and completed without major implementation problems. Site visits indicate that staff trained under the project are operating the plants effectively. The plants' additional capacity helped to avoid a potential shortfall situation at the time they became operational.

- The Ismailia Thermal Power Plant Project (263-0009) added 3 150 MW units of capacity to the power system. (A fourth unit is financed by the ExIm Bank.) This project was also contracted on a turnkey basis. It encountered significant implementation problems during construction; since start-up of the plant, there has been a continuing history of operational problems. These problems are being addressed, but they raise questions about long-term plant reliability.

  With the benefit of hindsight, the contracting mechanism should have provided greater owner involvement and control. Nevertheless, despite continuing problems, the plant is one of the more efficient in Egypt. It has added substantial capacity to the power system and contributed to reconstruction and development of the Suez Canal area.

- The National Energy Control Center (263-0023), a computerized system to control power generation and transmission throughout the power grid, is now in the final stages of testing. The NECC has great potential to enhance system reliability and efficiency. Adequate personnel have been trained by the project, but their skills have not yet been fully tested.

USAID staff are concerned that additional technical assistance may needed to ensure that EEA utilizes the NECC system so as to obtain its full intended economic benefits. USAID is also concerned with the adequacy of current procurement of replacement parts; given rapid technological developments, procurement of sufficient spare parts is important to avoid premature equipment obsolescence.

- The Shoubra El Kheima Power Plant (263-0030) is a 4 unit 1260 MW thermal plant located in the northern suburbs of Cairo, financed by a consortium of donors. 3 completed units have significantly contributed to overall system supply and reliability, adding 945 MW in generating capacity at a major load center. Site visits indicate that the plant is effectively operated by trained personnel. Key factors in successful implementation of this project were a strong consultant group, their close collaboration with counterparts, and timely decision-making by EEA.

- The Urban Electric Distribution Project (263-0033) aims to rehabilitate and expand electric distribution systems in four cities, and involves several implementing agencies. It is a long-term institutional development effort to assist Egyptian distribution companies to reduce energy losses and improve their efficiency.

  The lack of a single GOE agency responsible for project implementation resulted in major delays. Moreover, the consultant's contract did not provide for adequate levels of support to individual distribution companies. Finally, GOE agencies do not yet recognize the importance of efficient distribution systems. Project institutional objectives have thus been less than fully achieved.

- The Aswan High Dam Runner Replacement Project (263-0160) will improve reliability of the High Dam plant by repairing and replacing existing equipment. The project is being implemented on a turn-key basis.

  When work commenced after some initial delays, rehabilitation needs were found to be greater than originally anticipated. The cost and rehabilitation schedule were accordingly renegotiated. 4 of 12 runners have been replaced to-date, and replacement of the other runners is progressing according to the revised schedule.

  The major current issue is the discovery of major additional rehabilitation needs that cannot be met within the project's funding authorization. This problem remains to be resolved. However, there is a high level of uncertainty associated with major rehabilitation efforts, and the problems encountered in this project are not unusual.

- The Talkha Combined Cycle Project (263-0196) will add a 110 MW steam cycle unit to the Talkha gas turbine plant. The new unit, to be driven by exhaust from the gas turbines, will result in significant fuel savings over traditional thermal plants. The project was only recently approved; it is too early to evaluate project progress.

## II. MAJOR LESSONS LEARNED:

The experience with large power sector projects provides guidance for procurement of equipment and services in future, similar projects:

- The contracting method is a key initial decision in designing a power plant. When the procurement is a standard package, the turnkey approach has been very effective.

  However, greater client control is needed when a "customized" product is procured. Such projects should procure consultant services to prepare detailed designs, and then proceed with procurement and construction under the coordination and supervision of the consultant. The implementation strategy used for construction of the Shoubra plant, emphasizing consultant and owner involvement, appears particularly appropriate for large, multi-donor projects.

- Development of distribution systems requires fundamental institutional and technological changes. There should be an overall plan for developing Egypt's power distribution systems, but any future distribution projects should be tailored to individual distribution companies and their service areas.

- Solicitation of proposals is preferable to developing equipment specifications and IFBs, in procuring sophisticated state-of the art technology. It is important to provide for procurement of sufficient spare parts for the expected life of the equipment. Introducing new technologies requires a long-term, intensive educational effort at various organizational levels.

## III. PROJECT OUTCOMES:

- USAID-financed power generation projects have increased EEA's generation capacity by approximately 1977 MW to-date - about 24% of total existing capacity. USAID-assisted projects will contribute 2532 MW to total generating capacity by 1990.

- EEA operations data indicate that AID-financed plants are operating at planned production levels, and that revenue generated is adequate to cover plant operating costs.

- EEA financial reports indicate that new AID-financed power plants are more efficient than older plants. For example, fuel consumption at the Ismailia plant is 18% below the EEA average. Lower fuel consumption rates mean lower operating costs and energy savings.

- USAID has assisted in upgrading the technical capability of EEA's operations personnel. USAID projects have introduced modern, more efficient technologies, and trained EEA personnel in their operation.

## IV. USAID POWER SECTOR STRATEGY:

USAID strategy has evolved from assisting Egypt in rebuilding vital infrastructure through rapidly disbursing construction projects with major contract opportunities for U.S. suppliers, to greater emphasis on technology transfer aimed at improving system efficiency. Most recently, USAID's primary concern has been low energy tariffs; future sectoral assistance has been made contingent on major price increases.

## V. RECOMMENDED FUTURE INVESTMENTS:

A. Improving System Efficiency and Reliability: USAID should consider the following activities to improve efficiency of the power system, even in the absence of tariff reforms:

- Upgrading the operating efficiency of existing generation units should be given the highest priority. USAID is considering funding for a study to identify priority rehabilitation activities, and should consider financing specific activities identified by the study.

- Reducing excessive energy losses in the distribution and transmission systems is also a high priority; opportunities for USAID assistance include installing capacitors; upgrading distribution equipment; improving distribution systems in the Delta and Northern Upper Egypt; and establishing a Regional Control Center in Alexandria.

- Strengthening EEA capacity to plan and operate its rapidly growing system, for example improving metering and billing practices.

- Feasibility analyses for new facilities in EEA's expansion plan.

- A study to identify improvements needed in transmission systems as a result of load growth. (However, funds for physical improvements in transmission systems are readily available from other donors.)

- A Cost-Of-Service and Rate Design study. This could provide a better basis for decisions on energy pricing, and for a more meaningful dialogue on price reform issues.

B. Increasing Base Load Generating Capacity: By 1990, many EEA facilities will be ready for retirement or extensive rehabilitation. If demand outstrips growth in generating capacity, a shortfall in reserve capacity could curtail planned maintenance and result in equipment breakdowns and interruptions in service. If progress on tariff reform is satisfactory, USAID should support the following elements of EEA's plan to further expand base load generating capacity:

- Support for the proposed nuclear power plant at El-Dabaa, within existing legislative limits;

- Support for a 1200 MW steam-thermal power plant. USAID commitment would help to attract the necessary financing from other sources;

- Research and field testing to identify reliable and affordable renewable energy systems.

ELECTRES. SC. 5/10/87

## USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

### 2. EGYPT'S ENERGY PROBLEM

**Introduction:** This paper, prepared in-house by USAID/Egypt in November 1986, analyzes the magnitude of current implicit energy subsidies in Egypt and the consequences of maintaining artificially low energy prices. It suggests reforms to eliminate current price distortions, and projects future electricity demand and the impact of higher tariffs.

**Energy Subsidies in Egypt:** Nominal prices of virtually all energy products in Egypt are substantially lower than their economic prices:

- The economic price of fuel oil - based on its export value - is about $70 per ton, compared with a domestic price of about $4 to $17 per ton, or 5-24% of its economic value. The implicit subsidy on petroleum products is estimated at about LE 1.7 billion annually.

- The economic price of electricity - based on its long-run marginal cost (LRMC) - is about 10.4 piastres. The nominal price of electricity is, however, only 2.1 piastres per KWH, or about 20% of its economic price. This represents an implicit subsidy of about LE 2.8 billion annually, or the equivalent of 8% of GDP.

- The economic price of natural gas is about LE 174 per ton, based on its energy equivalent in natural gas and fuel oil. Natural gas is sold in Egypt at a price of LE 7.2 per ton, or about 4% of its economic price, with an annual implicit subsidy of LE 701 million.

- The market price of gasoline is close to its economic price. The GOE could increase public revenues substantially if it increased the nominal price above the economic price.

Hidden subsidies on energy products in Egypt, resulting from underpricing energy for domestic use, are therefore very large: they total LE 4.7 billion, or the equivalent of 13% of GDP. Since most of these subsidies are implicit, they are largely excluded from GDP and the GOE budget. They nevertheless have a major economic impact.

**The Consequences of High Energy Subsidies:**

- **Subsidies encourage overconsumption:** Egypt's per capita energy consumption is estimated to be 40% greater than the average for other middle-income countries. Energy consumption has grown very rapidly; from 1975 to 1985, growth in generation and peak load averaged about 12%, compared with GDP growth of only 8%. (The pace of power generation has subsequently slowed somewhat.)

- **Cheap energy encourages inefficiency and waste:** The magnitude of the energy subsidy suggests that it may be one of the major factors behind the low productivity that characterizes Egyptian industry. The Nag Hammadi and Kima plants, the largest electricity consumers, are examples of this inefficiency. The energy cost alone in producing a ton of aluminum at Nag Hammadi exceeds the world price of aluminum. The obsolete fertilizer production process at Kima costs seven times the cost elsewhere. These inefficiencies are masked by the lowest electricity tariffs in Egypt.

- **Energy subsidies have significant opportunity costs:** While these are difficult to measure, it is estimated that eliminating energy subsidies would decrease energy consumption enough to permit export of additional petroleum products worth approximately LE 1.6 billion.

The GOE Response to the Problem: The GOE has made relatively little effort to reduce energy subsidies in recent years. The average energy tariff has actually declined in relative terms in the last decade; the nominal price of electricity, for example, grew 50% from 1974 to 1984, while the wholesale price index tripled. Energy prices were increased by 37% in July 1985, but inflation has since eroded most of this increase. Price increases in 1985-86 for other energy products were insignificant.

Appropriate Reform Measures: The solution to underpriced energy is to raise prices. An appropriate plan would be phase out of almost all subsidies by 1992. This would respond to urgent economic problems, while diffusing adverse effects of price increases over a six year period. The following summarizes a series of measures to improve Egypt's utilization and conservation of energy resources:

- Accept a LRMC framework for electricity pricing, and increase prices to LRMC levels over five years.

- Raise all electricity tariffs by 40% immediately. (20% for residential consumers of less than 100 KWH a month.)

- Establish a floor rate of 4 piastres per KWH and a ceiling rate at or slightly above LRMC, to narrow the margin between favored public sector entities and less favored private sector users.

- Raise electricity tariffs by 18% per year in real terms between July 1987 and July 1992. The subsidy on low residential consumers could be continued, but should be adjusted annually for inflation.

- Immediately increase the prices of other petroleum products as follows: fuel oil to LE 50 per ton; gas oil and diesel to LE 80 per ton; kerosene to LE 85 per ton; and natural gas to LE 65 per ton.

- These prices, should be adjusted for inflation and for changes in international prices, and raised to economic price levels in six subsequent annual increments.

Major Implications of Energy Price Increases: The two major factors influencing future demand for electricity are the rate of economic growth and electricity prices. The paper estimates future demand for electricity over the period 1986/87 - 1992/93 under two scenarios - with and without the increases in tariffs advocated above. It uses a model developed by the World Bank, and assumes demand to be relatively inelastic with respect to price, based on experience in other countries. Annual growth in GDP is assumed to be between 3 and 5%. An important underlying assumption is that closure of Nag Hammadi and major reorganization of Kima Fertilizer are inevitable under a reform scenario.

The outcomes of the simulation are as follows:

- Annual increases in demand over the period 1986-1992 would average slightly less than 1% per year under a reform scenario, compared with about 5% without reforms.

- Under the reform scenario, total demand for electricity in 1992 would be about 25% less than in the case without tariff increases. Total demand over the same period would increase by 301 MW or 5.7% in the event of reforms, compared with an increase of 2238 MW or 42% without reforms. EEA would clearly need enormous additional resources to meet demand in the absence of reforms.

- Substantial additional capacity would probably be needed after 1992 if GDP continued to grow at 5% per year or more.

- EEA annual revenue would increase by 46% in real terms by 1991/92 without reforms, compared with more than 700% under a reform scenario. The reform program would generate additional annual revenue estimated at LE 2.6 billion in 1991/92.

This revenue gain from electricity would be augmented by receipts derived from price increases on other energy products. There will also be increased foreign exchange earnings as more petroleum is available for export. Reforms would also lead to more efficient patterns of energy use and better allocation of investment funds. All these factors are expected to alleviate pressures on the public sector budget.

Moreover, these additional revenues could be extremely valuable during the first years of a comprehensive reform program, since they could provide a cushion to facilitate the structural adjustments required by a serious economic reform program. Revenues could be used to set up a special fund to finance temporary investments needed by Egyptian industry to adjust to new economic conditions. Any such assistance should, of course, be strictly temporary, and in support of financially and economically sound projects. The fund could also channel resources into projects needed to safeguard the welfare of groups who might otherwise be adversely affected by the reform program.

Finally, projections of stagnant demand for electricity over the next five to six years, under a reform scenario, do not necessarily imply that investments in the sector should be insignificant. To the contrary, replacement of aged and deteriorating equipment may well be a high investment priority, particularly in view of the long lead time necessary to realize new energy investments and the anticipated increase in demand after the reform period.

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# USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

PART I

**EGYPT-REVIEW OF USAID'S**

**ELECTRICITY SECTOR PROJECTS**

**USAID/Egypt**
**DR/ID**
**March 1987**

13

# EXECUTIVE SUMMARY

## A. THE USAID POWER SECTOR PROGRAM

With the initiation of U.S. assistance to Egypt during the 1970's, it was recognized that activities to support the expansion and rehabilitation of the power sector would represent an important part of the USAID program. Indeed since 1975 USAID has provided over $1.0 billion to support nine projects and significant commodity import activities.

The initial USAID projects were designed to help rehabilitate and expand the power sector infrastructure, parts of which were damaged or deteriorated following periods of conflict with Israel. Subsequent power sector projects focussed more on introducing new technologies and procedures. In recent years, as a part of the Mission's overall energy sector program, USAID has engaged in a dialogue with the GOE on the need to reduce the implicit subsidies for electricity users by recovering the opportunity cost of the fuel used in the power generating plants. In furtherance of this dialogue, the Mission has decided not to finance any additional improvements in the power sector (rehabilitation or new generation) in the absence of significant electricity price increases.

## B. PURPOSE AND METHODOLOGY

The purpose of the Electricity Program Evaluation is to examine the effects and impacts of past USAID assistance to the electric power sector and to identify lessons learned that can improve the efficiency and effectiveness of future assistance, if any, to the sector. The purpose of this paper is to present the results of the in-house DR/ID review of the USAID-assisted projects in the electricity sector and constitutes the first part of the evaluation exercise (per Cairo 9309). The second part of the exercise, an examination of the sector-wide economic issues of electricity pricing and an assessment of USAID's policy dialogue in this sector, will be completed by USAID/PPP.

In reviewing the power sector activities DR/ID utilized a number of information sources. Most important was the personal knowledge and experience of the DR/ID project officers, many of whom have worked directly on individual USAID projects for periods ranging between three to six years. Some of these officers were even involved during the early phases of power sector projects approved by USAID in 1975.

The official USAID historical record of power sector projects was extensively reviewed. This included a review of all relevant project papers, Action Memos, Audit Reports, programing documents (e.g. CDSS), etc. DR/ID officers also relied upon personal field observations and information obtained from contractors and EEA during meetings and site visits and from regular reports.

## C. MAJOR FINDINGS AND CONCLUSIONS

DR/ID has found that overall, the USAID power sector projects are achieving their intended objectives. Those activities which have been completed appear to have been successful and to have benefited all income groups in Egypt. These activities also appear to have had a significant impact on sustaining and supporting the growth of Egypt's economy and have not added an economic burden. Based on a review of those project activities which are still in progress, there appears to be no reason to believe that ongoing or future AID activities in this sector will not also achieve their intended objectives and be equally successful.

Implementation of many of the power sector projects has suffered from serious difficulties relating to the procurement of essential goods and services. While steps have already been taken to permit the successful implementation of all USAID power sector projects, there are two issues remaining for which USAID management assistance may be requested:

- Under the National Energy Control Center Project the Mission will need to continue to encourage full utilization of the project financed systems in order to maximize the intended economic benefits.

- Under the Aswan High Dam Runner Replacement Project, USAID will need to encourage the GOE to locate assured sources of funding to carry-out all necessary rehabilitation activities.

## D. LESSONS LEARNED

Several important lessons have been learned during the implementation of the USAID power sector program which may be useful to consider when designing similar projects.

1. USAID's initial efforts in this sector were designed to address Egypt's immediate needs for reconstruction and expansion. These initial efforts essentially consisted of equipment transfers with minimal introduction of new technologies and procedures. As a result, no major implementation problems were encountered.

   More recent USAID financed activities have focused on the longer-term development and policy dialog issues. These activities have attempted to introduce new technologies, to change management philosophies and procedures and to change GOE pricing policies. Implementing such activities in any developing country is clearly not easy since it entails moving from the known and comfortable position to the unknown and depends upon the critical but uncertain support and involvement of key host government implementing officials. Accordingly, the Mission should anticipate that problems will be encountered which inhibit the timely carrying out of such activities. Such problems can be solved only by a long term intensified educational process at a number of levels.

2. An important threshold decision in the design of a procurement plan for a power generating facility is the contracting method to be utilized for the equipment procurement and site construction. Where the equipment is to be installed on a "unitized" basis (e.g. the equipment provided, such as a gas turbine, is essentially a standard package) a turnkey contracting method may be the most effective. Using such an approach can sometimes simplify implementation by minimizing the need for many critical decisions on the part of the host government once the contract is effective.

   Where a customized product is to be procured, a significant amount of owner control during implementation may be necessary to assure that the equipment meets specifications with sufficient safety factors and overload characteristics. In such circumstances it might be advisable to have a consultant (as the owner's representative) provide the detail design and specifications and proceed either on a turnkey basis with a single contractor or divide the project into a number of procurements. When there are multiple procurements the consultant would prepare the procurement documents and cost estimates, evaluate the bids, assist in negotiation of contracts, monitor contracts, supervise construction and monitor performance tests.

3. Studies for proposed new power plants should identify the optimal and ultimate capacity of a plant that could be installed at the site. AID should not finance the development of any other site until plans for the full exploitation of the originally financed site are being implemented (within the limitations permitted by system security - i.e. the overall grouping of power units and the risks associated with a potentially large localized system failure). IFB's and contracting documentation for new generation facilities should include an options clause with agreed to pricing formulas for the procurement of additional units needed to fill the site from the same suppliers.

4. The development of an electrical utility often involves the use of the latest, most sophisticated solution or involves the selection of one solution approach out of number of feasible proposals with varying degrees of complexity. In such situations, the procurement should probably be carried-out following procedures for the solicitation of proposals rather than trying to develop equipment specifications and IFB's for systems utilizing technologies which are rapidly changing. Furthermore, when the equipment being procured is known to be subject to a great deal of technological change, the systems procurement plan should include the procurement of a sufficient amount of spare parts to provide for the specified operation of the system over the normal expected life of the equipment.

5. For large power plants the methodology used for the Shoubrah El Kheima project offers a useful model for effective consultant and owner involvement and control over the day-to-day construction decisions and such key project factors as design, safety, qualification of construction contractors and suppliers, etc. Implementation of the Shoubrah El Kheima Power Plant project has benefited from the use of a strong consultant group and a host country management team staffed with motivated people and supported by relatively timely GOE decisions. The result is a high quality, reasonable cost product.

6. The long-term development of electrical distribution systems is an extremely difficult process. Changing the technical philosophies and procedures needed for an effective and efficient distribution system often means changing the philosophies of host country officials regarding economies, system standards and organizational practices. Furthermore, in order for a distribution project to be successful in Egypt, the authorities and responsibilities of the GOE implementing institution must be specific and adequate to carry-out the project. Since a project to improve distribution systems in Egypt entails developing institutional capability, it is suggested that projects be for a specific distribution company. The development of a distribution system is a dynamic process and requires a great deal of detailed monitoring and frequent engineering/implementation adjustments. Finally, implementing a project with several host country institutions (which always lack sufficient coordination) simultaneously in several geographically widespread areas, is extremely difficult and completion is unlikely, if ever, to be realized in a timely manner. While there can be an overall plan for developing Egypt's distribution systems, such a plan can only be implemented according to its individual systems.

**EGYPT - REVIEW OF USAID ELECTRICITY SECTOR PROJECTS**

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## GLOSSARY OF ABBREVIATIONS:

| | |
|---|---|
| A-C | Allis-Chalmers Manufacturing Corporation |
| ADC | Alexandria Distribution Company |
| AID | Agency for International Development |
| BUREC | U.S. Department of Interior, Bureau of Reclamation |
| CDC | Control Data Corporation |
| CIP | USAID Commodity Import Program |
| DR/ID | USAID Development Resources/Office of Infrastructure Development |
| DPPE | USAID Development Program, Planning and Evaluation Division |
| EEA | Egyptian Electricity Authority |
| EIB | European Investment Bank |
| FY | Fiscal Year |
| GAI | Gilbert Associates, Inc. |
| GE | General Electric Company |
| GOE | Government of the Arab Republic of Egypt |
| HARZA | Harza Overseas Engineering Company |
| IFB | Invitation for Bids |
| JICA | Japan International Cooperation Agency |
| KV | Kilo volt |
| MOEE | Ministry of Electricity and Energy |
| MW | Megawatt |
| NECC | National Energy Control Center |
| OBI | Overseas Bechtel, Inc. |
| PACD | Project Assistance Completion Date |
| PASA | Participation Agency Service Agreement |
| PD&S | Program Development and Support |

| | |
|---|---|
| RP | Requirements Precedent |
| Rpm | Revolutions per minute |
| RTU | Remote Terminal Units |
| S&W | Stone & Webster, Inc. |
| TFF | AID Trade Financing Facility |
| UPS | Unified Power System |
| USAID | United States Agency for International Development |

# Review of USAID Electricity Sector Projects

## I. The USAID Electricity Sector Project Portfolio:

Since 1975 AID has authorized over $1.0 billion for the expansion and rehabilitation of the Egypt's power supply and distribution systems*. About $916 million has been obligated to-date to finance the foreign exchange costs associated with nine projects (Table 1). The local currency for these projects has been provided by the GOE and, on the average, represents about 30% of total project costs. Two projects (Canal Cities Distribution and Helwan/Talkha Gas Turbines) with a combined cost of $97 million have been completed. The existing $265 million pipeline includes $179 million obligated since May 1984 to support six ongoing projects.

An additional $180 million in assistance has been provided through the USAID Commodity Import Program (CIP) to provide the following equipment:

- Electrical equipment and supplies, e.g., cables, circuit breakers, distribution boxes, etc.
- Support equipment, e.g., cranes, pickup trucks, etc.
- Hydro and gas turbines and diesel generators
- Spare parts for gas turbines and diesel units
- Condenser tubes

While in recent years the funding for the AID-financed projects has been linked to GOE actions to reduce subsidies for the fuel used to generate electricity, the CIP resources have not been linked to tariff reform.

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* During the mid 1960's and early 1970's AID provided funding for the turnkey construction of four 87.5 MW steam turbine generating units at Cairo West (350 MW) which nearly doubled the generating capacity then in service.

**Table 1**

**USAID/EGYPT ELECTRICITY SECTOR**

**PROJECT PORTFOLIO, 1975-86/1**

| PROJECT #/TITLE | | TOTAL AUTHORIZATION ($ 000's) | OBLIGATIONS (THRU FY 1986) ($ 000's) | ORIGINAL AGREEMENT DATE | DISBURSEMENT AS OF 12/31/86 ($000's) | PACD |
|---|---|---|---|---|---|---|
| 0001 | Electric Power Distribution | $ 30,000 | $ 29,834 | 5/75 | $29,834 | 6/80 |
| 0008 | Helwan-Talkha Gas Turbine | 69,000 | 67,307 | 7/76 | 67,299 | 12/80 |
| 0009 | Ismailia Thermal Power Plant | 250,000 | 250,000 | 5/76 | 231,442 | 10/87 |
| 0023 | National Energy Control Center | 43,500 | 43,500 | 9/76 | 41,599 | 7/87 |
| 0030 | Shoubrah Thermal Power Plant | 263,000 | 263,000 | 8/79 | 192,698 | 6/89 |
| 0033 | Urban Electric Distribution | 97,200 | 97,200 | 9/77 | 53,951 | 9/89 |
| 0160 | Aswan High Dam Rehabilitation and Modernization | 100,000 | 100,000 | 4/82 | 51,464 | 7/90 |
| 0196 | Talkha Combined Cycle | 65,000 | 65,000 | 8/86 | — | 8/89 |
| | TOTAL PROJECT OBLIGATIONS TO DATE | | $915,841 | | | |

/1 Non-project assistance not shown.

A. **Electricity Power Distribution Project (Project No. 263-0001):**

This project was closed out in 1981. The Grant Agreement was signed on May 28, 1975 and provided $30 million for the reconstruction of power distribution systems in the cities of Port Said, Ismailia and Suez. The project was designed to directly deal with the damage to the canal cities distribution systems caused during the October 1973 conflict and the lack of maintenance during the period of the conflict and the withdrawal of the Israel troops from the Suez Canal area. The Project Grant financed the foreign exchange costs of required electrical distribution equipment and materials. This grant also finance the required architect/engineer services for the preparation of equipment specifications and bid documents and assistance in bid evaluations and contract awards for procurement of the equipment and materials.

The project met its objective of quickly providing materials and equipment for the reconstruction of the power distribution systems in the three Canal cities. Utilizing equipment and material lists prepared by the EEA, commodities were procured through competitive bidding and were made available for installation in these three cities within 24 months from project inception. The equipment was supplied under host country contracts with twelve U.S. firms. Installation was completed by three public sector firms (i.e. Kahromica, Hydelco and Eleject) under contracts to EEA. The equipment and materials have been installed to rehabilitate the distribution systems in the Canal area. While some sizes of cable were supplied that could not be utilized *, surpluses of cable in some sizes and deficiencies in other sizes is to be expected in a project conceived and implemented on an expedited basis with material requirements subject to change as distribution plans evolved. Clearly the intent was not to provide all of the materials to reconstruct the distribution systems but to provide a major equipment and material input.

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* As a result of USAID monitoring, certain quantities of cable were identified as not needed under the project. Subsequently EEA requested and USAID approved the transfer of these stocks of cable to AID Project 263-0033, Urban Electric Distribution, to be used in the rehabilitation and expansion of distribution systems in Cairo, Alexandria, Beni Suef and Shebin El Kom.

As noted in the Project Completion Report, prepared in October 1981, future AID projects for distribution development, should place attention on dealing effectively with the inherently volatile planning requirements. Distribution system rehabilitation and expansion is subject to constant modification, revision and redefinition. The requirements of a distribution system are continually changing and longer-term system planning of distribution systems does not provide the precise and well defined project traditionally financed by AID. Distribution planning is a dynamic process which is always changing and long range detailed planning is not possible. In addition, to effectively meet the needs of a distribution system at a particular point in time, an inventory of critical materials must be maintained in country.

It was also noted in the Project Completion Report that proper monitoring of the construction/installation of distribution facilities requires more frequent field monitoring.

Conclusion:

This project has achieved the intended purpose in a timely manner. The provision of the project financed materials and equipment has had a significant and dramatic impact on life in the canal cities. It facilitated the rebuilding of the basic infrastructure of these canal cities and the reemergence and development of residential, commercial and industrial activity.

The basic project objective was a simple one: provide needed distribution materials in a timely manner. To accomplish this, control of the project involved only one GOE entity and no effort was made to introduce new distribution planning or control procedures. As a result there were no major implementation delays and the project achieved its purpose.

B. Helwan - Talkha Gas Turbine (Project No. 263-0008):

This project was completed in 1980. The Project Agreement was signed on July 31, 1976 (AID Loan No. 263-K-032) for $50 million and was later amended to provide an additional $17.3 million. The funds were used to finance the construction of a 120 MW gas turbine generator plant near Helwan and a 192 MW gas turbine generator plant near Talkha. The goods and services financed under the project were procured following normal AID competitive procedures for host country contracts. EEA contracted with Gilbert Associates, Inc. to provide the engineering review and construction monitoring services. General Electric Company (GE) was contracted by EEA to provide, on a turnkey basis, the power plant facilities.

The selection, award, negotiation and execution of the project financed contracts and establishment of proper financing documents took much longer than anticipated. Previous to this project EEA had no experience with the U.S. procurement procedures required for construction contracts under AID-financed projects. Completing the various requirements therefore took much longer than it might otherwise have. In addition, EEA's decision making process was extremely centralized and cumbersome and resulted in unusually long time periods for approvals of contracting documents. Furthermore, before the contract became effective, EEA was required to open a Bank Letter of Credit in favor of GE. Since both the local banking institutions and EEA were unfamiliar with the procedures for opening such instruments (particularly where AID Letters of Commitment were involved), this process also took much longer than it might have otherwise. Once the contracts became effective, however, construction of the power plant facilities progressed within the contracting period.

Under this project GE trained 40 EEA staff (20 members of the operating staff and 20 members of the maintenance staff) who were subsequently assigned to the respective plants. Site visits and reports from EEA indicate that the personnel have obtained sufficient technical skills to effectively operate and maintain the plant facilities.

Conclusion:

This project was and is successful. Once the contracting and financing documents were in place implementation progressed without major problems. This can be attributed to the fact that EEA was already familiar with gas turbine technology for power generation and had no difficulty in learning how to operate the new equipment. In addition, the equipment was supplied on a "unitized" basis and construction services were provided under a turnkey arrangement which was simple and eliminated the need for many critical decisions on the part of the GOE once the contract was effective.

The project achieved the intended purpose and had important impacts. The two gas turbine generating plants were constructed and are in operation. The additional 300 MW of generating capacity was made available at a critical time and helped alleviate interim power supply shortages resulting from projected delays in the construction of needed base load generating facilities. As a result, the stability and reliability of the Unified Power System was significantly improved and industrial and commercial development in the area was strengthened.

C. Ismailia Thermal Power Plant (Project No. 263-0009):

The scope of this project has been enlarged significantly since the original project design was developed in early 1976. The original Grant Agreement was signed on May 30, 1976 and provided $99 million for financing the consultant engineering services and for the construction of a thermal power plant consisting of 2-150 MW generating units. As amended, the Project currently provides U.S. $250 million in AID grant financing for the turnkey construction of a thermal power plant composed of 3-150 MW generating units (a fourth 150 MW unit is being financed by Exim Bank and supplier credits). Also financed with these grant resources are the consultant services for engineering, engineering administration, training and construction monitoring services for the 600 MW plant, along with supervision during start-up and initial operation.

Gilbert Associates Inc. (GAI) is providing the engineering, O & M training and construction monitoring services. General Electric (GE) was contracted to design, furnish, install, test and start-up the plant on a turnkey basis. For the work related to Units 1 and 2, both the GAI and GE contracts were awarded in accordance with normal AID competitive procedures. AID competitive procedures were waived to allow EEA to contract with GAI for additional consulting services related to the construction of Unit 3 and also for Unit 4 and to contract with GE for the construction of Unit 4.

The project has suffered from significant implementation delays; particularly with regard to Units 1 and 2. Incomplete soils information resulted in a need to revise original designs. In addition, the EEA required changes in the specifications also resulted in a need to revise designs. Furthermore, major difficulties were experienced in obtaining timely GOE customs releases for project materials and equipment. When the testing of the units finally began, equipment failures repeatedly interrupted the operational test program and delayed the Provisional Acceptance. During the start-up and operational testing, boiler capacity deficiencies were identified that limited the generator output to less than the performance guarantees. Modifications to the boiler, turbine and generator were subsequently completed and the three units initially met their output and heat rate performance guarantees.

While final acceptance certificates were signed by EEA for Units 1, 2 and 3, operational problems continued to occur. Following the testing of the units (in accordance with the terms of the contract), EEA has been unable to operate the units at the maximum design capability for any extended period and performance reliability has been disappointing. In recent months the units have been reported out of operation frequently. While resolution of the troubles may be covered by the contract warranty, and even though the contractor is still making modifications to the equipment, the impact on long term performance, capability and reliability is uncertain.

For several months EEA and GE were actively negotiating a number of claims associated with the construction of Units 1 and 2. The parties recently concluded the claims negotiations and signed a settlement agreement which provides for a payment by EEA to GE of $9,360,785 and LE 2,100,000 of which $6,210,113 and LE 1,545,875 are earned retention amounts. This agreement also provides for the submission to USAID of a GE claim for payment of bunker fuel surcharge costs valued at $1.5 million. (To date USAID has not made any determination on this claim for bunker fuel costs.)

Construction of Unit 4 started on March 4, 1984 with completion scheduled for May 1987. On March 4, 1987 construction was completed and the unit was released for performance testing.

Both GE and Gilbert provided on-site training to develop the skills of the EEA personnel in the operation and maintenance of the plant facilities. This on-site training appears to have been successfully provided. During the earlier phases of the project, GE provided general training in the United States for EEA personnel covering plant operations and maintenance. This training was not effective, however, since the U.S. utilities involved in the project would not permit hands-on training of the EEA trainees. At the same time, it was apparent that the Egyptian Electricity Authority (EEA) personnel were not sufficiently trained or experienced to ensure proper plant operations. Therefore, in 1983 EEA requested and USAID/Cairo approved the use of GAI to supervise and train EEA personnel in the power plant operations and maintenance.

In total 310 persons have been trained in the following areas:

1. Operations Training:

   52 engineers and 126 technicians were trained in this area. The training consisted of seven basic training courses lasting ten weeks and two advanced engineering seminars lasting fifteen days each.

2. Maintenance Training:

   A total of 22 engineers and 110 technicians were trained in the areas of electrical, instrumentation and mechanical plant maintenance.

Conclusion:

The project is achieving its intended purpose. The project has already made available 450 MW of additional name plate rated base load generating capacity. This additional generating capacity has significantly enhanced EEA's ability to meet the demand for electricity during a critical development period. It has also enhanced EEA's ability to prevent major power outages associated with load shedding and has facilitated the rebuilding and new construction of a number of industries and the construction of housing in the Suez Canal area. In addition, the project has significantly strengthened EEA's ability to meet demand for electricity nationwide and has thereby supported the GOE's overall development efforts. Even considering the performance to-date of Units 1 and 2, the project financed facilities are one of the most efficient plants within EEA's power supply system.

In an attempt to provide the generating units as expeditiously as possible and, at the same time, minimize the additional workload required of EEA, a turnkey contracting mode was utilized. Under this approach, the turnkey contractor selected the design and supplied the equipment to meet minimum performance specifications. Given the difficulties mentioned above to successfully operate the plant generating facilities, a significant amount of owner control during implementation might have been useful to assure that the equipment met specifications with sufficient safety factors and overload characteristics. In retrospect it might have been appropriate for the consultant (as the owner's representative) to have provided detailed designs and specifications and proceeded on a turnkey basis with a single contractor or divided the project into a number of procurements. If there had been multiple procurements the consultant would have prepared the procurement documents and cost estimates, evaluated the bids, assisted in negotiation of contracts, monitored contracts, supervised construction and monitored performance tests.

D. National Energy Control Center (Project No. 263-0023):

The project provides for the establishment of the National Energy Control Center (NECC) at the Egyptian Electricity Authority (EEA) Dispatch Office. The NECC is a sophisticated computer system including 38 remote terminal units located at selected power stations and substations throughout Egypt. The project also finances a communications subsystem to connect the NECC to the remote terminal unit sites. This computer system will provide monitoring, supervision, and on-line computer control of the generation and transmission of electric power in the UPS.

The NECC Project is funded by Loan Number 263-K-037/037B for $41.0 million and by Grant Number 263-0023 for $2.5 million. The original Project Agreement was signed on September 30, 1976 with an anticipated life-of-project of 68 months after meeting the CP's. The PACD has since been extended a number of times and is now July 31, 1987.

Following normal AID competitive procurement procedures, EEA contracted with Control Data Corporation (CDC) to engineer, furnish and install the NECC (under a "turnkey" contract) and with Gilbert Associates for the required consulting services. The NECC communications network, comprising microwave and power line carrier facilities for data and voice communications, was subcontracted by CDC to General Electric (GE).

The project has been plagued with delays. Poor performance by the public sector building contractor, Kahromika, delayed construction for two years. In addition, serious problems occurred during the contracting of the project financed equipment systems. Because of the complexity of the project, review of technical proposals took nearly six months. In addition, resolution of a dispute of the proposed award by one of the bidders further delayed award of the final contract. Based on bid price evaluation results and the increased work resulting from delays in the completion of the project work, additional project funding had to be authorized.

After the contract with CDC was fully funded and became effective, Control Data's subcontractor, SCI, was unable to develop the needed software packages due to the loss of a number of key personnel who resigned to establish their own firm. Accordingly, project delays attributable to the procurement and funding processes amounted to 19 months.

Installation and commissioning of the equipment has finally been completed. System facilities and communications reliability tests were completed in January 1985. While the tests of the on-line software program have been progressing (albeit at a very slow rate), provisional acceptance testing of the automatic generation control system has not yet been completed. Concern has been raised over the extent to which EEA will eventually utilize the Automatic Generation Control (AGC) system features to control by computer the generating units and thereby maximize the potential fuel savings of the project. While the AGC system will probably soon be fully operational, it is possible that operations of the generating facilities will still be at the power plant stations and dispatch might therefore end up being by voice communications rather than by using the AGC. Finally, given the continually changing and advancing environment associated with state-of-art technologies, concern has been raised over the extent to which adequate plans for replacement parts have been developed to deal with eventual equipment obsolescence.

Training under the project has been provided by CDC. To-date 35 persons have been trained in the use and maintenance of hardware, software and communications facilities. MPIC granted its approval for training of dispatchers and systems engineers using other available AID resources for financing training. Fourteen NECC staff attended English classes in preparation for the training. Twelve passed the English test and ten were selected. EEA now appears reluctant to send the full group for this training and has decided to send only five of the ten candidates and is considering other personnel not directly associated with the project for the remaining five training slots. In general, it appears that sufficient numbers of staff have been trained to operate the system. At the same time, until the consultant's assistance to NECC is completed and the NECC staff has to integrate future physical expansions of the power supply system into the NECC, the skills of the project trained personnel will not be fully tested.

Recently, EEA requested another extension of the PACD in order to permit the financing of the CDC advisors during the warranty periods for the software and the AGC. Initiation of these warranty periods was delayed due to delays in completing provisional acceptance.

Conclusion:

The project objective has still not been fully achieved. Nevertheless, the NECC system does currently provide important generation data from all EEA steam and hydro generating stations which is analyzed daily by the NECC computer system. As a result of this analysis a more economic and reliable mode of dispatch can be identified and NECC can give appropriate dispatch instructions to power station operators. While this improved decision making capability has probably increased the reliability and stability of the electricity power supply, the effectiveness of the project financed system can not be thoroughly assessed until the automatic generating control subsystem is in full operation. Nonetheless the project financed system has the real potential for significantly enhancing the reliability and economy of operation of the UPS. Furthermore, the success of this project financed system will represent an important and visible element of the GOE's efforts to modernize its power supply system. Egypt is very proud to own such a state-of-the-art technology for economically controlling power supply.

The development of an electrical utility often involves the use of the latest, most sophisticated solution or involves the selection of one solution approach out of number of feasible proposals with varying degrees of complexity. In such situations, the procurement should probably be carried-out following procedures for the solicitation of proposals rather than trying to develop equipment specifications and IFB's for systems utilizing technologies which are rapidly changing. Furthermore, when the equipment being procured is known to be subject to a great deal of technological change, the systems procurement plan should include the procurement of a sufficient amount of spare parts to provide for the specified operation of the system over the normal expected life of the equipment.

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E. Shoubrah El Kheima Power Plant (Project No. 263-0030):

The scope of this power plant project has been enlarged significantly since the original design was agreed to in 1979. The original Grant Agreement, was signed on August 29, 1979. The agreement provided $100 million to finance: the consultant engineering services and selected commodity procurements for a nominally rated 600 MW two unit plant; the engineering of the transmission connection of the plant to the system; and technical assistance during start-up and initial operation. The power plant is located approximately five miles north of downtown Cairo on the east bank of the Nile River.

The project has been amended twice and now provides for a 1260 MW plant consisting of four 315 MW generating units. The total cost of this multi-donor financed project is $794.2 million. AID is providing $263 million in grant financing for the engineering services and items of major equipment. The other project financiers include the GOE, World Bank, African Development Bank, EIB, Italy, France, Canada and Japan.

For Units 1, 2, and 3, AID funds were utilized to finance: Overseas Bechtel Inc. (OBI) services as the consultant engineer, project manager and construction manager for the project; Westinghouse for the supply and installation of the turbine generators and the panels and controls system; Southwestern Engineering for the supply of the condensers and heaters; and Transamerica Delaval for the supply of the main system pumps. For Units 1, 2 and 3 all firms were selected following AID competitive procurement procedures. For Unit 4 AID waived the normal competitive procedures and authorized the negotiation of contracts with the same equipment suppliers and construction contractors. Since the World Bank chose not to participate in Unit 4, those contracts previously financed by the Bank were financed by AID and the other donors. Accordingly, USAID agreed to finance the reinforcing steel (Owen Steel Company) and water treatment systems (Infilco Degremont, Inc.) contracts since the

Training of EEA's operating and maintenance staff was funded by other donor financial institutions. On-site visits and EEA reports on the operations of Units 1, 2 and 3 indicate that the project trained personnel have obtained sufficient skills to effectively operate the plant facilities.

Conclusion:

The project is achieving the intended purpose. The project has already made available 945 MW of additional base load generating capacity. The plant is an efficient facility and is providing power to the EEA UPS at a major load center. Accordingly, this project has significantly improved the supply, stability and reliability of EEA's electric power supply system needed for continuing industrial, commercial and residential expansion and economic growth.

Project implementation benefited from the use of a strong consultant group staffed with motivated people working closely with the GOE implementing agency and supported by relatively timely GOE decisions. For large power plants where various investors are involved in the implementation, the arrangement used for the Shoubrah El Kheima project appears to be the only feasible approach. This approach provides for a greater level of consultant and owner involvement and control over the day-to-day construction decisions and such key matters as design, safety, qualification of suppliers, etc. The result is a high quality, reasonable cost product.

F. Urban Electric Distribution (Project No. 263-0033):

The purpose of this project is to rehabilitate and expand the electric distribution systems in Cairo, Alexandria, Shebin El Kom and Beni Suef. In 1977, AID authorized the incremental funding of $97.2 million over the life of the project. The initial increment of $17 million was obligated on September 30, 1977. The last increment of $21.188 million was obligated on August 15, 1985. Implementation of the project has been much slower than anticipated and the PACD has been extended a number of times and is currently September 30, 1989.

Following normal AID competitive procurement procedures, Harza Engineering Company was selected by EEA to provide the initial feasibility and implementation study required for development of the project. EEA then negotiated a contract with Harza for the consulting services and construction supervision needed during the implementation of the project. Following normal competitive procurement procedures, EEA has also contracted with over 30 U.S. manufacturers or suppliers for the needed equipment and materials.

The materials purchased with the $56 million obligated from 1977 through August 31, 1980 were allocated among of the four cities based on the Harza study. Serious problems, however, were experienced under the project in effectively utilizing the equipment and materials provided. Many of these problems relate to the reorganization of the MOEE during 1980, when implementation responsibilities were assigned to more than one organization. At the same time, EEA (the originally designated implementing agency) was limited in its authority to the areas of generation and transmission of energy at high voltages and was relieved of responsibility for distribution to the low voltage customers. Indeed, no single GOE organization was ever given the overall responsibility and authority to implement the project.

As a result of this GOE reorganization, project implementation was made much more difficult. GOE decisions and actions were delayed and project financed commodities were not used in a timely manner. Specifically, the Delta (Shebin El Kom) and Upper Egypt (Beni Suef) distribution companies were unable to utilize the equipment as quickly as had been anticipated and the installation of the distribution material was very slow. At the same time, Alexandria and Cairo have effectively utilized the materials allocated. Two major substations, one at Shebin El Kom and the other at Rod El Farag in Cairo are complete and in operation.

In response to this implementation experience, plans were developed to more effectively utilize delivered project commodities and significant amounts of commodities were transferred to project areas where needed. In large part these actions have already been completed. Furthermore, all remaining uncommitted AID resources will be used for the Alexandria Distribution Company (ADC) to rehabilitate and expand the electrical distribution system; an area where implementation has proven effective. Nonetheless, it should be noted that the inability of the individual distribution companies to effectively carry out their project management responsibilities, is still a problem and continues to hamper and complicate decision making.

Under the project, training was provided by the equipment suppliers to distribution company personnel primarily in the use, operation and maintenance of project financed equipment and systems. USAID and ADC are discussing the need for management level training in the U.S.

**Conclusion:**

The Urban Electric Distribution project is an important development effort with enormous potential impact. It represents a significantly different effort from the previous USAID distribution project and has attempted to do much more than just provide needed materials and equipment. The Urban Electric project is designed to go beyond the concept of the previous AID distribution effort and deals with the longer term development problems by attempting to introduce new technologies, systems and procedures in the Egyptian distribution companies.

The ongoing Urban Distribution project is expected to significantly impact the efficiency of Egypt's power supply system for several reasons. A great deal of electricity being generated can be saved since approximately 50-60% of the energy currently being lost in the power supply system is lost within the distribution element. Furthermore, it is in the distribution system where improvements in meter accuracy can take place.

It must be pointed out, however, that despite the efforts made under the project, the importance of effective distribution planning and procedures has not been adequately recognized by host country officials. Most design and operating decisions being made by management level officials of the Egyptian distribution companies still do not appear to have been made on the basis of economic and financial implications. Rather, these decisions appear to be based upon a philosophy that it is better (and easier) to overbuild and include unnecessary redundancy. Good planning and the proper design and sizing of equipment appears to be regularly overcome by outdated standards or customs. Furthermore, the local distribution companies do not appear to recognize the need to provide any minimum level of service to customers. Some areas (usually areas with higher income customers) appear to have a much higher standard of service than others.

In large part, the problems in implementing this project resulted from the way it was laid out. Indeed, there was no realistic plan in the Project Paper for carrying it out. The original project description never identified who would do what. Furthermore, the scope of work for the engineer/consultant was unclear and the proposed staffing arrangements appear to have been inadequate to support the carrying out of project activities in many geographically widespread areas simultaneously.

In order for a distribution project to be successful in Egypt, the authorities and responsibilities of the GOE implementing institutions must be clear and sufficient to carry out the project. In addition, since a project to improve distribution systems in Egypt entails developing institutional capability, such a project should focus activities on a specific distribution company service area. Furthermore, the development of a distribution system is a dynamic process and requires a great deal of close monitoring and frequent engineering/implementation adjustments. Finally, implementing a project with several host country institutions (which lack sufficient intercommunications and planning) simultaneously in several geographically widespread areas, is extremely difficult and completion is unlikely to be realized in a timely manner. While there can be an overall plan for developing Egypt's distribution systems; such a plan can only be implemented according to its individual systems.

In sum, while the project has suffered from significant delays, the causes have been clearly identified and are being effectively dealt with. In large part, the project inputs which have been provided (Annex B) appear to have been effectively utilized. At the same time, AID has not fully achieved all of the institution building objectives contemplated under the project. Changing technical philosophies and procedures needed for an effective distribution system is extremely difficult. Part of the problem is related to a belief by many host country officials that modern, more effective technologies are simply not needed. For example, local distribution company officials would most likely install a transformer sized for a 40 year projected demand rather than one which could be more cost effective but sized for a project demand over a much shorter (10-15 years) period.

G. **Aswan High Dam Runner Replacement (Project No. 263-0160):**

The Aswan High Dam Rehabilitation/Modernization Project is a major project to correct deficiencies in the twelve Russian supplied hydro-turbine generators and to improve the reliability of the plant through replacement of obsolete protective equipment and instrumentation. AID grant assistance for the project was authorized on March 29, 1982 for $100 million.* The Project Grant Agreement was signed on April 12, 1982 and provided $85 million to be used primarily for financing consultant services and the turnkey contract for the replacement of the twelve Frances turbine runners. In 1985 the remaining $15 million was obligated to fully finance the replacement of the obsolete protective equipment and instrumentation.

The U.S. Department of Interior, Bureau of Reclamation (BUREC), was selected by EEA to provide technical advisory services for the rehabilitation program of station upgrading. The BUREC under a PASA with AID assisted EEA in the negotiation of the turnkey runner replacement contract with the U.S. owned firm, Allis-Chalmers Manufacturing Corporation (A-C).

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* The Aswan High Dam and Hydroelectric Power Station, designed and constructed by the Soviet Union in the 1960's, constitutes a bloc project as defined in Chapter 9 of AID Handbook 1, Supplement B. Accordingly, AID assistance in the rehabilitation and modernization of the Aswan High Dam Power Station can be construed as commingling in that this assistance will promote the efficiency and reliability of the Aswan Dam's power generation, a project which has already been identified as bloc in nature. Section 620(h) of the FAA states that use of foreign assistance dollars in a manner which, contrary to the best interests of the United States, promotes or assists activities of Communist bloc countries, is prohibited.

It was determined at the time the project was authorized that there is no absolute prohibition against commingling if it serves AID's program interests and would not be contrary to the best interests of the United States. Thus it was determined by the AID Administrator that promotion of this important project would not be contrary to the best interests of the United States and, in fact, would be supportive of our economic and political relationship, political stability within Egypt and will significantly enhance Egypt's ability to promote its critical long-range economic development. Failure to support this activity was determined to be contrary to the best interests of the United States.

Project implementation is progressing in accordance with the revised schedule. The schedule has been revised to reflect experience gained during the replacement of the first two runners and is considered realistic based upon projects of similar size and complexity. Replacement of the first two runners began on February 15, 1985 and was completed in April 1986. These units have been returned to operation and have been available for operation as required by the National Energy Control Center to meet EEA's system requirements.

There were, however, some significant delays during the early phase of project implementation. A portion of the delays was related to events outside the control of all the involved parties. The A-C contract specified the installation of the first two runners beginning in August 1984. A Force Majeure action, A-C strike, resulted in a 120 day delay. Furthermore the original A-C contract had scheduled the sandblasting and painting of the water passages to be completed prior to the commencement of runner replacement. EEA, however, did not make the units available to A-C due to operational constraints and it was necessary therefore to integrate this reconditioning into a lengthened schedule. This reconditioning was integrated into a revised schedule and the rehabilitation work commenced on February 15, 1985 with a scheduled completion date of December 21, 1985 (the need for additional rehabilitation had been foreseen and provided for in the original Allis-Chalmers contract).

After Units 9 and 10 were removed from service and turned over to A-C on February 15, 1985 there were a number of important discoveries. During disassembling and inspection of the generators, the coils were found to be covered with an oily substance, insulation was found to be cracked and numerous wedges, holding the coils in place, were found to be loose. BUREC and A-C both recommended that the wedges be replaced and the coils be cleaned and painted with insulating varnish. The need to rewedge the generators extended the completion of Units 9 and 10 by five weeks. In addition to the above, sandblasting of the steel lined water passages exposed many areas of metal erosion and poor or non existent welding of the steel plates. Patching and more extensive welding than anticipated has been required. Units 9 and 10 were returned to service in April and upon completion of testing were released for commercial operation in May.

The contract provided for the renegotiation of the cost and schedule following completion of the first two units. Following negotiations, EEA and Allis-Chalmers agreed on a revised schedule and runner replacement cost for the remaining five pairs of runners. The PACD was extended to April 12, 1992 to comply with the agreed upon schedule.

In late February 1986, following receipt of bids for the 500 KV protective relay replacement it became evident that authorized funds for this project would not be sufficient to permit the carrying out of the full range of activities originally contemplated by AID and the GOE. The original need and cost estimated to replace or modernize circuit breakers, relaying and instrumentation were based upon data collected during BUREC site inspections in early 1982. During the more detailed evaluations made prior to and during the development of the specifications required for the procurement of equipment and services, major inadequacies in the supporting systems were identified which necessitated more extensive upgrading than that originally estimated. Replacement of relays had been originally planned but subsequent investigation revealed that the basic intelligence required to operate the relays was inadequate. Therefore, the existing current and potential transformers supplying the intelligence require replacement. The existing control houses did not contain sufficient space for the new equipment and would have to be expanded. Existing control cables require replacement. In addition, much of the control instrumentation at the power station is not functioning and can not be repaired, thus the original plan to replace selected individual instruments is no longer a realistic approach to modernize the plant instrumentation. Substantial information necessary for the reliable operation of the power plant is not being collected and recorded and without adequate information continued reliable operation of the plant could be jeopardized.

Recently, EEA has found that the operating and maintenance gates at the entrance and exit of the water passages are badly deteriorated with many of the penstock operating gates on the verge of being inoperable. When units are shut down for maintenance, sump pumps must operate continually to remove water that is leaking around the gates which would otherwise flood the unit and auxiliary equipment. The operating gates also serve as the safety backup to the governor controlled wickets gates and are the only means of cutting off the water should the wicket gate control fail. The BUREC has inspected the gates and confirmed their deteriorated condition and agrees with EEA that rehabilitation of the gates is required.

Modernization of the protective relaying will enhance the reliability of the transmission system and facilitate utilizing the additional power output resulting from the redesign of the turbine runners with less risk to the plant. Replacement of the 500 KV circuit breakers in conjunction with the more sensitive relaying will permit faults to be cleared faster and will improve the stability of the supply from the power station and the stability of the entire UPS. New circuit breakers will permit safer, quicker isolation of defective equipment and thereby minimize the magnitude of disruptions on the UPS and avoid major power outages. Modernization of the High Dam instrumentation would provide to the operators critical information necessary for the safe and efficient operation of the plant. The rehabilitation of the pen stock and draft tube maintenance and operating gates will minimize water leaking during maintenance of the units and assure maximum safety to the unit in the event of a wicket gate failure.

EEA requested an additional $25 million to fully fund the rehabilitation program. On October 15, 1986 USAID advised EEA that all AID funds for FY-87 were fully programmed and that EEA should discuss the additional funding requirements with MPIC.

Recently, Voith Hydro, Inc. (VHI) and Allis Chalmers Hydro, Inc. (ACH) of York, Pennsylvania announced the sale of the Allis Chalmer's hydro-turbine operation to Voith Hydro, Inc. As a part of this transaction, Voith has assumed responsibility for the runner replacement contract. This action has resulted in no change in work progress at the site.

The U.S. equipment suppliers have provided the required training to EEA staff. Fourteen persons have attended classes on the operation and maintenance of the turbine runners and six persons have attended classes on the governor. Site visits and EEA reports indicate the trained staff are being effectively used to operate the High Dam facilities. Additional training on the relay equipment will be provided under the supplier contract.

Conclusion:

Implementation of the project is progressing generally well. Given the amount of uncertainty that surrounds any rehabilitation activity of this size and complexity, the problems encountered under this project are not considered excessive or unusual.

It is too early in the implementation phase of this project, however, to begin to assess its impact on improving reliability, efficiency and output. At the same time, it should be noted, that the drought in Africa has been the main cause of the reduced flow of the Nile into Lake Nasser resulting in a reduction in the output of the hydro-generating plant at Aswan. To maintain an adequate irrigation flow, the water level in the reservoir of Lake Nasser has been falling thereby decreasing the hydraulic head on the turbines and reducing the generating output. If this situation continues the output of the hydro power plant using the new AID-financed runners will be significantly less than that originally anticipated as the design is based on a much higher minimum head for efficient operation.

In many ways, this project symbolizes the basic economic and political relationship between the U.S. and Egypt and could significantly contribute to political and economic stability of Egypt.* For this reason the successful implementation of the project is extremely important. It is therefore recommended that AID consider making available financing for the project and, if necessary, work with the GOE to locate assured sources of funding to carry-out the additional rehabilitation activities discussed above.

H. Talkha Combined Cycle (Project No. 263-0196):

This project provides $65 million to finance the foreign exchange costs associated with the engineering and construction of a 110 MW steam cycle addition at the Talkha gas turbine plant. The steam cycle addition will consist of heat recovery steam generators (boilers), steam turbine generators, mechanical auxiliary equipment, remote control systems, and necessary piping, circulation water supply, control interconnection and expansion of the existing 220KV substation and existing control room.

The heat recovery steam generators will utilize thermal energy in the form of exhaust gases, being discharged from the gas turbines, to convert water into steam which will drive the steam turbine generators to produce an additional 106MW of electric energy when the eight gas turbines are generating at full output. The gas turbines will be upgraded to achieve greater output and efficiency. A U.S. consulting engineer will provide necessary related technical and project monitoring assistance during the design, and manufacturing, and supervision during installation, testing and start-up in Egypt.

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In December 1986 the socialist party newspaper (People) contained a front page story relating to the recent visit of a team of Soviet officials to Egypt. The article indicates that the Soviets claimed that the new turbines runners, being installed by the U.S. will cause failure of the Dam and is a part of a U.S. sponsored conspiracy against the Soviet constructed Aswan High Dam Project. As understood from a liberal translation of the article, the Soviets wanted the work to be stopped, and they would repair and maintain the plant plus doubling the number of turbines in the power station.

The project was approved based primarily upon the anticipated fuel savings resulting from the combined-cycle addition. To expedite implementation, the Project Authorization included a waiver of competition to permit negotiations of contracts with General Electric (GE) and Gilbert Associates. The Grant Agreement was signed on August 28, 1986.

On December 25, 1986 EEA and GE signed the turnkey contract for the supply, installation, testing and training associated with the combined cycle addition at Talkha at a price of $60.7 million and L.E. 19.2 million. On March 1, 1987 EEA and Gilbert signed the consultant services contract with a value of $3.5 million.

Conclusion:

It is too early to evaluate project impacts or implementation progress.

## II. Project Impacts:

### A. Power System Development:

USAID's assistance to Egypt's electricity sector has significantly contributed to the strengthening of this country's power supply system. To-date AID has financed power generation projects which have increased EEA's generation capacity by approximately 1977 MW or about 24 percent of Egypt's existing total supply system. By 1990 the current USAID financed project portfolio will have financed an additional 555 MW of generating capacity to the EEA power supply system for a total of 2532MW.

### B. Economic and Financial Impacts:

The USAID power sector projects appear to be economically and financially viable activities. The findings made at the time the projects were approved still appear valid (i.e. that the projects are the least cost alternatives for meeting the projected power requirements of Egypt). A review of EEA's operating data indicates that the AID financed plants are producing the anticipated levels of electricity and that these levels are sufficient to generate revenues to cover plant operating costs. In general terms the USAID financed projects have not added an economic burden. Indeed the USAID financed projects appear to have had a significant impact on sustaining and supporting the growth of Egypt's economy. Figure 1 and Table 2 attempt to portray the relationship between the supply of power provided and GNP from 1979 to 1985, with and without the USAID financed projects. As can be seen, GNP would have been significantly less had the USAID projects not been undertaken.

Furthermore, without the AID financed improvements and expansions in the electrical power supply system, the implementation of many important GOE projects and programs might not have taken place. Many of the AID financed projects in Egypt, which were designed to improve industrial and agricultural productivity and create more jobs, to improve basic rural health and education and to encourage decentralization of urban populations, could not have been implemented without the improvements made to the electricity supply system.

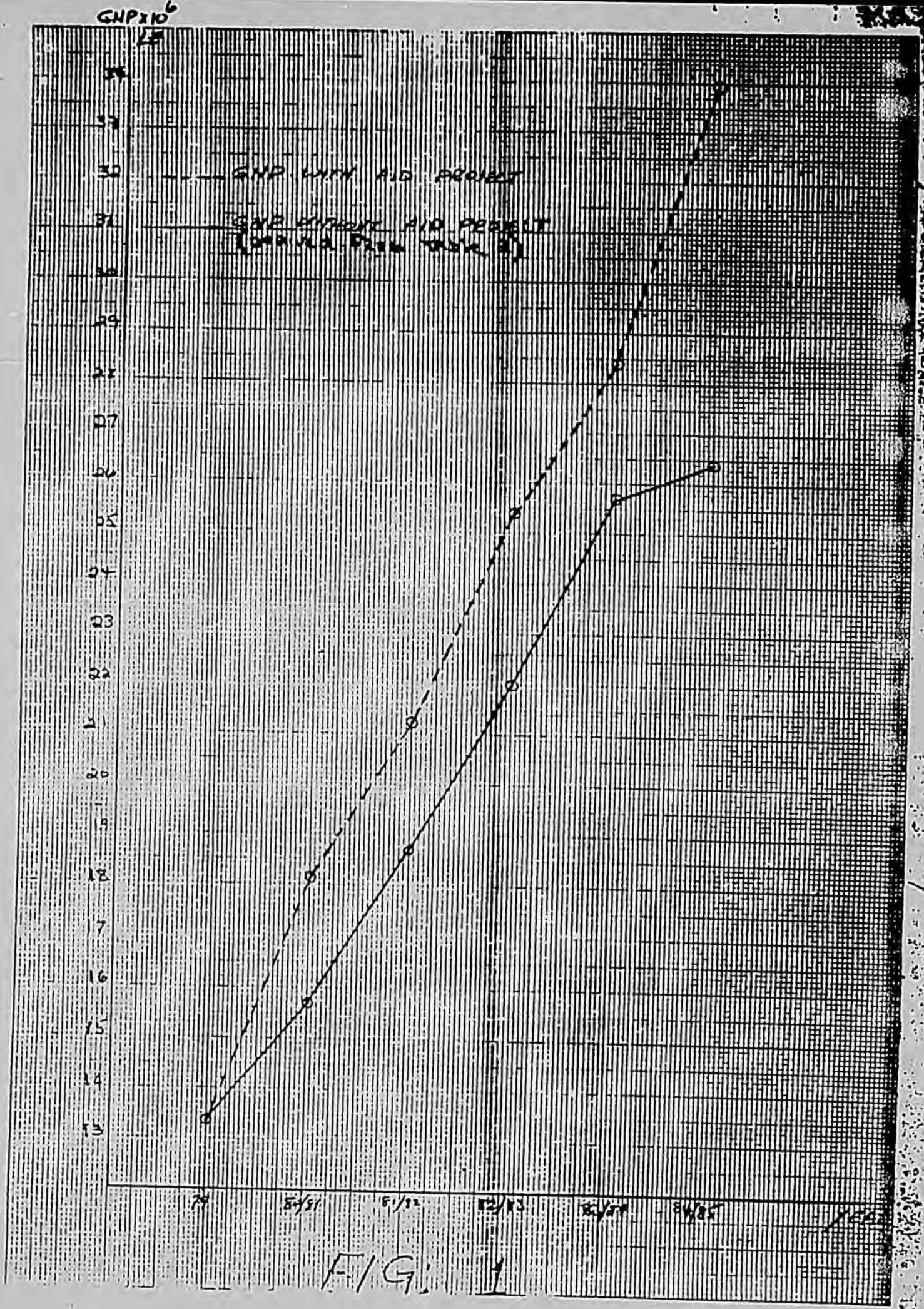
Current EEA financial reports indicate that more efficient fuel use is taking place at the newer steam power plants, many of which have been financed by AID. The average rate of fuel consumption for steam power plants in Egypt in 1985 is 270 gram/KwH, while the rate of fuel consumption for Abu-Sultan plant is 222 gram/KwH, 17.8 percent less than the average. It is also worth noting that the average rate of fuel consumption for gas turbine plants in Egypt in 1985 is 400 grm/KwH, while the rates of fuel consumption for Helwan and Talkha gas plants are 360 and 364 gm/Kwh respectively. These lower rates of fuel consumption can be translated into lower fuel costs and real energy savings. (It should also be noted that while the fuel consumption for the AID financed gas plants ranks well among other gas turbine plants they still consume considerably more than those facilities designed for base load use).

C. Beneficiaries:

The availability of electricity has increased dramatically since 1975. This increase and AID's contribution to this increase has been limited primarily to the major urban areas serviced by the UPS. While all customers have benefited from this increase, some may have benefited more than others. As can be seen in Table 3; important changes in usage patterns have occurred. In particular, while the total amount of electricity consumed by the heavy industry users has remained high, as a group it appears to be losing its significance in terms of its overall share of the total energy requirements in Egypt.

D. Institutional Impacts:

USAID has not financed any activities designed to directly change the overall effectiveness of EEA's administration and management. USAID has, however, provided significant assistance to improve the technical capability of EEA's operating personnel. Most notably, the AID financed NECC project should have a major impact on the overall efficient operations of the Egypt's unified grid. In addition, a major aspect of all the USAID financed power sector projects has been the introduction


GNP x 10^6
GNP WITH AID PROJECT
GNP WITHOUT AID PROJECT
30
29
28
27
26
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18
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16
15
14
13
79
80/81
81/82
82/83
83/84
84/85

FIG. 1

## TABLE 2

## Growth in Electric Power Supply and GNP

| | 1979 | 80/81 | 81/82 | 82/83 | 83/84 | 84/85 |
|---|---|---|---|---|---|---|
| GNP - $10^6$LE | 13,395 | 18,117 | 21,262 | 25,411 | 28,395 | 33,934 |
| Energy generated ($10^6$KwH) | 16,359 | 19,588 | 22,050 | 24,616 | 27,464 | 30,253 |
| GNP/Energy Generated | 0.8188 | 0.9279 | 0.9643 | 1.032 | 1.0339 | 1.1217 |
| Est. Energy Generated by AID projects ($10^6$KwH) | 0 | 1,590 | 1,788 | 1,930 | 2,036 | 5,683 |
| Est. % Energy by AID Projects | 0 | 8.12 | 8.11 | 7.84 | 7.41 | 18.78 |
| % Increase in GNP | 0 | 35.25 | 17.36 | 19.51 | 11.74 | 19.51 |
| % Increase in GNP due to AID Projects | | 2.86 | 1.41 | 1.53 | .87 | 3.66 |
| Cumulative % Increase in GNP due to AID Projects | | 2.86 | 4.27 | 5.80 | 6.67 | 10.33 |

Source: EEA Annual Reports.

## TABLE 3

### Electricity Consumption*

| YEAR | CATEGORY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | U.H.V.(1) INDUSTRY(4) | | | H.V.(2) INDUSTRY+AGR(5) | | | M.V. & L.V.(3) INDUSTRY+AGR+ RESIDENTIAL+ COMMERCIAL | | |
| | Quantity (KwH)$10^6$ | (%) | (%) Increase | Quantity (KwH)$10^6$ | (%) | (%) Increase | Quantity (KwH)$10^6$ | (%) | (%) Increase |
| 1979 | 3647 | (25%) | — | 712 | (5%) | — | 10,190 | (70%) | — |
| 1980 | 3825 | (24%) | 4.9% | 920 | (6%) | 29.2% | 11,318 | (70%) | 11.1% |
| 1981 | 4186 | (23%) | 9.4% | 1,234 | (7%) | 34.1% | 12,519 | (70%) | 10.6% |
| 1982 | 4088 | (22%) | -2.5% | 1,237 | (7%) | 0.2% | 13,710 | (72%) | 9.5% |
| 1983 | 4152 | (19%) | 1.6% | 1,402 | (7%) | 13.3% | 15,991 | (74%) | 16.6% |
| 1984 | 4774 | (19%) | 15.0% | 1,500 | (6%) | 7.0% | 18,355 | (75%) | 14.8% |
| 1985 | 4623 | (18%) | -3.2% | 1,642 | (6%) | 9.5% | 19,753 | (76%) | 7.6% |

1) Ultra High Voltage
2) High Voltage
3) Medium and Low Voltage
4) Kima, Aluminum, Somed, & Assiut Cement
5) Katamia & Alex. Cement, Aresnal, Egypt Chemical co. Nasr Petroleum Co., Alex. Petroleum Co., fertilizer plants, Mehallah Kobra Spin, and Amiria Spin.

Source: EEA Reports

of modern, more efficient technologies into EEA's operating facilities. Related to these new technologies, the AID financed power sector projects have also included significant amounts of on-the-job and off shore training in the proper operations of the equipment provided.

## III. USAID's Strategy in the Power Sector:

USAID's strategy in the power sector has evolved a great deal over the past several years. The USAID power sector program, which was initiated in 1975, was designed primarily to support Egypt's efforts to rehabilitate and rebuild this vital infrastructure system which was seriously damaged during the many years of war with Israel. In selecting activities in the power sector, USAID initially focused on activities which had a high potential for rapid disbursements. Furthermore, it was the intent of USAID to try to emphasize those projects which included the financing of large amounts of U.S. goods and services and thereby provide meaningful support to important sectors of the U.S. economy.

Following this initial phase of the program, certain adjustments were made in the Mission's strategy. Projects authorized more recently have been designed to better address the country's needs for improved efficiency in the power supply system through technology transfer. In addition, the Mission is now engaged in a policy dialogue with the GOE regarding the need for tariff reform in energy pricing. Current Mission strategy is not to finance any further funding for physical improvements in this sector (rehabilitation or new generation) in the absence of significant price increases. This change in Mission strategy has resulted in a tendency by USAID to move away from supporting large scale capital infrastructure type projects. This change in strategy will also likely result in less AID financing for contracts with major U.S. construction and equipment supplier firms.

## IV. Future Investments in the Electric Sector:

EEA estimates that customer demand for power will grow but at a gradually decreasing rate, from the current rate of ten percent to less than six percent beginning in 1996** and that it will reach a peak load of 16,000 MW in the year 2000. In March 1985 published EEA plans called for the addition to the integrated system of 26 new generating units at 11 different sites between 1985 and 1994. These units, ranging in size from 150 MW to 900 MW with a total capacity of nearly 7,900 MW, are to be installed by 1995. They will require an investment of nearly six billion dollars.*** EEA has assured financing for only eight of the planned 26 units and is currently trying to obtain financing for a nuclear power facility and for two of the planned steam plants. However, for the remaining 15 units, no financing has been identified. In sum, Egypt cannot hope to successfully meet its power generation requirements unless substantially more money is provided on a timely basis for the development of the power sector.

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** EEA's demand forecasts have been carefully scrutinized by a number of independent organizations. Among these is a report by Stone & Webster, Inc. (S&W) and work done by the Japan International Cooperation Agency (JICA). S&W made a series of tests of the EEA demand estimates which included using varying assumptions for electricity prices. Based upon this analysis, S&W concluded that the EEA demand forecast is realistic.

*** DR/ID has reviewed the official EEA expansion plan and believes that the March 1985 timetable is no longer realistic. From the time that sufficient funding is in place, it normally takes between five and six years to have a major base load generating plant in commercial operation. Over the past few years, however, EEA has been unable to attract sufficient financing through international development organizations. In addition, the financial condition of the GOE has precluded direct commercial financing of projects and suppliers offered only limited credits. Accordingly, EEA has been unable to pursue a logical and least-cost expansion program, has delayed the initiation of larger, more efficient base load facilities and has had to increase capacity, whenever technically feasible, by duplicating generating units at existing plant sites. Annex C presents DR/ID's estimate of the timtables for the installation of the new generating facilities currently under consideration by EEA.

A. Energy Savings and Reliability Improvement:

In addition to encouraging reductions in the energy price subsidies, USAID has been actively encouraging the GOE to initiate, as soon as possible, activities which would directly improve the efficiency of the existing power generation and supply system. Prior to recommending AID support for any major expansion of the generating capacity, consideration should be given to EEA's efforts to improve the efficiency of Egypt's power system. However, no matter what the GOE decision on further increasing the electricity rates, it is recommended that AID be prepared to support these types of projects.

Of primary importance in this effort is the upgrading of the operating efficiency and the recovery of capacity from the existing power generation units (i.e. steam, gas and hydro). Included in such an effort would probably also be the identification and taking out of service of selected units for which efficiency can not be practically improved. This rehabilitation program is now seen by both EEA and AID as a high priority activity that has the potential, over a relatively short period of time, for dramatically increasing the available generating capacity. Accordingly, a scope of work for technical assistance to help identify and implement specific rehabilitation tasks is now being reviewed by the GOE. In addition, $1.5 million of P.D. & S. resources has been tentatively budgeted by USAID for this study. It is expected that a contract will be awarded during 1987. Once this technical assistance activity accurately identifies the needed inputs, AID financing of specific plant rehabilitation (including equipment replacement and repair) could be considered (perhaps with CIP and/or Project funds). Included in such support might also be the rehabilitation of the Aswan Low Dam Hydro generation plant which was placed in operation in 1960.

Another set of energy improvement project activities relates to the need to reduce the amount of energy lost over the distribution and transmission systems. This loss is estimated at 25-30% which is far in excess of normal losses in more efficient systems (in the U.S this loss is estimated at about 7-8%). Part of this loss is associated with the need to improve the power factor through the systematic installation of fixed and switched capacitors. Both AID and the GOE agree that a project to install such equipment should be given high priority. Indeed, the GOE has already initiated a limited amount of capacitor installation with its own resources.

Associated with correcting system losses is a need to upgrade and replace existing distribution equipment (e.g. cable equipment, substations, etc.). Under our ongoing Urban Distribution Project (No. 263-0033) AID has provided major inputs designed to improve the Cairo and Alexandria distribution networks. System losses in these areas appear to be significantly less than in other areas of Egypt. At the same time, system losses appear much higher in the Delta and Northern Upper Egypt zones, areas that are vital to Egypt's agricultural development. Accordingly, projects to improve the reliability and efficiency of the distribution systems in the Delta and/or the Northern Upper Egypt zones are recommended during the next two years as a logical next AID activity to continue efforts in distribution system development.

The GOE and AID also agree that an important development activity for this sector is the establishment of a Regional Control Center in Alexandria which will provide capability to monitor and control the subtransmission and distribution systems in that area more effectively.

The USAID power sector program could also make available each year a limited amount of funding for assistance to complement and strengthen GOE's capacity to effectively plan and operate its large and growing power system. Included in such an effort would be assistance to establish a capability to identify and correct causes of lost sales through improved metering and billing practices. There is limited support for such a project in various working levels within EEA and EDA and among top management. USAID should encourage and provide funding for this kind of activity. Current GOE policy regarding financing of expatriate consultants, may cause difficulty in obtaining MPIC approval unless local currency from the Special Account is made available to finance a significant amount of local expertise. It is estimated that about LE 1.0 million would be required each year to complement the U.S. dollar inputs.

Resources for studies should also be made available to carry out feasibility analysis for major new power plant facilities needed to implement EEA's expansion plan. In addition, while AID has not invested in expansion of the transmission system*, a study of the transmission system should, nevertheless, be undertaken soon to identify needed improvements resulting from load growth. The financing of such a study is viewed as an appropriate and important AID activity. (Again current GOE policy regarding the use of expatriate advisors will probably impact the exact design of such an activity).

It is recommended that USAID also make available resources to finance a Cost-of-Service and Rate Design study which could establish a basis for future GOE decisions regarding energy prices and subsidies. Such an activity would provide AID with an important mechanism for continued and meaningful dialogue on price reform issues, provide more opportunities for mutual understanding of these issues (e.g. how much EEA really could pay for fuel and remain financially viable) and at the same time, reduce USG vulnerability to criticism of improper involvement in GOE sovereign affairs.

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*The power sector program must be a balanced program which realistically takes into account the need for adequate support to each major element of the system (i.e. generation, transmission, and distribution). The size of each element is, to a large extent, a function of the size of the other. Thus, major increases in generating capacity will normally result in a need to expand the other two elements. In addition, the GOE has apparently not experienced great difficulty in obtaining financing for transmission investments (significant amounts of financing have been obtained from Italian, Japanese and Canadian sources). Accordingly, AID support for transmission system investments is not foreseen, at this time.

B. New Power Plant Generation Facilities:

Without any major increase in plant generation capability Egypt's existing facilities will continue to work under a severe strain. All plants (even the inefficient oil consuming plants which should otherwise be retired) must continue to operate everyday in order to meet as much of the immediate demand as possible. In addition, since it usually takes up to five years for new base-load capacity to be in service, EEA's supply system in 1991 will be relying on nearly 400 MW of generating equipment which will be more than 30 years old and an additional 900 MW of generation equipment in excess of 20 years of operation, all of which would otherwise be ready for retirement or extensive rehabilitation. If the empirically derived estimate of lower loads (based on anticipated tariff increases) does not materialize (or the economy recovers) and growth in demand exceeds the growth in new capacity additions, a shortage in reserve capacity will result which will curtail planned maintenance. This will lead to equipment breakdowns and interruptions in service. The lead time to make any correction in a capacity deficiency could exceed four years under the best of conditions and would not allow for the most effective use of financial resources.

Accordingly, it is recommended that USAID be prepared to provide financial resources to support EEA's plans to expand its base load generating capacity. A part of Egypt's plan to expand the electricity generation capacity currently includes the development of a nuclear power plant at El-Dabaa. Within legislative limits, it might be in AID's best interests to provide support for training GOE personnel in the construction, operations and maintenance of the plant and for specific site works peripheral to the main power plant facility.

Once GOE progress on tariff reform and subsidies is determined to be acceptable by USAID, investments in major new thermal generation facilities should be given serious consideration. At that time, the best investment to expand the power supply system would probably be a 1200 MW steam-thermal power station plant. It should be pointed out that from a practical standpoint, however, the magnitude of the total funding requirements for a major new base load generating plant would, most likely preclude a totally AID-financed option. At the same time, however, AID's early involvement in the initial stages of development of such an activity should also act to attract substantial financial input from other financial institutions.

Financing is also needed to support activities which can use renewable energy resources to increase Egypt's electricity supply. It is entirely possible that some day a significant amount of Egypt's electric power supply could come from renewable energy based systems. The first step in this process, however, is research to identify systems that can be installed for reliable, continuous operation and can produce electricity at affordable costs. USAID should be prepared to make available financing for research and field testing of such systems.

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FOR ANE/PD/E, LINDA LION

E.O. 12356: N/A
SUBJECT: ELECTRICITY PROGRAM EVALUATION

A. USAID HAS PREPARED A DRAFT SCOPE OF WORK FOR SUBJECT EVALUATION SCHEDULED FOR THE THIRD QUARTER OF FY 86. THE PURPOSE OF THE EVALUATION IS TO EXAMINE THE EFFECTS AND IMPACTS OF PAST USAID ASSISTANCE TO THE ELECTRIC POWER SECTOR AND TO IDENTIFY LESSONS LEARNED THAT CAN IMPROVE THE EFFICIENCY AND EFFECTIVENESS OF FUTURE ASSISTANCE TO THE SECTOR. THE RESULTS OF THE EVALUATION WILL BE USED IN THE DESIGN AND IMPLEMENTATION OF NEW PROJECTS IN THE SECTOR AS WELL AS TO STRENGTHEN THE IMPLEMENTATION OF ONGOING PROJECTS. WE ALSO ANTICIPATE THAT THE EVALUATION FINDINGS WILL BE UTILIZED IN THE DEVELOPMENT OF THE FY 1989 CDSS.

B. WE PLAN TO DIVIDE THIS EVALUATION INTO TWO DISTINCT COMPONENTS, PERFORMED BY SEPARATE TEAMS. THE FIRST COMPONENT IS AN EXAMINATION OF USAID-ASSISTED PROJECTS AND THEIR IMPACTS IN THE SECTOR. THE SECOND IS AN EXAMINATION OF THE SECTOR-WIDE ECONOMIC ISSUES OF ELECTRICITY PRICING AND AN ASSESSMENT OF USAID'S POLICY DIALOGUE IN THIS SECTOR. THERE ARE DIFFERENT AUDIENCES FOR THE TWO COMPONENTS. THE FIRST, GEARED AT PROJECT-LEVEL ISSUES, WILL BE USED PRIMARILY BY THE GOE COUNTERPART AGENCIES, PARTICULARLY THE EEA, AND USAID PROJECT MANAGEMENT STAFF. THE SECOND COMPONENT WILL BE USED PRIMARILY BY USAID SENIOR MANAGEMENT, FOR PROGRAMMATIC DECISION-MAKING AND FOR THE POLICY DIALOGUE. THE REPORT FROM THE FIRST COMPONENT WILL BE SHARED WIDELY WITH THE GOE. THE REPORT FROM THE SECOND COMPONENT WILL RECEIVE MORE LIMITED DISTRIBUTION THAN THE FIRST, AND SECTIONS MAY BECOME CLASSIFIED. THE SECTION RELATING TO USAID'S POLICY DIALOGUE MAY REMAIN STRICTLY INTERNAL TO AID. DESPITE THIS DIVISION, WHICH IS USEFUL FOR PRESENTATION PURPOSES, USAID VIEWS THE TWO COMPONENTS AS PART AND PARCEL OF A COMPREHENSIVE ELECTRICITY PROGRAM ASSESSMENT. THE TWO TEAMS SHOULD BE AT WORK CONCURRENTLY, AND SHOULD COORDINATE THEIR EFFORTS. A SUMMARY OF THE SCOPE OF WORK FOR THE TWO COMPONENTS FOLLOWS.

C. STATEMENT OF WORK:
THE FIRST COMPONENT WILL BE A COMPREHENSIVE REVIEW OF USAID-ASSISTED PROJECTS IN THE POWER SECTOR, INCLUDING THE IMPLEMENTATION EXPERIENCE TO-DATE, THEIR CUMULATIVE

CONTRIBUTION TO POWER SECTOR DEVELOPMENT, THEIR MAJOR ECONOMIC EFFECTS AND BENEFICIARIES, AND THEIR TECHNOLOGICAL, FINANCIAL AND INSTITUTIONAL VIABILITY (QUESTIONS ONE THROUGH NINE BELOW.)

1. ARE USAID-ASSISTED PROJECTS IN THE SECTOR ACHIEVING PLANNED OUTPUTS? IF NOT, WHY NOT? WHAT APPEAR TO HAVE BEEN THE MOST SUCCESSFUL IMPLEMENTATION STRATEGIES AND CONTRACTING MODES AND THE MOST EFFECTIVE MODELS FOR DONOR COLLABORATION? UNDER WHAT CIRCUMSTANCES SHOULD THESE BE REPLICATED IN THE DESIGN AND IMPLEMENTATION OF FUTURE PROJECTS? WHAT HAVE BEEN THE MAJOR IMPLEMENTATION PROBLEMS, AND HOW CAN THESE BE REMEDIED IN ONGOING PROJECTS AND AVOIDED IN FUTURE PROJECTS?

2. HAVE USAID-ASSISTED PROJECTS INCORPORATED ADEQUATE TRAINING FOR TECHNICAL PERSONNEL TO OPERATE AND TO MAINTAIN THE PLANTS AND EQUIPMENT PROVIDED? DISCUSS THE APPROPRIATENESS OF THE LEVEL OF TECHNOLOGY PROVIDED BY USAID PROJECTS. WHAT ADDITIONAL TRAINING ASSISTANCE SHOULD USAID CONSIDER INCORPORATING IN FUTURE PROJECTS?

3. WHAT IMPACT, IF ANY, HAVE USAID-ASSISTED PROJECTS HAD ON THE INSTITUTIONAL DEVELOPMENT OF GOE IMPLEMENTING AGENCIES? IS EXISTING INSTITUTIONAL CAPACITY ADEQUATE TO MANAGE AND TO IMPLEMENT CURRENT AND PLANNED INVESTMENTS IN THE SECTOR? WHAT ARE THE MOST IMPORTANT INSTITUTIONAL DEVELOPMENT NEEDS, AND WHAT STRATEGIES MIGHT BE APPROPPIATE FOR PROVISION OF USAID ASSISTANCE TO MEET THESE NEEDS?

4. ARE USAID-ASSISTED PROJECTS IN THE ELECTRICITY SECTOR ADDRESSING PRIORITY NEEDS IN THE SECTOR? SHOULD FUTURE INVESTMENTS EMPHASIZE POWER GENERATION, TRANSMISSION OR DISTRIBUTION? WHAT ARE RELATIVE PRIORITIES FOR CONSTRUCTING ADDITIONAL CAPACITY VERSUS IMPROVING THE EFFICIENCY OF EXISTING INFRASTRUCTURE?

5. HOW IMPORTANT HAS USAID ASSISTANCE BEEN FOR THE OVERALL EXPANSION AND DEVELOPMENT OF THE ELECTRIC POWER SECTOR OVER THE LAST DECADE? WHAT INCREASES IN GENERATION, TRANSMISSION AND DISTRIBUTION CAPACITY AND



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WHAT IMPROVEMENTS IN SYSTEM EFFICIENCY AND RELIABILITY CAN BE ATTRIBUTED TO USAID ASSISTANCE?

6. HAVE THE ELECTRIC POWER SECTOR PROJECTS ASSISTED BY USAID BEEN FINANCIALLY SOUND INVESTMENTS? LOOKING AT THESE PROJECTS IN PURELY FINANCIAL TERMS (THAT IS, IGNORING SHADOW PRICES), HAVE THESE PROJECTS GENERATED, OR ARE THEY LIKELY TO GENERATE, SUFFICIENT REVENUES TO COVER THEIR COSTS?

7. WHAT HAVE BEEN THE ECONOMIC EFFECTS AND IMPACTS OF USAID ASSISTANCE TO THE ELECTRIC POWER SECTOR? HOW HAS THIS ASSISTANCE CONTRIBUTED TO ECONOMIC GROWTH? THE DISCUSSION OF ECONOMIC EFFECTS AND IMPACTS SHOULD INCLUDE QUANTITATIVE ESTIMATES OF THEIR MAGNITUDE.

8. TO WHAT EXTENT HAS EXPANSION OF THE ELECTRIC POWER SECTOR OVER THE PAST DECADE INCREASED ACCESS TO ELECTRICITY? WHO HAVE BEEN THE MAJOR BENEFICIARIES OF POWER SECTOR EXPANSION? HAS THIS EXPANSION BEEN DETRIMENTAL TO ANY GROUP WITHIN EGYPTIAN SOCIETY? WHICH POPULATIONS REMAIN UNSERVED BY ELECTRIC POWER? IS IT POSSIBLE TO ISOLATE AND TO QUANTIFY BENEFICIARIES OF USAID ASSISTANCE TO THE SECTOR?

9. ARE FINANCIAL RESOURCES OF THE VARIOUS IMPLEMENTING AGENCIES ADEQUATE TO OPERATE AND MAINTAIN THE EXISTING POWER SYSTEM? WHAT IS THE CAPACITY OF THE IMPLEMENTING AGENCIES TO CONTRIBUTE TO ADDITIONAL CAPITAL INVESTMENTS? WHAT IS THE POTENTIAL FOR GENERATION OF ADDITIONAL RESOURCES? HOW CAN THEIR FINANCIAL VIABILITY BE FURTHER STRENGTHENED?

D. THE SECOND COMPONENT WILL BE AN ANALYSIS OF THE EFFECTS AND IMPACTS OF POWER SECTOR EXPANSION ON THE OVERALL ECONOMY, INCLUDING AN EXAMINATION OF PRICING POLICIES, THE POTENTIAL IMPACTS OF CHANGES IN ELECTRICITY TARIFFS AND THE EFFECTIVENESS OF USAID POLICY DIALOGUE IN THE POWER SECTOR (QUESTIONS ONE THROUGH FOUR BELOW.)

1. TO WHAT EXTENT HAVE ELECTRICAL PRICING POLICIES ENCOURAGED OR IMPLICITLY PERMITTED INEFFICIENT OR WASTEFUL USES OF ELECTRICAL ENERGY? TO WHAT CATEGORIES OF CONSUMERS DOES THIS PRIMARILY APPLY, AND HOW WOULD THEIR FINANCIAL VIABILITY BE AFFECTED BY TARIFF INCREASES?

2. WHAT FACTORS ARE LIKELY TO AFFECT OVERALL DEMAND FOR ELECTRICITY AND THE NEED FOR FUTURE INVESTMENT OVER THE NEXT TEN YEARS? HOW MIGHT VARIOUS TARIFF SCENARIOS AFFECT DEMAND FOR ELECTRICITY OVER THIS PERIOD? ARE PROPOSED FUTURE USAID INVESTMENTS APPROPRIATE, GIVEN ANTICIPATED BENEFITS AND OPPORTUNITY COSTS TO THE GOE COMPARED WITH ALTERNATIVE INVESTMENTS, AS WELL AS RECURRENT COST IMPLICATIONS?

3. HOW WOULD CHANGES IN ELECTRICITY PRICES AFFECT PRICE AND DEMAND FOR OTHER IMPORTANT INDUSTRIAL AND CONSUMER PRODUCTS? WHAT WOULD BE THE PROBABLE IMPACT ON WHOLESALE AND CONSUMER PRICE INDEXES IF ELECTRICITY PRICE INCREASES

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WERE PASSED ON TO THE CONSUMER, UNDER VARIOUS TARIFF SCENARIOS?

4. HAS USAID USED ASSISTANCE TO THE ELECTRIC POWER SECTOR EFFECTIVELY AS A VEHICLE FOR POLICY DIALOGUE? SHOULD IT DO MORE IN THIS AREA IN THE FUTURE? SHOULD THIS DIALOGUE EXTEND BEYOND TARIFF INCREASES? WHAT OTHER ENERGY CONSERVATION MEASURES ARE FEASIBLE IN THE EGYPTIAN CONTEXT?

E. TEAM COMPOSITION:
FOR THE FIRST COMPONENT, WE ARE CURRENTLY PLANNING A COLLABORATIVE EFFORT BETWEEN U.S. EXPERTS, GOE PERSONNEL AND/OR EXTERNAL EGYPTIAN CONSULTANTS. WE PROPOSE THAT THE U.S. TEAM MEMBERS INCLUDE:

-AN ELECTRIC UTILITY MANAGEMENT SPECIALIST TO EXAMINE THE MANAGEMENT OF USAID-ASSISTED PROJECTS AS WELL AS INSTITUTIONAL CAPACITY AND NEEDS OF GOE IMPLEMENTING AGENCIES. THIS INDIVIDUAL WILL ALSO BE THE TEAM LEADER, AND SHOULD HAVE STRONG LEADERSHIP AND WRITING SKILLS IN ORDER TO COORDINATE INPUTS FROM OTHER TEAM MEMBERS AND PREPARATION OF THE DRAFT AND FINAL REPORTS.
-AN UTILITY ECONOMIST/FINANCIAL ANALYST WITH EXTENSIVE EXPERIENCE IN THE POWER SECTOR AND ELECTRIC



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-A SENIOR ENGINEER WITH EXTENSIVE EXPERIENCE IN MANAGING ELECTRIC POWER PROJECTS TO REVIEW THE IMPLEMENTATION EXPERIENCE WITH COMPLETED AND ONGOING USAID-ASSISTED ELECTRICITY SECTOR PROJECTS TO-DATE.

USAID PROPOSES THAT THE EGYPTIAN TEAM MEMBERS SHOULD INCLUDE:

-AN ELECTRIC UTILITY MANAGEMENT SPECIALIST TO WORK IN COLLABORATION WITH THE TEAM LEADER/UTILITY MANAGER ON MANAGEMENT/INSTITUTIONAL DEVELOPMENT ISSUES.

-A SENIOR MECHANICAL ENGINEER WITH EXTENSIVE EXPERIENCE WITH ELECTPICITY SECTOR PROJECTS, TO REVIEW THE DESIGN, IMPLEMENTATION AND OPERATION OF THE MECHANICAL ASPECTS OF USAID-ASSISTED PROJECTS.

-A SENIOR ELECTRICAL ENGINEER WITH EXTENSIVE EXPERIENCE WITH ELECTRICITY PROJECTS TO REVIEW THE DESIGN, IMPLEMENTATION AND OPERATION OF USAID-ASSISTED POWER PROJECTS.

F. WE PROPOSE TO CONDUCT THE SECOND COMPONENT USING DPPE/PAAD ENERGY SECTOR BACKSTOP CHARLES RICHTER, AND A SENIOR ENERGY ANALYST, WHO SPECIALIZES IN ENERGY USE AND ENERGY PRICES. WE WOULD CONSIDER EITHER OUTSIDE CONSULTANT EXPERTISE OR AN AID/W TDYER, IF SOMEONE WITH REQUISITE BACKGROUND AND SKILLS IS AVAILABLE. THIS SHOULD BE A HIGHLY EXPERIENCED INDIVIDUAL, WHO WILL HAVE STRONG CREDIBILITY WITH THE GOE. ONE CANDIDATE WHO COMES TO MIND IS RUSSELL DE LUCIA, WHO WE UNDERSTAND IS AVAILABLE THROUGH S AND T/EY'S HAGLER-BAILLY CONTRACT. THIS EFFORT WILL BE INDEPENDENT OF THE FIRST COMPONENT I.E., THE INDIVIDUALS CONDUCTING IT WILL NOT REPORT TO THE TEAM LEADER FOR THE FIRST COMPONENT AND WILL DRAFT A SEPARATE REPORT. THEY WILL, HOWEVER, COORDINATE THEIR EFFORTS WITH THE TEAM, AND IN PARTICULAR WILL WORK CLOSELY WITH THE UTILITY ECONOMIST ON THE TEAM TO AVOID DUPLICATION OF EFFORT.

G. TIMING:
THE EVALUATION IS TENTATIVELY SCHEDULED FOR A SIX TO EIGHT WEEK PERIOD BEGINNING IN MID-JUNE AND ENDING IN LATE JULY/EARLY AUGUST.

H. REQUESTED AID/W ASSISTANCE:
WE CONSIDER THIS EVALUATION TO BE AMONG THE MOST IMPORTANT AMONG THOSE SCHEDULED FOR FY 86 AND REQUEST AID/W ASSISTANCE IN IDENTIFYING A FIRST-CLASS TEAM AND TEAM LEADER. WE ARE WILLING TO SUPPORT EITHER A MIXED TEAM OF AID DIRECT-HIRE AND IQC CONSULTANTS, OR A TEAM

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SOLELY OF IQC CONSULTANTS, DEPENDING UPON QUALIFICATIONS OF AVAILABLE PEOPLE. OUR PAST EXPERIENCE WITH MIXED TEAMS HAS BEEN VERY GOOD, AND WE CONSIDER AID PARTICIPATION IMPORTANT TO MAINTAINING AN OPERATIONAL PERSPECTIVE, BUT WE DO NOT HAVE SPECIFIC INDIVIDUALS IN MIND. FOR IQC ASSISTANCE, WE WOULD PREFER A BROAD-BASED FIRM WELL GROUNDED IN ECONOMIC AND FINANCIAL AS WELL AS ENGINEERING MATTERS, SUCH AS BOOZ-ALLEN AND HAMILTON OR CH2M-HILL. WE WOULD APPRECIATE YOUR RECOMMENDATIONS FOR INDIVIDUAL TEAM MEMBERS. GIVEN OE CONSTRAINTS, WE COULD NOT FUND MORE THAN ONE TEAM MEMBER FROM AID. WE ALSO REQUEST YOUR ASSISTANCE IN IDENTIFYING AN ENERGY ANALYST TO WORK WITH CHARLES RICHTER ON THE IN-HOUSE MACROECONOMIC ANALYSIS.

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I. FUNDING:
IQC CONSULTANT SERVICES WILL BE FUNDED FROM PROJECT 263-0102, TECHNICAL COOPERATION AND FEASIBILITY STUDIES IV. LOCAL CONSULTANTS WILL BE FUNDED FROM THE FT-800 SPECIAL ACCOUNT. WE HAVE NOT YET FORMALLY REQUESTED EEA OR MPIC FOR FUNDING, AND INDEED WOULD PREFER TO DEFER THIS REQUEST UNTIL WE HAVE A BETTER IDEA REGARDING THE FINAL MIX OF AID AND EXTERNAL TEAM MEMBERS AND ACTUAL IQC COSTS. SINCE THE SECOND COMPONENT IS RELATED TO PROGRAMMATIC RATHER THAN PROJECT CONCERNS, AND BECAUSE OF

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# URBAN ELECTRIC DISTRIBUTION PROJECT
## (NO. 263-0033)
## PLANNED VERSUS ACTUAL UTILIZATION OF PROJECT EQUIPMENT & MATERIALS FOR THE FIRST YEAR OF THE PROJECT

| ITEM | QUANTITY PER CITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAIRO | | ALEX | | BENI SUEF | | SHEBIN EL KOM | |
| | Planned (1) | Actual (2) | Planned (1) | Actual (2) | Planned (1) | Actual (2) | Planned (1) | Actual (2) |
| 1. Substation | - | 1 | - | - | - | - | 1 | 1 |
| 2. Transformer Equipment | 97 | 75 | 113 | 46 | 22 | 24 | 45 | 41 |
| 3. Single core 15 KV Cables | 420 | 430 | 214 | 149 | 22.5 | 0 | 22.5 | 45 |
| 4. Multi core 15 KV Cables | 338 | 150 | 167 | 108 | 30 | 29 | 30 | 31 |
| 5. Low Voltage Cables | 75 | 0 | 361 | 290 | 652 | 790 | 652 | 793 |
| 6. Warehouses | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 |
| 7. Construction Equipment | 137 | 131 | 77 | 100 | 19 | 20 | 19 | 20 |

.. Source: Project Reports Prepared by Harza Engineering Co. - April, 1979.

.. Source: Project Reports Prepared by Harza Engineering Co. - January, 1983

# URBAN ELECTRIC DISTRIBUTION PROJECT
## (NO. 263-0033)
## PLANNED VERSUS ACTUAL UTILIZATION OF PROJECT FUND FOR THE FIRST YEAR OF THE PROJECT

| ITEM | $ VALUE PER CITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAIRO | | ALEX | | BENI SUEF | | SHEBIN EL KOM | |
| | Planned (1) | Actual (2) | Planned (1) | Actual (2) | Planned (1) | Actual (2) | Planned (1) | Actual (2) |
| 1. Substation | 0 | 6,108,710 | 0 | 0 | 0 | 0 | 2,573,000 | 2,467,375 |
| 2. Transformers | 1,906,500 | 1,992,445 | 1,624,800 | 1,343,863 | 242,400 | 474,333 | 513,300 | 909,110 |
| 3. Single core 15 KV Cables | 2,529,600 | 4,511,143 | 1,461,520 | 1,152,259 | 123,300 | 0 | 123,300 | 278,323 |
| 4. Multi core 15 KV Cables | 5,591,200 | 3,099,562 | 2,664,430 | 2,009,323 | 481,700 | 560,696 | 481,700 | 601,395 |
| 5. Low Voltage cables | 1,455,000 | 0 | 1,069,440 | 713,328 | 527,600 | 674,782 | 527,600 | 682,676 |
| 6 Warehouses | 962,000 | 1,214,927 | 222,000 | 807,531 | 289,600 | 272,957 | 289,600 | 273,742 |
| 7. Construction Equipment | 2,280,630 | 2,744,363 | 1,759,150 | 2,367,951 | 363,100 | 520,349 | 363,100 | 520,349 |
| Total | 14,724,930 | 19,671,150 | 8,801,340 | 8,394,255 | 2,027,700 | 2,503,117 | 4,871,600 | 5,732,970 |

1. Source: Project reports prepared by Harza Overseas Engineering Co. - April, 1979

2. Source: Project reports prepared by Harza Overseas Engineering Co. - January, 1983

## LOAD FORECAST OF EEA GENERATION EXPANSION PLAN

(BASED ON COMMERCIAL IN-SERVICE DATES)

(APRIL 1987)

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | FUTURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GAS TURBINE UNITS | | | | | | | | | | | | |
| DAMIETTA | | | | | 4-100(7) | | | | | | | |
| STEAM TURBINE UNITS | | | | | | | | | | | | |
| CAIRO WEST | | | | | | 1-300(3) | | | | | | |
| ABU SULTAN | 1-150(1) | | | | | | | | | | | |
| KAFR EL DAWAR | 1-110(1) | | | | | | | | | | | |
| ATTAKA | | 1-300(1) | | | | 1-300(1) | | | | | | |
| SHOUBRAH EL KHEIMA | | | 1-315(1) | | | | | | | | | |
| TALKHA CC ADDITION | | | | 2-55(1) | | | | | | | | |
| ASSIUT | | | | | | 1-300(1) | | | | | | |
| SUEZ | | | | | 1-100(1) | | | | | | | |
| DAMMANHOUR | | | | | | 1-300(3) | | | | | | |
| EL-KUREIMAT | | | | | | | | 1-600(3) | | 1-600(3) | | 1-600(3) |
| AYOUN MOUSSA | | | | | | | | 2-300(3) | | | | |
| SIDI KRIER | | | | | | | | | 2-300(2) | | | |
| ZAFARANA | | | | | | | | | 1-600(3) | | | |
| DAMIETTA CC ADDITION | | | | | | 2-100(3+7) | | | | | | |
| MAHMOUDIA CC ADDITION | | | | | | | 2-55(9) | | | | | |
| EL TEBBIN | | | | | | | 1-200(3) | | | | | |
| TALKHA | | | | | | | 1-200(3) | | | | | |
| HYDRO TURBINE UNITS | | | | | | | | | | | | |
| ASWAN | 1-67(1) | | | | | | | | | | | |
| | 327 | 300 | 315 | 110 | 500 | 1400 | 510 | 1200 | 1200 | 600 | - | 1500 |

1. UNDER CONSTRUCTION
2. FEASIBILITY STUDY PHASE
3. FINANCING PHASE
4. BID EVALUATION PHASE
5. PLANNING PHASE
7. SPECIFICATION PREPARATION
9. POTENTIAL ADDITION

UNITED STATES AGENCY for INTERNATIONAL DEVELOPMENT

CAIRO, EGYPT

MEMORANDUM

TO : Distribution

FROM : Vivikka Molldrem

THROUGH : George Laudato

SUBJECT : ELECTRICITY PROGRAM EVALUATION

This is to record the decisions made regarding the direction of this evaluation at a meeting in Mr. Kimball's office on Tuesday, May 13. Present were Frank Kimball, Art Handly, George Laudato, Ray Van Raalte, Fred Zobrist, Paul Crowe, Charles Richter, and myself.

Component I (question 1 - 9) of the proposed scope of work was questioned for several reasons. One, it appears that the GOE will finance its future electric power needs through supplier credits rather than traditional project assistance. Therefore, lessons learned on project implementation may not have great relevance for future programming. Second, Tom Pearson's memo to the Director of May 11, 1986 stated that the answers to all of these questions are already available in existing documentation. Third, Ray Van Raalte cited ongoing IBRD studies on EEA's financial and economic viability, questions we had intended to answer in the evaluation. Fourth, we are skeptical of what insights a group of outside consultants can leave in a short time period on this complex topic.

Nonetheless, we agreed that an evaluation which answered all or most of the questions identified in the scope of work of Component I would be useful. It would serve as our institutional memory of our assistance in the sector. It would place in one document the major implementation issues in the sector and how we have dealt with them. And it would provide an assessment of our project successes and impacts in the sector.

Therefore, we agreed to go ahead with a modified Component I evaluation, drawing primarily upon the in-house staff resources of DR/ID, because of their knowledge of the programs, but also requesting AID/W TDY support from Dean Moody, if he is available.

e agreed to go ahead with Component II, the sectoral economic
ssues, as planned, since this analysis will feed directly into
he CDSS and policy dialogue. We will not expand the scope of
his analysis, as AID/W suggested, because we feel this would
omplicate the assessment beyond our ability to do well or in a
imely fashion.

istribution:

D/IS, R. Van Raalte
D/DR, F. Zobrist
R/ID, T. Pearson
R/ID, T. Hammann
PE/PE, S. Conly
PE/PAAD, C. Richter

earance DD, A. Handly
D, F. Kimball

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ISN 50761

# USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

## PART II

## THE ENERGY PROBLEM

Charles Richter
Staff Working Paper
November 12, 1986

The energy sector in Egypt is, indeed, plagued by serious problems. The crux of these problems relates to one common element - prices. They are far too low. They are so low that they deprive the nation of valuable foreign exchange while at the same time they force the public sector to forego badly needed revenues. Pervasive low energy prices consistently give the wrong signals to industrial and commercial establishments, encouraging them to adopt inefficient production processes while in some extreme cases even providing plants with incentives to produce the wrong goods and services. Similarly, households in Egypt perceive energy as being almost free and utilize it accordingly, often putting it to wasteful uses.

Not only are energy prices generally too low in Egypt, but the practice of price differentiation for similar products creates artificial preferences in favor of privileged users, further distorting the patterns of energy utilization. Electrical energy, for instance, is generally sold much cheaper to public sector firms than to private enterprises, thereby giving an undue advantage to the former. Fuel oil too is offered at extremely low prices, benefitting certain firms, usually of the public sector, while private enterprises generally pay more. Natural gas is rationed with public sector enterprises having greater access to this scarce energy product. Unlike other fuels, gasoline is offered at prices comparable to its value on world markets; however, even this resource is probably underpriced because the public sector foregoes a potentially valuable source of revenue by not taxing gasoline.

This document has as its purpose, the identification of the nature of the energy problem in terms as clear as possible. It starts by estimating the economic prices of several energy products, followed by comparisons between these prices and those at which energy products are offered on domestic markets. This difference is approximately equal to an implicit subsidy. The document proceeds to describe the serious consequences of maintaining energy prices at artificially low levels. It then shifts to examine what Egypt is doing to alleviate the energy problem and suggests reforms to effectively eliminate the energy price distortions by the end of the 1991/1992 Egyptian

fiscal year. Finally the document projects the demand for electricity and explores the direct budgetary impact of higher electricity tariffs.

## The Economic Prices of Energy Products

The utilization of economic prices seeks to express the values of goods and services in terms of one common unit of measurement, usually foreign exchange. Wherever possible, this unit of measurement requires that the prices of goods and services reflect their respective values at the borders through which they are traded. Thus the value of an exported good is the price it commands at the point of export. This is normally its value on international markets less any transport and insurance costs borne by the exporter. Similarly, the value of an imported good is the total cost the importer pays for it at the port of entry, including any costs borne by the importer in getting it there. That is, the value of an import reflects the price of the good or service offered in the producing country plus any additional costs, such as transport or insurance, paid by the importer.

In the case of exportable products, no special problem is encountered in determining their economic or "border" prices. Being an oil exporter, crude petroleum as well as refined products are worth what Egypt receives for them at the point of export. For instance in the case of fuel oil, if it is assumed that a similar quality to that sold on international markets is produced in Egypt and it is also assumed that shipping costs are negligible (for simplicity, these assumptions are made throughout this paper), the economic price of fuel oil, sometimes referred to as "mazout" is approximately $US 70 per ton. This compares to domestic prices ranging from LE 7.5 to 32 per ton. If it is furthermore assumed that the free market exchange rate of about LE 1.90 per US dollar reflects the economic value of the pound 1/, the

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1/ Throughout this document, it is assumed that the economic value of the Egyptian pound is reflected by the exchange rate $US 1 = LE 1.90.

price equivalent of domestically sold fuel oil in dollars is about US $4 to $17 per ton, representing somewhere between 5% and 24% of its economic value. By subsidizing this and other products sold domestically, Egypt is foregoing foreign exchange revenues that could otherwise be obtained through increased exports. Other important petroleum products whose market prices are relatively easy to compare with their economic prices are listed in Table 1.

Shifting to natural gas, it is seen that some difficulties are initially encountered in determining its economic price. This is because Egypt does not export this product, nor is it expected to do so in the near future. However, natural gas serves as a close substitute for petroleum products, especially for fuel oil in the generation of electrical energy. Thus the value of gas can be estimated on the basis of its potential to replace fuel oil in the generation of electrical energy. Since, according to the Egyptian Electricity Authority (EEA), the energy equivalent of a ton of natural gas is approximately the same as 1.31 times that of a ton of fuel oil, this factor serves to implicitly determine the economic value of natural gas in Egypt. As a result, the economic value of a ton of natural gas is 1.31 times the net export value of a ton of fuel oil.

Like natural gas, electrical energy does not trade across Egyptian borders. However, the determination of the economic value of electricity is complicated not only by it being a non-tradable, but also by the lack of a convenient formula permitting its expression in terms of the energy equivalent of another product as was derived for the case of natural gas. Despite these obstacles, there is a generally accepted methodology, based on the principle of long run marginal costs (LRMC), which is widely used in determining the economic value of electrical energy. The World Bank, in particular, makes widespread use of this concept in conducting economic analyses of electrical energy projects.

The LRMC principle assumes that electricity, like other goods and services, will continue to be demanded by users as long as the marginal benefits accruing from its consumption equal or exceed the corresponding

marginal costs. Thus, in a free market equilibrium with tariffs set at LRMC levels, the marginal benefit of electricity consumption should be equal to its LRMC, thereby permitting the determination of its economic value, as perceived by users, to be approximately equal to its marginal cost. 1/ Unlike the usual

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1/ This conclusion has important implications for project analysis. It suggests that with LRMC pricing the benefits to be derived from an investment in electrical energy would be approximately equal to the LRMC of providing the service. Nevertheless, the subsidization of electrical energy in Egypt clearly impedes the utilization of this approach. For this reason, USAID/Cairo does not use the LRMC of electricity as a proxy for measuring the marginal benefit of the service. Instead, it uses the expected nominal prices of electrical energy as a basis for determining the benefits to be derived from electrical energy projects. Assuming that the price charged is close to the LRMC and that users would continue to demand electricity as long as the marginal benefit exceeds or is equal to the cost, the benefits would normally be equal to the economic value or LRMC of this service. However, this is clearly not the case in Egypt since the market price of electricity is kept far below the LRMC and there is no firm evidence that the GOE intends to reduce the distortion between the nominal and the economic prices of electricity. Again basic neoclassical economic principles tell us that, regardless of whether the price of energy is high or low, users will continue to demand it as long as the marginal benefits are not less than the marginal cost or price (here reference is made to the marginal cost as perceived by users as opposed to the marginal cost associated with the economic costs of providing the service). In Egypt, users have come to expect highly subsidized electricity and they make their plans accordingly. Thus they will continue to use this service as long as the benefits perceived are worth more than the nominal price of electrical energy. Since this price is very low and most users have probably come to expect the continuation of highly subsidized electricity prices, they continue to consume it as long as the benefits are greater than the low subsidized price. This implies that, in the absence of a program to correct the distortion in electricity rates, the evaluation of electricity projects should base estimates of benefits on the expected nominal price of electricity relative to the prices of other goods and services. Given that the economic costs of electrical energy projects are generally much higher than their benefits with the latter based on nominal electricity tariffs, as long as the GOE continues to underprice electrical energy, it would be exceedingly difficult to justify investments in electrical energy projects, especially those which entail the expansion of highly subsidized energy sales.

definition of marginal costs, which only considers variable costs, the LRMC principle dictates that economic value is determined by all the costs of providing a good or service, including those incurred for system expansions. The requirement of taking into consideration all the costs of providing electricity is a direct consequence of the long term planning horizon usually accompanying investments in electrical energy.

Since most of the inputs necessary for providing electrical energy either enter into international trade or are already valued at their equivalent trade values, the costs of providing electrical energy assume an important role in determining the economic value of the service. The major inputs which have readily determinable international values are petroleum products, capital costs for imported equipment, imported spare parts and imported raw materials, such as the coal proposed for future additions to generating capacity. Likewise, since the value of natural gas is determined in terms of the equivalent amount of petroleum products it could replace, its economic value is also easy to determine. Other costs, which are relatively minor such as labor and domestically produced capital and spare parts, are not so easy to measure in economic terms. Fortunately, because of their relatively minor importance, the errors involved are minimal in estimating them quickly through accounting ratios derived by the World Bank several years ago.

Since the principle of LRMC pricing of electricity bases its economic value on the costs of providing the service, tariffs should be sufficient to cover all costs, including the capital costs of expanding the system's generating capacity. The application of LRMC pricing requires an estimate of the cost per unit of electricity needed for meeting future demands. Instead of utilizing hypothetical "world market" energy prices as a basis for determining tariffs, the LRMC concept is especially appealing because it permits energy rates to be based on the cost characteristics specific to a given country. The IBRD espouses this basis for electricity pricing and it appears to be appropriate for USAID recommendations as well.

If a nation utilizing LRMC pricing feels that the demand for new electricity is sufficient to warrant an expansion in generating capacity, it should search for the most inexpensive form of generating the new energy. This search must, of course, be properly inserted in the long term planning horizon for electricity investments. Assuming that a proposed investment is deemed to be of the appropriate size, it is necessary to estimate the fully distributed cost of providing a unit of electricity and then set rates which reflect this cost. Whenever new projects are needed for additional system expansions, these additions would probably require more expensive investments per unit of electricity generated and consequently would justify even higher tariffs. This is because it is reasonable to assume that the cheapest generating projects would probably (but not always) be chosen first (considering projects which are capable of providing sufficient electricity to meet future needs). As a system requires increasingly greater expansions, more costly investment projects would have to be undertaken, thereby increasing the LRMC of providing the additions. In turn, these additions should be accompanied by higher tariffs.

Some preliminary work has been performed to provide an estimate of the LRMC of electrical energy in Egypt. It must be clearly emphasized that the work is, at best, tentative as it only considers the fully distributed costs of two proposed power projects, the Talkha Combined Cycle Project and the Kureimat Plant. It excludes many other potential investments designed to increase the supply of electrical energy such as the Damietta Combined Cycle Plant, for which the GOE is currently seeking donor support, and the nuclear power plant.

Of the two projects used as bases for the LRMC estimate, the Talkha Combined Cycle Plant is a no more than a special case. Although this project represents one of the least expensive additions to generating capacity, the increment would only amount to 110 MW, representing less than a two percent addition. The plant is especially economical because the generators would utilize hot air currently being discharged from the plant without incurring

additional fuel costs. Moreover, the construction time for the new unit is relatively short, about two years. A more expensive investment which is considerably larger than the Talkha Combined Cycle Project and much more representative of the costs of major system expansions in electrical generating capacity is the Kureimat Thermal Power Plant. It would be powered by imported coal and, at 1200 MW, would provide more than ten times the capacity expansion of the Talkha Combined Cycle Addition. This power plant would require a construction time of about five years.

Assuming a shadow exchange rate of $1.00 = LE 1.90 and a discount rate of 10%, the LRMC associated only with the combined cycle addition to the Talkha Plant is 1.76 cents per KWH which is the equivalent of 3.36 piastres per KWH. 1/ In addition, if one assumes a border coal price of $40 per metric ton and an internal transport cost of coal at LE 2 per metric ton, the LRMC associated with the Kureimat Plant is 4.39 cents or 8.36 piastres per KWH.

The above figures represent approximations to the LRMC of generating electrical energy over the next few years. However, to fully recuperate costs, the price charged for electricity must make allowances for all costs, including those incurred in the transmission and distribution stages. Transmission losses make up an important part of these costs. Currently more than 20% of electricity generated is lost and no significant improvement is foreseen over the next few years. In order to cover these losses, the prices charged for electricity must be increased by approximately 25% over the LRMC associated with the generation of electricity, thus representing 20% of the price charged. This means that the LRMC needed to cover transmission losses would increase to 4.2 piastres for the Talkha Combined Cycle Addition and to 10.4 piastres for the Kureimat Plant. In addition electricity prices should

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1/ This figure is somewhat misleading if one utilizes an interpretation of the LRMC principle requiring that the value of the energy derived from the combined cycle addition be based not only on the additional costs of the combined cycle itself, but also on the fully distributed cost of the entire Talkha plant already in existence.

scarce investment funds to alternative projects making much better use of its limited resources. Moreover, it would decrease current electricity consumption by approximately 17%, thereby offering a valuable fuel saving.

In the World Bank document discussing the closure of the Nag Hamadi smelter and the modification of Kima's energy inputs, two possible negative consequences were noted: the effect of these measures on employment in Upper Egypt and the possible need for additional transmission facilities to the North. As already noted, the savings from these measures would be great enough to permit a generous compensation of workers adversely affected. The savings are also likely to be great enough to justify the improvement of transmission lines to the North.

It is important to mention that the Nag Hamadi and Kima plants were singled out for attention because they are two of the most important consumers of electricity. It is likely that other plants also utilize electrical power inefficiently. Unfortunately, time constraints and difficulties in obtaining reliable data impede a more in depth analysis of the other cases of inefficiencies and waste.

Perhaps the greatest burden of the Egypt's energy subsidies is that related to the cost of foregone opportunities, that is, the opportunity cost. While there is no clear methodology available for a precise measurement of this cost, it is possible to make very tentative approximations in the direction of measuring a minimum value of this cost. Assuming that the elimination of Egypt's policy of subsidizing domestic energy prices would lead to an internal energy consumption averaging that of other nations with similar per capita incomes, this would imply the decrease of domestic energy consumption by the equivalent of 163 kg. of petroleum per capita. 1/ Since the population of Egypt is about 50 million, the total energy saving would be about 8.2 billion kg. (or 8.2 million metric tones) of petroleum. At a

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1/ This estimation is based on the energy consumption figures from the previously cited World Bank, World Development Report, 1986.

current international petroleum price of close to $100 per ton, the opportunity cost of not exporting the petroleum (or its equivalent) currently used to support an inflated domestic demand could be estimated at $820 million dollars. This is the equivalent to approximately LE 1.6 billion.

If the GOE instituted a far reaching program of economic reforms which priced energy products close to their economic values, this would undoubtedly have an enormous budgetary impact. Not only would there be an expanded inflow of foreign exchange resulting from increased energy sales abroad, but there would be two other major favorable implications on the budget: (1) the government would receive additional revenues from the domestic energy sales and (2) the decrease in the quantity demanded of energy products on the local market would reduce the need for heavy capital expenditures required to expand the nation's generating capacity. While there is no easy way of separating out these effects, in the absence of better information it can be presumed that the composite effect may be close to the amount of the energy subsidy, currently estimated at approximately LE 4.7 billion.

## The GOE Response to the Problem

Despite the advantages inherent in setting energy prices at least as high as their economic values, the GOE does not appear anxious to reduce the large energy subsidies currently in effect. To the contrary, these prices have declined greatly in relative terms over the past ten years. By referring to Table 4, it is seen that the nominal price of electrical energy was about 50% higher in 1984/85 than in 1974. Nevertheless, over this same time period, the wholesale price index tripled, implying that the price of electricity declined by 50% relative to the prices of other goods and services.

Table 4 seems to indicate that the average tariff decreased from 1975 to 1977. While nominal tariffs did not go down in this period, the apparent reduction in the average tariff may be due to sharp increases in consumption by the Nag Hamadi aluminum smelter, the most heavily subsidized enterprise.

TABLE 4

AVERAGE ELECTRICITY PRICES, 1974 TO 1984/1985

| Year | Sales in millions of KWH | Value in millions of pounds | Average tariff in milliemes/KWH | Wholesale price index (1974=100) | Price index of electricity (1974=100) |
|---|---|---|---|---|---|
| 1974 | 6895 | 50.2 | 7.27 | 100.0 | 100.0 |
| 1975 | 8308 | 74.3 | 8.94 | 100.0 | 123.0 |
| 1976 | 9662 | 83.3 | 8.62 | 110.3 | 118.6 |
| 1977 | 11489 | 92.0 | 8.00 | 121.7 | 110.0 |
| 1978 | 12722 | 110.3 | 8.67 | 131.6 | 119.3 |
| 1979 | 14546 | 107.3 | 7.38 | 154.1 | 101.5 |
| 1980 | 16114 | 120.4 | 7.47 | 177.1 | 102.8 |
| 1981/82 | 19036 | 145.0 | 7.62 | 205.1 | 104.8 |
| 1982/83 | 21546 | 179.7 | 8.34 | 249.6 | 114.7 |
| 1983/84 | 24630 | 240.2 | 9.75 | 273.0 | 134.1 |
| 1984/85 | 26175 | 287.6 | 10.99 | 297.2 | 151.0 |

SOURCE: Average tariff estimations are based on data from the Egyptian Electricity Authority (EEA) and the World Bank.

NOTE: In this Table, the average tariff is estimated by dividing the "value" of electricity as defined by EEA by the number of kilowatts sold. There is a discrepancy between the tariffs calculated by this method and previous tariff estimations. The differences may be due to electricity sales to distribution companies at lower tariffs than charged to final users, unpaid bills not recorded as "value" by EEA or late payment of bills.

Between 1974 and the 1981/1982 Egyptian fiscal year, it can be seen that the wholesale price index more than doubled while the average electricity tariff remai.. virtually unchanged (the price index of electricity is 104.8 in 1981/1982 using 1974 as a base). Over the last three years included in the table (1981/1982 through 1984/1985), electricity price increases were slightly greater than the recorded increment in the wholesale price index. No acceptable explanation can be found for the apparent temporary increment in the average tariff in 1978. It was not due to a tariff increase.

While information is not complete for the 1985/1986 year, an average increment of about 37% in nominal electricity tariffs announced in July 1985 indicates that the relative price of electricity probably increased in relation to the wholesale price index, with the latter being likely to show an increment in the 15 to 20% range for the year ending in to July 1986. However, it is disappointing to note that no increment in electricity prices has been announced for July 1986 despite an expected nominal increment of approximately 26%. Without a sharp increase soon, the impact of the tariff increase of July 1985 will be quickly eroded by inflation.

Over the past year there have been few important increments in the prices charged for other energy products. In 1986, an announcement was made that fuel oil prices would be increased from 7.5 to 32 pounds per ton for four industries: cement, lime, bricks and gypsum. However, this increment exempts EEA, the nation's most important user of fuel oil. Even though an increment of this size appears important in percentage terms (it is a 427% increase), the base price is so low compared to the international fuel oil price of about US $70 per ton, that the large percentage increase still leaves the domestic price far below the international price of fuel oil. At LE 32 per ton, the international price remains more than four times the domestic price, implying only a slight reduction in the enormous opportunity cost of subsidizing local consumption.

In July 1986 gasoline prices were raised from 20 to 25 piastres per liter for regular and from 25 to 30 pt. for premium gasoline. At these prices

there is no important subsidy. However by charging much less for gasoline than many other nations, Egypt is foregoing an important source of revenue while at the same time missing an opportunity to reduce traffic on congested city streets.

Measures for Correcting the Problem

The solution to the problem of underpricing energy products is relatively straightforward. It, of course, entails raising prices. The only major difficulties concern the details of an implementation plan.

USAID and other international donors, in particular the World Bank, have on many occasions encouraged the GOE to adopt a program designed to sharply reduce the energy subsidy 1/. At the current time, it seems appropriate to design and implement a program having as its objective the elimination of almost all energy subsidies within the time period spanned by the forthcoming five year plan, that is by July 1992. A five year program is considered adequate to respond to the urgent need to increase rates rapidly, while showing prudence in mitigating the most adverse effects of price increases which will undoubtedly affect certain users now accustomed to receiving heavy energy subsidies. The proposed program would provide much needed revenue to the public sector, not only through the direct effects of increased rates, but also by increasing the amount of petroleum available for export as the

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1/ USAID concerns about low energy prices were apparent ten years ago when a covenant was placed in the 1976 project agreement for the Ismailia Steam Power Plant (263-0009) specifying that within three years (from 1976) tariffs should be set at a level high enough to produce an annual rate of return of 9% on average fixed assets in operation. It might be added that there were no tariff increases over the cited three year period. Again, in 1979, another power plant project agreement (for the Shoubrah El Kheima Thermal Power Plant, 263-0030) called for a minimum 5% rate of return in 1980 (a year of only minor tariff adjustments) and a 9% rate of return in 1983 and thereafter. The GOE also agreed to hold periodic consultations with USAID concerning power rates.

quantity of energy products demanded domestically contracts in response to higher prices. Tariffs based on the cost of providing energy products would provide clear signals to users, thereby eliminating the incentives currently inducing inefficiency and waste. To the extent that price increases curtail the rapidly growing demand for cheap energy, they will benefit the nation by decreasing (but not eliminating) the need for costly investments in physical infrastructure. To reduce the large distortions stifling productivity in the Egyptian economy, the program to reduce subsidies should carefully focus on the rapid elimination of the largest subsidies. At the same time, provisions should be considered for cushioning the adverse impacts on some users. Particular reference is made to the effects on low income households. Employment effects must also be considered as certain industrial users are forced to curtail production as they are confronted with paying the real costs of inputs, including energy inputs. In certain circumstances, special temporary assistance may be provided to industrial establishments needing support in converting to energy efficient production processes.

Keeping in mind the previously specified objectives, the following proposal outlines a series of measures which could greatly improve Egypt's utilization and conservation of its energy resources:

<u>Measures relating to electrical energy prices</u>:

- Accept a long run marginal cost (LRMC) framework for determining electricity tariffs based on the cost of providing the service, including the capital costs of system expansions as well as on the variable costs of producing electricity. As the LRMC of electricity changes (and it undoubtedly will due to exchange rate fluctuations and price changes of petroleum products on international markets), there should be appropriate changes in the program of electricity price increments such that the objective of equating nominal tariffs with their LRMC levels is attained in five years. The program outlined in this document is based on the current values of the Egyptian pound and petroleum products on international markets. To get electricity pricing

on the correct path, it recommends very sharp immediate increments in prices, followed by additional increases over a five year period.

- Raise all tariffs by 40% immediately (approximately the inflation rate of last year plus 20%). Residential users consuming less than 100 KWH monthly could be subject to rate increases limited to the inflation rate (about 20%).
- Establish a floor rate of 4 piastres (40 milliemes) per KWH immediately for all users, again with the exception of users consuming 100 KWH or less in a month. The concept of a floor rate is proposed to narrow the margin between the most highly favored public sector entities and certain private sector users paying rates almost ten times as high.
- Establish a ceiling rate at, or perhaps slightly over (perhaps by 5 to 10%) the LRMC determined tariff (currently estimated at 10.4 pt. per KWH) at which no user will be charged unless all are so charged, again with the possible exception of low income households. As in the case of the floor rate, the ceiling is proposed with the objective of narrowing the discrimination currently practiced against private sector users of electricity. By adhering to maximum rates, the private sector users currently paying the highest tariffs will be protected from the impacts of flat percentage increments which, in the absence of ceiling tariffs, would fall harder on those currently paying the highest rates.
- From July 1987 to July 1992, raise electricity tariffs by 18% per year in real terms, that is the rate increases will be equal to 18% plus the level of inflation. 1/ For purposes of measuring inflation, the wholesale price index is probably the most appropriate measurement. Again, it must be emphasized that the proposed tariff increments are based on prices observed in September 1986. Any further increase in

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1/ While a real percentage rate in the order of magnitude of 18% may sound high, it must be remembered that the base for measurements is so low as to make even moderate increments appear large in percentage terms.

these prices is likely to require even sharper annual price increments to achieve the goal of equating nominal and economic prices of electricity in five years.

- If the GOE considers that the poor are truly benefitted by subsidizing the consumption of the first 100 KWH of electricity, this consumption could continue to be subsidized however it should still be subject to a yearly price adjustment of not less than the rate of inflation. Perhaps the most appropriate rate of inflation for this tariff increment would be based on the change in the consumer price index. This would maintain the real price of electricity paid by low income users. However, in order to avoid billing problems, it is probably necessary to charge a lower rate for the first 100 KWH consumed for all residential users with much higher marginal rates applying to consumption over that threshold. The subsidy granted to the first 100 KWH consumed by households would probably affect no more than 20% of electricity sales, however accurate information on the numbers of household users by quantity consumed is not available.

Measures relating to petroleum and gas prices:

- Increase the price of fuel oil to LE 50 per ton immediately for all users. In order to reach the September 1986 level of international prices, the real domestic price (that is, the price after correcting for inflation) should be raised by 18% in six annual increments from July 1987 through July 1992. Any important change in the international price of fuel oil should be reflected in the increments needed to bring the domestic price up to comparable world levels.
- Raise the prices of gas oil and diesel to LE 80 per ton immediately, followed by six annual real price increments of 18% each. These would start in July 1987 in order to equate the domestic prices with those determined in international markets by July 1992.
- Raise the kerosine price to LE 85 per ton immediately and then by six 18% annual increments in the real price starting in July 1987.

- Similar increments should be planned in the prices of other petroleum products to fulfill the objective of reaching international prices in the specified five year period.
- Raise the price of natural gas immediately to LE 65 per ton, followed by six annual real price increments of 18% each from July 1987 through July 1992.

In the short run, it is likely that the above program of price increases would cause hardships to the most inefficient users of energy products, especially to certain public sector firms. While no special provisions should be made to cushion the rate increases to private sector firms, most of whom are already paying relatively high rates, some public sector enterprises may require limited budgetary support while their operations are reorganized to reflect the economic cost of their energy inputs. Even though an effective economic reform program requires that all price changes be fully passed through to consumers, perhaps some temporary (strictly temporary) budget support could be made available to certain commercial users threatened by bankruptcy due to increased costs. To be eligible for budgetary support, an enterprise must present a well-defined adjustment plan which, in turn, must be determined economically and financially viable. Any such support should have clearly defined cut-off dates and should not be provided to enterprises failing to provide plans for quickly overcoming short term difficulties due to energy price increases.

Major Implications of Energy Price Increases

Some of the important impacts of energy price increments have already been mentioned or at least implied in this document. A major reform bringing energy prices in line with their economic values will lead to more efficient patterns of energy use, improved factor productivity, increased exports, better allocation of investment funds and increased public sector revenues.

This section will focus on the implications of increased electricity prices on future sales of electrical energy, thus providing a basis for measuring the system capacity needed to sustain the projected demand. Projections are made for future electrical energy requirements with and without a program of price reforms. By combining the demand projections with the schedule of electricity tariffs recommended as a basis for the reform program, estimates are then derived of the direct budgetary impacts of the proposed electricity price increments. This is done over the five year adjustment period during which nominal energy prices are brought up to their economic levels.

The projection of the future demand for electrical energy utilizes, as a starting point, some of the basic characteristics of a model set up by the World Bank to simulate the impact of price increments on future requirements for electrical generation capacity. 1/ The assumptions used for the elasticities of electrical energy demand, both with respect to GDP and prices are the same ones used by the Bank. Thus it is assumed that the elasticity of demand for electrical energy of the industrial sector with respect to GDP is 1.48; that is, with other factors being constant (in particular, prices) a one percent increase in industrial GDP would lead to about a 1.48 percent increment in the utilization of electricity by this sector. Similarly the demand elasticity of electrical energy with respect to GDP of agriculture is estimated at 0.89. For the rest of the economy, including for consumption, it is estimated at 1.35. These figures suggest that the elasticity of demand for electrical energy with respect to income tends to be positive; as incomes go up, and other factors remain unchanged, the demand for electricity tends to increase more than proportionally to the increment in income. Only the agricultural sector appears to have a slightly inelastic demand.

It is much more difficult to draw accurate conclusions concerning the price elasticity of demand for electrical energy in Egypt. These prices have

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1/ World Bank, "Egypt Investment Review, Power Subsector Issues," op. cit., pages 4-11.

been highly subsidized for a long time without enough variation to permit an adequate econometric estimation of their elasticities. In order to even approximate this elasticity, it is necessary to look at the response of demand changes with respect to price changes for electrical energy in other nations. On this subject, there is considerable information. In general, the elasticity tends to be quite inelastic, that is in the -0.10 to -0.30 range with some studies suggesting that it may be more inelastic over longer periods of time. For purposes of the present study, a price elasticity of -0.10 is assumed. This is a conservation estimate which may tend to overestimate the future demand for electricity if, as appears to be the case for Egypt, there will soon be major increments in prices. If the elasticity is much more elastic than that used, then the contraction in demand as a response to major price increases may be much greater than the estimates in this paper would indicate.

It should also be noted that no studies were found which document the demand response to price increments of even close to the order of magnitude projected for Egypt. This adds an even greater degree of uncertainty to the estimates used in this paper.

As a starting point, Table 5 presents the most recent electricity sales data available of EEA to certain industrial and commercial users as well as to distribution companies who, in turn, sell electricity to both residential and non-residential users. It should be noted that over three-quarters of EEA's sales, measured either in kilowatts or in revenues, are to distribution companies. Little information is available concerning the corresponding sales of these companies to final users. Table 5 shows that overall sales of EEA to both end users and distribution companies reached 26,175 million kilowatt hours in 1984/85 for a total of LE 287.6 million. This implies an average tariff of 10.99 milliemes per KWH. These figures provide the basis for the construction of scenarios representing the effects of maintaining the status quo or implementing serious economic reforms designed to bring nominal electricity prices up to their economic value by the end of the next five year

TABLE 5

ENERGY SALES IN 1984/1985
(in millions of KWH)

| | Quantity | Value 1/ | Average Tariff 2/ |
|---|---|---|---|
| Kima Fertilizer | 1369.64 | 8702.69 | 6.35 |
| Nag Hamadi Aluminum | 3044.46 | 17075.77 | 5.61 |
| Sonmed Co. | 207.07 | 1449.86 | 7.00 |
| Assuit Cement | 2.50 | 49.33 | 19.73 |
| Subtotal - Very High Voltage | 4623.67 | 27277.64 | 5.90 |
| Katamia Cement Co. | 0.33 | 10.08 | 30.55 |
| Alex. Ship Building (Arsenal) | 10.86 | 99.02 | 9.12 |
| Egypt Chemical | 130.69 | 1169.43 | 8.94 |
| El-Nasr Oil | 139.00 | 995.64 | 7.16 |
| Abou Dir Fertilizer | 5.25 | 46.98 | 8.93 |
| Talkha Fertilizer | 353.13 | 3157.92 | 8.94 |
| Mahala Textiles | 54.99 | 813.67 | 14.80 |
| Alex.-Oil | 112.02 | 817.05 | 7.31 |
| Alex. Cement | 66.37 | 1726.30 | 26.01 |
| El Amiria Textiles | 84.26 | 1528.25 | 18.14 |
| Egypt-Iran (Miratex) | 58.67 | 795.68 | 13.56 |
| Irrigation and Drainage | 582.05 | 4977.15 | 8.55 |
| Land Rec'amation | 15.33 | 131.13 | 8.55 |
| Batra Broadcast (Government) | 29.44 | 263.89 | 8.96 |
| Subtotal - High Voltage | 1642.43 | 16533.09 | 10.07 |
| Suez Cement | 69.75 | 3878.72 | 55.90 |
| El Sokhna Pipe Co. | 0.04 | 1.14 | 28.50 |
| Irrigation and Drainage | 38.31 | 685.96 | 17.91 |
| Salhia Projects | 47.63 | 652.08 | 13.69 |
| Subtotal - Medium Voltage | 155.73 | 5237.90 | 33.63 |
| Distribution Companies | 19753.21 | 238552.29 | 12.08 |
| TOTAL | 26175.04 | 287600.92 | 10.99 |

SOURCE: EEA and Estimations

1/ In thousands of Egyptian pounds
2/ In millimes per KWH

plan.

The tariff scenarios for electrical energy with and without reforms are found in Table 6. Its first column reproduces the tariffs observed for the 1984/85 year (originally presented in Table 5). The second column estimates the tariffs charged in 1985/86, all of which were increased by 37% with respect to the previous year. While EEA statistics indicate that major users of very high voltage and high voltage electricity had to pay a tariff increment of 37% in that year and that the average overall rate increase was also 37%, it appears that EEA did not distribute the burden of the increment evenly among all the medium voltage users. Neither did the distribution companies allocate the increase evenly among all their customers. In general, the largest electricity consumers (both residential and non-residential) had to bear larger percentage rate increases.

In the absence of a reform program, it is assumed that the rates of 1985/86 persist in the future over the period covered by the simulation realized in this exercise. It should, however, be emphasized that these rates are in real terms, that is nominally corrected for any inflation which may occur.

Under a reform program similar to that presented in this paper, the projected electricity tariffs over the 1986/87 to 1992/93 period are as projected in the last seven columns of Table 6. Again, these tariffs are in real terms, implying that all nominal tariffs are adjusted for the effects of inflation. The table assumes that relative prices remain unchanged; in the event this assumption does not hold, the simulations should be modified accordingly. It can be seen that the economic reform scenario adjusts all the tariffs in the table to the estimated LRMC for electrical energy by July 1992, the end of the forthcoming five year plan.

Once the assumptions are set for the prevailing prices with and without economic reforms, the next step involves simulating the effects of the two sets of prices on the demand for electrical energy. This is accomplished in Tables 7 and 8. Both assume that GDP will grow by 4% in 1986/87 followed by

TABLE 6

AVERAGE ELECTRICITY TARIFFS, 1984/1985 THROUGH 1992/1993
(In millieses per KWH) 1/

| | Observed 1984/85 | Estimated 1985/86 | Projected 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | 1991/92 | 1992/93 |
|---|---|---|---|---|---|---|---|---|---|
| Kima Fertilizer | 6.35 | 8.70 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Nag Hamadi Aluminum | 5.61 | 7.68 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Soned Co. | 7.00 | 9.59 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Assuit Cement | 19.73 | 27.03 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Subtotal - Very High Voltage | 5.90 | 6.08 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Katania Cement Co. | 30.55 | 41.85 | 58.57 | 69.13 | 81.58 | 96.26 | 104.00 | 104.00 | 104.00 |
| Alex. Ship Building (Arsenal) | 9.12 | 12.49 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Egypt Chemical | 8.94 | 12.25 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| El-Nasr Oil | 7.16 | 9.81 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Abou Qir Fertilizer | 8.93 | 12.23 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Talkha Fertilizer | 8.74 | 12.25 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Mahala Textiles | 14.80 | 20.27 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Alex. Oil | 7.31 | 10.02 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Alex. Cement | 26.01 | 35.63 | 49.67 | 58.87 | 69.46 | 81.97 | 96.72 | 104.00 | 104.00 |
| El Amiria Textiles | 18.14 | 24.85 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Egypt-Iran (Miratex) | 13.56 | 18.58 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Irrigation and Drainage | 8.55 | 11.71 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Land Reclamation | 8.55 | 11.72 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Ratra Broadcast (Government) | 8.96 | 12.28 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Subtotal - High Voltage | 10.07 | 13.79 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Suez Cement | 55.90 | 76.58 | 104.00 | 104.00 | 104.00 | 104.00 | 104.00 | 104.00 | 104.00 |
| El Sokhna Pipe Co. | 28.50 | 39.05 | 54.46 | 64.50 | 76.11 | 89.81 | 104.00 | 104.00 | 104.00 |
| Irrigation and Drainage | 17.91 | 24.53 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Salhia Projects | 13.69 | 18.76 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| Subtotal - Medium Voltage | 33.63 | 46.08 | 64.51 | 76.12 | 89.83 | 104.00 | 104.00 | 104.00 | 104.00 |
| Distribution Companies 2/ | 12.08 | 16.54 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |
| TOTAL | 10.99 | 15.05 | 40.00 | 47.20 | 55.70 | 65.72 | 77.55 | 91.51 | 104.00 |

SOURCE: Observations for 1984/85 are from EEA.
All other figures are estimated or projected.

ASSUMPTIONS:

A minimum tariff of 40 millieses per KWH is introduced in 1986. It does not apply to the first 100 KWH consumed by households.
The tariff for household consumption of 0-100 KWH per month only increases by the rate of inflation.
From July 1987 to July 1992, tariffs are raised by 18% annually.
A maximum tariff is established at 104 millieses per KWH (assumed to be the LRMC of electrical energy).

1/ Tariffs for 1984/85 and 1985/86 are in current millieses. Others are in constant millieses of 1986.
2/ The tariffs for sales to distribution companies are average tariffs per KWH for electricity sold by EEA. The distribution companies sell this electricity at different rates

TABLE 7

REFERENCE CASE: ELECTRICITY SOLD, 1984/1985 THROUGH 1992/1993 WITH NO ECONOMIC REFORMS
(In millions of KWH)

| | Observed 1984/85 | Estimated 1985/86 | Projected 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | 1991/92 | 1992/93 |
|---|---|---|---|---|---|---|---|---|---|
| Kima Fertilizer | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 |
| Nag Hamadi Aluminum | 3044.46 | 3044.46 | 3044.46 | 3044.46 | 3044.46 | 3044.46 | 3044.46 | 3044.46 | 3044.46 |
| Somed Co. | 207.07 | 224.51 | 237.92 | 248.56 | 263.42 | 283.14 | 304.34 | 327.13 | 351.63 |
| Assuit Cement | 2.50 | 2.71 | 2.87 | 3.00 | 3.18 | 3.42 | 3.67 | 3.95 | 4.25 |
| Subtotal - Very High Voltage | 4623.67 | 4641.32 | 4654.90 | 4665.66 | 4680.70 | 4700.66 | 4722.12 | 4745.18 | 4769.97 |
| Katania Cement Co. | 0.33 | 0.36 | 0.38 | 0.40 | 0.42 | 0.45 | 0.49 | 0.52 | 0.56 |
| Alex. Ship Building (Arsenal) | 10.86 | 11.77 | 12.48 | 13.04 | 13.82 | 14.85 | 15.96 | 17.16 | 18.44 |
| Egypt Chemical | 130.68 | 141.68 | 150.15 | 156.87 | 166.24 | 178.69 | 192.07 | 206.45 | 221.91 |
| El-Nasr Oil | 139.00 | 150.70 | 159.71 | 166.85 | 176.82 | 190.06 | 204.30 | 219.59 | 236.04 |
| Abou Qir Fertilizer | 5.25 | 5.69 | 6.03 | 6.30 | 6.68 | 7.18 | 7.72 | 8.29 | 8.92 |
| Talkha Fertilizer | 353.19 | 382.92 | 405.80 | 423.95 | 449.29 | 482.93 | 519.09 | 557.96 | 599.74 |
| Mahala Textiles | 54.99 | 59.62 | 63.18 | 66.01 | 69.95 | 75.19 | 80.82 | 86.87 | 93.38 |
| Alex. Oil | 112.02 | 121.45 | 128.71 | 134.47 | 142.50 | 153.17 | 164.64 | 176.97 | 190.22 |
| Alex. Cement | 66.37 | 71.96 | 76.26 | 79.67 | 84.43 | 90.75 | 97.55 | 104.85 | 112.70 |
| El Amiria Textiles | 84.26 | 91.35 | 96.81 | 101.14 | 107.19 | 115.21 | 123.84 | 133.12 | 143.08 |
| Egypt-Iran (Miratex) | 59.67 | 63.61 | 67.41 | 70.43 | 74.64 | 80.22 | 86.23 | 92.69 | 99.63 |
| Irrigation and Drainage | 582.05 | 631.06 | 653.48 | 670.89 | 694.73 | 723.56 | 757.76 | 791.39 | 826.51 |
| Land Reclamation | 15.33 | 16.62 | 17.21 | 17.67 | 18.30 | 19.11 | 19.96 | 20.84 | 21.77 |
| Batra Broadcast (Government) | 29.44 | 31.92 | 33.83 | 35.34 | 37.45 | 40.26 | 43.27 | 46.51 | 49.99 |
| Subtotal - High Voltage | 1642.43 | 1780.72 | 1871.44 | 1943.02 | 2042.45 | 2173.64 | 2313.69 | 2463.22 | 2622.89 |
| Suez Cement | 69.75 | 75.62 | 80.14 | 83.73 | 88.73 | 95.37 | 102.52 | 110.19 | 118.44 |
| El Sokhna Pipe Co. | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 |
| Irrigation and Drainage | 38.31 | 41.54 | 43.01 | 44.16 | 45.73 | 47.76 | 49.87 | 52.09 | 54.40 |
| Salhia Projects | 47.63 | 51.64 | 53.47 | 54.90 | 56.85 | 59.37 | 62.01 | 64.76 | 67.63 |
| Subtotal - Medium Voltage | 155.73 | 168.84 | 176.67 | 182.83 | 191.36 | 202.56 | 214.46 | 227.10 | 240.55 |
| Distribution Companies | 19753.21 | 21416.41 | 22580.93 | 23500.22 | 24778.04 | 26465.04 | 28266.90 | 30191.43 | 32246.99 |
| TOTAL | 26175.04 | 28007.29 | 29283.94 | 30291.74 | 31692.55 | 33541.90 | 35517.16 | 37626.94 | 39860.41 |
| Percentage change | | 7.00% | 4.56% | 3.44% | 4.62% | 5.84% | 5.89% | 5.94% | 5.99% |

SOURCE: Observations for 1984/85 are from EEA.
All other figures are estimated or projected.

ASSUMPTIONS:

The Nag Hamadi aluminum smelter and the Kima fertilizer plant are assumed to maintain constant consumption at the level observed in 1984/85.
GDP is assumed to grow by 4% in 1986/87, 3% in 1987/88, 4% in 1988/89 and 5% annually beginning in 1989/90.
The income elasticity of demand is assumed to be 1.48 with respect to GDP for industrial users, 0.89 for agriculture and 1.33 for the rest of the economy.
In 1985/86 total demand was observed to have increased bt 7.0%. The distribution of this demand is estimated in the table.

TABLE 8

ECONOMIC REFORM SCENARIO: ELECTRICITY SOLD, 1984/1985 THROUGH 1992/1993
THE PRICE ELASTICITY OF DEMAND IS ASSUMED TO BE -.10
(In millions of KWH)

| | Observed 1984/85 | Estimated 1985/86 | 1986/87 | 1987/88 | 1988/89 | Projected 1989/90 | 1990/91 | 1991/92 | 1992/93 |
|---|---|---|---|---|---|---|---|---|---|
| Kima Fertilizer | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 1369.64 | 136.96 | 136.96 | 136.96 |
| Nag Hamadi Aluminum | 3044.46 | 3044.46 | 3044.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sonad Co. | 207.07 | 224.51 | 206.26 | 211.95 | 220.93 | 233.58 | 246.94 | 261.08 | 277.06 |
| Assuit Cement | 2.50 | 2.71 | 2.76 | 2.84 | 2.96 | 3.13 | 3.31 | 3.50 | 3.71 |
| Subtotal - Very High Voltage | 4623.67 | 4641.32 | 4623.13 | 1584.43 | 1593.53 | 1606.34 | 387.21 | 401.54 | 417.73 |
| Katania Cement Co. | 0.33 | 0.36 | 0.37 | 0.38 | 0.39 | 0.42 | 0.44 | 0.48 | 0.51 |
| Alex. Ship Building (Arsenal) | 10.86 | 11.77 | 11.11 | 11.41 | 11.90 | 12.58 | 13.30 | 14.06 | 14.92 |
| Egypt Chemical | 130.68 | 141.68 | 133.59 | 137.07 | 142.88 | 151.06 | 159.70 | 168.84 | 179.18 |
| El-Nasr Oil | 139.00 | 150.70 | 138.77 | 142.40 | 148.64 | 157.15 | 166.14 | 175.65 | 186.41 |
| Abou Qir Fertilizer | 5.25 | 5.69 | 5.36 | 5.51 | 5.74 | 6.07 | 6.42 | 6.78 | 7.20 |
| Talkha Fertilizer | 353.18 | 382.92 | 360.51 | 370.45 | 386.15 | 408.25 | 431.62 | 456.32 | 484.25 |
| Mahala Textiles | 54.99 | 59.62 | 59.03 | 60.66 | 63.23 | 66.85 | 70.67 | 74.72 | 79.29 |
| Alex. Oil | 112.02 | 121.45 | 112.07 | 115.16 | 120.04 | 126.91 | 134.17 | 141.85 | 150.53 |
| Alex. Cement | 66.37 | 71.96 | 73.74 | 75.77 | 78.98 | 83.50 | 88.28 | 94.20 | 101.26 |
| El Amiria Textiles | 84.26 | 91.35 | 92.31 | 94.86 | 98.88 | 104.54 | 110.52 | 116.85 | 124.00 |
| Egypt-Iran (Miratex) | 58.67 | 63.61 | 62.44 | 64.16 | 66.88 | 70.70 | 74.75 | 79.03 | 83.87 |
| Irrigation and Drainage | 582.65 | 631.06 | 577.96 | 583.63 | 594.44 | 610.63 | 627.26 | 644.34 | 664.38 |
| Land Reclamation | 15.33 | 16.62 | 15.22 | 15.37 | 15.66 | 16.08 | 16.52 | 16.97 | 17.50 |
| Batra Broadcast (Government) | 29.44 | 31.92 | 30.06 | 30.69 | 32.20 | 34.04 | 35.99 | 38.05 | 40.38 |
| Subtotal - High Voltage | 1642.43 | 1780.72 | 1672.34 | 1707.90 | 1765.98 | 1848.76 | 1935.77 | 2028.14 | 2133.67 |
| Suez Cement | 69.73 | 75.62 | 77.73 | 81.20 | 86.06 | 92.50 | 99.43 | 106.87 | 114.97 |
| El Sokhna Pipe Co. | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 |
| Irrigation and Drainage | 38.31 | 41.54 | 40.96 | 41.36 | 42.13 | 43.27 | 44.45 | 45.66 | 47.08 |
| Salhia Projects | 47.63 | 51.64 | 49.57 | 50.06 | 50.99 | 52.38 | 53.80 | 55.27 | 56.99 |
| Subtotal - Medium Voltage | 155.73 | 168.84 | 168.30 | 172.67 | 179.22 | 188.20 | 197.73 | 207.86 | 219.01 |
| Distribution Companies | 19753.21 | 21416.41 | 20672.95 | 21161.40 | 21945.79 | 23055.19 | 24220.66 | 25445.05 | 26831.97 |
| TOTAL | 26175.04 | 28007.29 | 27136.73 | 24626.40 | 25484.52 | 26698.48 | 26741.38 | 28082.59 | 29602.38 |
| Percentage change | | 7.00% | -3.11% | -9.25% | 3.48% | 4.76% | 0.16% | 5.02% | 5.41% |

SOURCE: Observations for 1984/85 are from EEA.
All other figures are estimated or projected.

ASSUMPTIONS:

The Nag Hamadi aluminum smelter is closed in July 1987.
The Kima fertilizer plant is converted to gas in July 1990. Before then, it maintains consumption at its 1984/85 level. Afterwards, its consumption decreases by 90%.
GDP is assumed to grow by 4% in 1986/87, 3% in 1987/88, 4% in 1988/89 and 5% annually beginning in 1989/90.
The income elasticity of demand is assumed to be 1.48 with respect to GDP.
Subsidies granted to households in the 0-100 KWH per month range are assumed to be completely offset by higher rates to upper income users.
In 1985/86 total demand increased by 7.0%.

3% in 1987/88, 4% in 1988/89 and 5% afterwards. Although it might have been more appropriate to assume lower growth rates for both scenarios (especially for the one which does not allow for economic reforms), in order to avoid underestimating the demand for electricity in future years, it is probably best to err on the side of rapid growth than slow growth.

There are two major factors which influence the future demand for electrical energy: (1) the general growth of the economy and (2) the price charged for electricity. In order to simplify the simulations of the demand for electrical energy, it is assumed that all sectors of the economy will experience the same growth rates over the period spanned by the analysis and the economy is divided into three major sectors - industry, agriculture and all the rest. Keeping in mind the demand elasticities for each of these sectors with respect to GDP as estimated by the World Bank (1.48, 0.89 and 1.35 respectively) and assuming that these same elasticities are close to those which will prevail over the next seven years, it is a relatively simple procedure to project the demand for electricity in the reference case, that is in the case without economic reforms.

Since the reference case assumes no real price changes for electricity, there is no need to complicate this case with a consideration of the possible effects of a variation in tariffs. Instead the application of the following formula is sufficient to project the demand for electricity by entity i:

$$\left(\frac{Q_i + \Delta Q_i}{Q}\right) = \left(\frac{Y_i + \Delta Y_i}{Y}\right)^e$$

where $Q_i$ = the quantity demanded of electricity by entity i,
$Y_i$ = the contribution to GDP of entity i,
e = the elasticity of demand of entity i with respect to GDP.

This formula is used to project the demand for electricity for all the entities included in the analysis, with the exception of the Nag Hamadi aluminum smelter and the Kima fertilizer plant. Since it is also assumed that

power shortages will not permit the further expansions of energy consumption by these firms, they are limited to the levels of consumption observed in the year 1984/85. The application of the elasticity formula and the special assumptions regarding Nag Hamadi and Kima permit the simulation of the demand for electrical energy in the reference case presented in Table 7.

This table projects the demand up to 1992/93 in a manner showing lower annual increments than were observed in the past. While the average annual increment in demand exceeded 12% over the 1975 to 1985/85 period, the simulation reduces the yearly increase in electricity demand to just over 5% from 1985/86 to 1992/93. This is for two reasons: first, GDP increases are projected to slow down from 8% to about 4.5% over the two respective periods 1/ and, second, restrictions on the ability to further expand system capacity are assumed to place limits on additional consumption by the two largest industrial users.

Even with the slower growth in demand projected in this scenario, EEA still faces increasing pressure on its capacity since it would still require a system expansion sufficient to meet the 42% increment in demand projected over the seven years. Unless there is an increased donor increase in financing new capacity (something quite unlikely in the absence of basic economic reforms), EEA may encounter serious difficulties in both financing system expansions while being pressured to increase outlays to maintain obsolete equipment.

While the maximum demand was 5279 MW in 1985 with a load factor of about 0.68, the continuation of the same load factor 2/ would increase the maximum

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1/ Given the magnitude of the problems facing the Egyptian economy, it is not unreasonable to assume a slowing down of economic growth. However, this decline in growth could well be much sharper than that projected by this paper. The primary reason for not utilizing lower growth projections is a result of an intent to avoid committing an error which might result in a serious underestimation of the future demand for electrical energy.

2/ This same load factor has prevailed from 1982 to 1985.

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demand to 7517 MW in 1992/93, an increment of 2238 MW or almost the size of four large 600 MW power stations (the size of the new proposed plant in Damietta is 600 MW). A decrease in the load factor to 0.65, perhaps possible with more peaking of consumer demand in the early evening, could result in a peak demand of 7364 MW, an increment of almost 2600 MW over the 1985 maximum. Any of these results could place a severe strain of EEA's generating capacity as well as on the GOE's investment budget. Perhaps the demand could not be met, but even if it could, the enormous resources needed to meet this demand for subsidized electricity could probably be better spent on projects capable of contributing much more to the nation's growth and development.

Shifting to the scenario with the energy pricing reforms presented in this paper, it is easy to imagine that price increments of the magnitude contemplated in the proposed reform program would restrict any expansion in demand to uses justified by a rather substantial additional outlay on electricity. The effects of these increased tariffs (those appearing in Table 6) on future demands for electrical energy are projected in Table 8. At the outset, it should be noted that this table embodies several specific assumptions:

- The price elasticity of demand for electricity is assumed to be -0.10, implying that an increase of the price of electricity by 10% will result in a decline in the demand for this service by about 1%. While it is frequently argued that the price elasticity of demand for electricity over longer time periods is considerably more elastic, perhaps in the range of -.30 to unitary (-1.0), a more inelastic demand was chosen to avoid projections of large decreases in the quantity demanded of electricity in response to substantial price decreases.
- A tariff increment of over 400% for the Nag Hamadi aluminum smelter is assumed to result in its closure at the start of the 1987/88 year. It has already been seen that this plant constitutes an enormous drain on the productivity of the Egyptian economy. Even by charging the plant for only 40% of the value of the electricity it consumes (the percentage

implied by the 400% tariff increment), the inefficient nature of the plant would become more apparent and possibly provide grounds for overcoming the political obstacles to closure.

- The increased electricity tariffs paid by the Kima Fertilizer plant are assumed to result in its conversion to natural gas at the beginning of the 1990/91 year. When this occurs, its electricity consumption is assumed to decline by 90%.
- By restricting tariff increments to the inflation rate for the first 100 KWH of monthly consumption by residential users, the distribution companies might be subject to economic and financial losses. It is assumed that these potential losses are fully offset by higher tariffs to non-residential customers and by a graduated rate structure for household consumption. The end result of this differentiated rate structure is that the distribution companies are assumed to charge an average rate which fully covers the LRMC of providing the service.

Even with a highly inelastic demand, Table 8 clearly shows that the implementation of the proposed tariff reforms may have a very important impact on electricity use. In 1992/93, the reform scenario projects the future demand for electricity at 29,602 million KWH, more than 25% less than the 39,880 million KWH simulated in the reference case. The reform scenario only projects a total demand increment of 5.7% over the seven years spanned by the analysis, the equivalent of an average annual increment in demand of slightly less than one percent. It is readily seen that the reform scenario projects a decrease in the demand for 1986/87, the year of the introduction of the minimum rate of 4.0 piastres per KWH 1/. An even larger decrease in demand

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1/ For computational convenience, the reform scenario assumes that tariff increments are introduced on July 1, 1986, a date which has already passed. If reforms similar to those proposed were to be introduced later in the year, there would still be an impact on the quantity of electricity demanded, but it would be somewhat less than that projected in Table 8.

(-9.25%) is simulated for 1987/88 when the Nag Hamadi aluminum smelter is closed. After that year, the major adjustments to the reform program will have been made and the demand for electricity again shows positive increments, in the range of 3.48% to 5.41% annually, with the exception 1990/91, the year when the Kima Fertilizer plant is converted to gas. Even though the tariffs continue to demonstrate sharp annual increments in the latter part of the five year adjustment period, the positive effect of the income elasticity (that is, the elasticity with respect to GDP) of demand more than offsets the negative effect of the price elasticity. This would not be the case, however, if another simulation were run with a price elasticity of demand at about -.30, an elasticity which seems closer to the empirical evidence obtained from other economies.

Upon looking more closely at the implications for system capacity of the reform scenario, it is seen that at a load factor near that which has prevailed in recent years (about 0.68), a demand of 29,602 million KWH in 1992/93 would require a peak load capacity of about 5580 MW, an increment of 301 MW over the maximum demand observed in 1985. This demand increment could be more than met with a power plant of the size contemplated for Damietta. However, it must be mentioned than once the period of economic reforms is complete, the continuation of a 5% annual growth rate in GDP without further real price increases could well require substantial capacity additions. Thus beginning in 1993/94, the annual increments in the demand for electric power could easily climb to 7.5%, implying the need for a capacity addition of at least 420 MW per year.

It must be emphasized that the above figures do not lead to the conclusion that a rather stagnant demand for electricity over the next five to six years should necessarily be accompanied by insignificant investments in the sector. To the contrary, the replacement of aged and deteriorating equipment may well be a high investment priority. Moreover, the time horizon for effective planning of energy investments is necessarily long, long enough to require projections much further out in time than those realized in this

paper. These projections must be accompanied by investments with sufficient lead time to permit their termination when they are needed.

It is interesting to note that the projected future demand for electricity grows much slower in the reform scenarios presented in this paper than in the previously cited simulations performed by the World Bank. Despite the fact that higher world oil prices resulted in an even larger disparity between the nominal and economic prices of energy products when the Bank study was conducted, this effect was more than offset by a much longer adjustment period for tariff reforms in the World Bank study. The proposed period was shortened after the completion of the cited study due to the serious deterioration experienced by the Egyptian economy in the following years. Furthermore the progress made on tariff reform since that time has been inconsistent and disappointing. At this time both the World Bank and USAID agree that tariff reform is much more urgent than it was three years ago.

Upon completing the tariff and demand simulations of Tables 6 through 8, it is a relatively simple step to project the revenue impacts of the two scenarios. These are found in Tables 9 and 10. Both show that estimated revenues for EEA in 1985/86 reached LE 424 million, up over 47% from the previous year; however the inflation-corrected increment in tariff revenues is only 30%. The rapid rise in nominal receipts is due to the 37% tariff increase of July 1985 and to an increase in the demand for electrical energy.

After the base year of 1985/86, a comparison of Tables 9 and 10 permits an estimation of the major revenue implications of electricity rate reforms. It is readily seen that real (inflation corrected) revenues increase by 46% from 1985/86 to 1992/93 without reforms (from LE 424 million to LE 621 million) while the implementation of the proposed pricing reforms would raise revenues by more than sevenfold (from LE 424 million to LE 3,079 million) over the same seven year period. The revenue increase of the scenario without reforms (averaging 5.5% per year) is due solely to the expansion of sales while the large revenue gains of the reform scenario (averaging almost 33% annually) are caused by sharply increased tariffs. It should be noted that

TABLE 9

REVENUES RAISED BY EEA WITHOUT ECONOMIC REFORMS, 1984/85 TO 1992/93
(In thousands of pounds) 1/

| | Observed 1984/85 | Estimated 1985/86 | Projected 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | 1991/92 | 1992/93 |
|---|---|---|---|---|---|---|---|---|---|
| Kima Fertilizer | 8703 | 11923 | 11923 | 11923 | 11923 | 11923 | 11923 | 11923 | 11923 |
| Nag Hamadi Aluminum | 17076 | 23394 | 23394 | 23394 | 23394 | 23394 | 23394 | 23394 | 23394 |
| Sonco Co. | 1450 | 2159 | 2282 | 2384 | 2527 | 2716 | 2919 | 3139 | 3373 |
| Assuit Cement | 49 | 73 | 78 | 81 | 86 | 92 | 99 | 107 | 115 |
| Subtotal - Very High Voltage | 27279 | 37543 | 37676 | 37782 | 37929 | 38125 | 38335 | 38561 | 38804 |
| Kalasia Cement Co. | 10 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 23 |
| Alex. Ship Building (Arsenal) | 99 | 147 | 156 | 163 | 173 | 185 | 199 | 214 | 230 |
| Egypt Chemical | 1169 | 1736 | 1839 | 1922 | 2036 | 2189 | 2353 | 2529 | 2718 |
| El-Nasr Oil | 956 | 1479 | 1567 | 1637 | 1733 | 1865 | 2005 | 2155 | 2316 |
| Abou Qir Fertilizer | 47 | 70 | 74 | 77 | 82 | 88 | 94 | 101 | 109 |
| Talkha Fertilizer | 3158 | 4691 | 4971 | 5193 | 5504 | 5916 | 6359 | 6835 | 7347 |
| Mahala Textiles | 814 | 1209 | 1281 | 1338 | 1418 | 1524 | 1638 | 1761 | 1893 |
| Alex. Oil | 819 | 1217 | 1289 | 1347 | 1427 | 1534 | 1649 | 1773 | 1905 |
| Alex. Cement | 1726 | 2564 | 2717 | 2839 | 3009 | 3234 | 3476 | 3736 | 4016 |
| El Nairia Textiles | 1528 | 2270 | 2406 | 2513 | 2663 | 2863 | 3077 | 3308 | 3555 |
| Egypt-Iran (Mirator) | 796 | 1182 | 1252 | 1309 | 1387 | 1491 | 1602 | 1722 | 1851 |
| Irrigation and Drainage | 4977 | 7393 | 7835 | 7860 | 8139 | 8500 | 8877 | 9271 | 9683 |
| Land Reclamation | 131 | 195 | 202 | 207 | 214 | 224 | 234 | 244 | 255 |
| Batra Broadcast (Government) | 264 | 392 | 415 | 434 | 460 | 494 | 531 | 571 | 614 |
| Subtotal - High Voltage | 16533 | 24557 | 25841 | 26855 | 28264 | 30126 | 32116 | 34243 | 36517 |
| Suez Cement | 3979 | 5791 | 6137 | 6412 | 6795 | 7303 | 7850 | 8438 | 9070 |
| El Sokhna Pipe Co. | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| Irrigation and Drainage | 626 | 1019 | 1055 | 1083 | 1122 | 1171 | 1223 | 1278 | 1334 |
| Salhia Projects | 652 | 967 | 1003 | 1030 | 1066 | 1114 | 1163 | 1215 | 1269 |
| Subtotal - Medium Voltage | 5239 | 7780 | 8197 | 8526 | 8985 | 9591 | 10239 | 10933 | 11676 |
| Distribution Companies | 238552 | 354334 | 373601 | 388811 | 409952 | 437864 | 467675 | 499517 | 533326 |
| TOTAL | 287601 | 424215 | 445315 | 461974 | 485131 | 515705 | 548366 | 583254 | 620523 |
| Percentage change | | 47.50% | 4.97% | 3.74% | 5.01% | 6.30% | 6.33% | 6.36% | 6.39% |

SOURCE: Observations for 1984/85 are from EEA.
All other figures are estimated using tables 6 (prices for 1984/85) and 7.

ASSUMPTIONS:
GDP is assumed to grow by 4% in 1986/87, 3% in 1987/88, 4% in 1988/89 and 5% annually beginning in 1989/90.
The income elasticity of demand is assumed to be 1.49 with respect to GDP.

1/ Revenues for 1984/85 and 1985/86 are in current pounds. Others are in constant 1986 pounds.



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TABLE 10

REVENUES RAISED BY EEA WITH ECONOMIC REFORMS, 1984/85 TO 1992/93
(In thousands of pounds) 1/

| | Observed 1984/85 | Estimated 1985/86 | Projected 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | 1991/92 | 1992/93 |
|---|---|---|---|---|---|---|---|---|---|
| Kima Fertilizer | 8703 | 11923 | 54786 | 64647 | 76283 | 90014 | 10622 | 12534 | 14244 |
| Nag Hamadi Aluminum | 17076 | 23394 | 121778 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sonad Co. | 1450 | 2154 | 6251 | 10434 | 12305 | 15351 | 19151 | 23891 | 25814 |
| Assuit Cement | 49 | 73 | 110 | 134 | 165 | 206 | 256 | 320 | 386 |
| Subtotal - Very High Voltage | 27278 | 37543 | 184925 | 74785 | 88753 | 105571 | 30029 | 36745 | 43444 |
| Katania Cement Co. | 10 | 15 | 21 | 26 | 32 | 40 | 46 | 50 | 53 |
| Alex. Ship Building (Arsenal) | 99 | 147 | 444 | 539 | 663 | 827 | 1031 | 1287 | 1552 |
| Egypt Chemical | 1168 | 1736 | 5336 | 6470 | 7958 | 9928 | 12385 | 15451 | 18635 |
| El-Nasr Oil | 996 | 1479 | 5551 | 6731 | 8279 | 10328 | 12885 | 16074 | 19386 |
| Abou Qir Fertilizer | 47 | 70 | 214 | 260 | 320 | 399 | 497 | 621 | 749 |
| Talkha Fertilizer | 3158 | 4691 | 14421 | 17485 | 21507 | 26831 | 33472 | 41758 | 50362 |
| Mahala Textiles | 814 | 1209 | 2361 | 2863 | 3522 | 4393 | 5481 | 6838 | 8247 |
| Alex. Oil | 819 | 1217 | 4483 | 5435 | 6686 | 8340 | 10405 | 12981 | 15655 |
| Alex. Cement | 1726 | 2564 | 3678 | 4460 | 5486 | 6844 | 8538 | 9797 | 10531 |
| El Amiria Textiles | 1528 | 2270 | 3693 | 4477 | 5507 | 6870 | 8571 | 10693 | 12896 |
| Egypt-Iran (Miralex) | 796 | 1182 | 2497 | 3028 | 3725 | 4647 | 5797 | 7232 | 8722 |
| Irrigation and Drainage | 4977 | 7393 | 23118 | 27547 | 33108 | 40131 | 48645 | 58964 | 69096 |
| Land Reclamation | 131 | 195 | 609 | 726 | 872 | 1057 | 1281 | 1553 | 1820 |
| Satra Broadcast (Government) | 264 | 392 | 1202 | 1458 | 1793 | 2237 | 2791 | 3482 | 4199 |
| Subtotal - High Voltage | 16533 | 24557 | 67629 | 81505 | 99456 | 122872 | 151625 | 186778 | 221902 |
| Suez Cement | 3899 | 5791 | 3084 | 3445 | 8950 | 9620 | 10340 | 11115 | 11947 |
| El Sokhna Pipe Co. | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 6 |
| Irrigation and Drainage | 686 | 1019 | 1638 | 1952 | 2346 | 2844 | 3447 | 4179 | 4697 |
| Salhia Projects | 652 | 969 | 1983 | 2363 | 2840 | 3442 | 4172 | 5058 | 5927 |
| Subtotal - Medium Voltage | 5238 | 7780 | 11707 | 12763 | 14139 | 15911 | 17966 | 20357 | 22777 |
| Distribution Companies | 236552 | 354334 | 626918 | 998818 | 1222293 | 1515216 | 1876339 | 2328484 | 2790525 |
| TOTAL | 287601 | 424215 | 1091160 | 1167872 | 1424641 | 1759570 | 2078159 | 2572364 | 3078648 |
| Percentage change | | 47.50% | 157.22% | 7.03% | 21.99% | 23.51% | 18.11% | 23.78% | 19.68% |

SOURCE: Observations for 1984/85 are from EEA.
All other figures are estimated using tables 6 and 8.

ASSUMPTIONS:
GDP is assumed to grow by 4% in 1986/87, 3% in 1987/88, 4% in 1988/89 and 5% annually beginning in 1989/90.
The income elasticity of demand is assumed to be 1.48 with respect to GDP.
The price elasticity of demand is -.10.

the revenues associated with the reform scenario are fully adjusted for the reduced consumption which necessarily accompanies higher prices.

The additional revenue in Table 10, amounting to more than LE 2.6 billion, is in itself almost one-third of the projected budget deficit of LE 8 billion for 1986/87. However, this revenue gain will be augmented by the additional receipts derived from price increases on other energy products. There will also be financial gains from expanded foreign exchange earnings as more petroleum is available for export. All of these factors are expected to alleviate the pressure on the public sector budget.

Upon a closer analysis of the revenues associated with the reform proposal, it can be noted that the introduction of the minimum electricity tariff in early 1986/87 is projected to increase revenues in that year by over LE 660 million. This is despite the impact of the rate increase on demand (which Table 8 projects will fall by just over 3%). With the closure of Nag Hamadi in early 1987/88, the revenue increment of increased electricity rates is only LE 107.

These additions to public sector revenues could be extremely valuable during the first years of a comprehensive reform program. They would serve not only to cover possible budgetary shortfalls, but along with the revenue implications of other energy price adjustments, they will provide a cushion to facilitate the structural adjustments required by a serious economic reform program. These additional revenues accompanying tariff increments could make an important contribution to a special fund designed to finance temporary investments needed by Egyptian industry to adjust to new economic conditions. Any such assistance should be strictly temporary in support of financially and economically sound projects. The fund could also channel resources into projects needed to safeguard the welfare of groups who might otherwise be adversely affected by the economic reform program.

EPROB:CR,PPP/E,11/5/86