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ELECTRIC POWER SECTOR STRATEGY

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USAID EGYPT: ELECTRIC POWER SECTOR STRATEGY

I. EXECUTIVE SUMMARY

Electricity has become the predominant form of energy for industry, commerce, agriculture and household utilities. It represents the simplest and most economic form of energy, has the least impact on the environment and is essential in all processes to preserve and protect the environment. Due to the strategic importance of electric energy in a nation's economy and to the well being of its citizens, a nation's electric utilities are second only to national defence in importance.

The Egyptian electric power system serves nearly 11 million customers concentrated in Cairo, Alexandria, the Delta, along the Suez Canal and along the River Nile. Per capita consumption of electric energy has nearly doubled in the past ten years encouraged by heavily subsidized electricity tariffs. The government of Egypt has invested nearly \$5 billion in foreign exchange, obtained from multi-lateral and bi-lateral financing agencies and LE 2 billion in local currency to develop the necessary facilities to reliably meet customer demands.

While the resulting generating facilities and transmission and distribution networks are currently adequate to meet today's customer demands, as the GOE proceeds with a program of major economic reforms designed to stabilize its economy, remove distortions and give impetus to the private sector as a central element in its growth strategy, substantial additional investments in facilities and networks will be required to meet the anticipated growth in demand. These investments will finance: committed generating facilities and associated transmission networks; expand and rehabilitate distribution networks; and upgrade and expand facilities to more effectively manage the operating power system.

The Ministry is alert to above normal losses on the transmission and distribution system and has plans to improve their performance. The distribution networks should receive a greater share of the financing for investments to assure reliability throughout the power system.

The development of middle management within the Ministry has not kept pace with the evolution of the utility system. Management training programs in the past were well received and are credited with the past successes of the Ministry. Unless there is greater attention to the development of today's middle management as managers, the Ministry could flounder.

Future USAID participation in the development of the Egyptian electric power sector will support the Mission's Program Goals of: enhanced human resource productivity and quality of life; and enhancement of Egypt's role as a model of stability, democracy, free markets and prosperity in the region. USAID will finance projects that will improve the efficiency and reliability of the power system, reduce energy losses, and provide the facilities that will

allow EEA to effectively and intelligently manage the network. An assessment of the Ministry of Electricity and Energy and the Egyptian Electricity Authority and studies to define strategies for loss reduction and energy efficiency improvements, along with the recently completed Electricity Pricing Strategy study, will establish the basis for the development of a time phased agenda of regulatory, policy and institutional reforms that would permit growth to meet increased demand while at the same time attaining a degree of financial independence. Implementation of the reforms would set the stage for the electric power sector to operate on a commercial basis and to be able to finance its expansion without relying constantly on grants or soft loans or infusion of funds from the Government of Egypt.

II. SECTOR OVERVIEW

Egypt is a large country covering 1 million square kilometers. Over 90 percent of the land is uninhabited desert. Essentially the entire population of 55 million occupies the rich agricultural lands of the Nile Valley, the Delta and communities along the Suez Canal. About one-third of the population lives in the cities of Cairo and Alexandria with the balance of the population living in the Delta, along the Suez Canal and along the River Nile from Aswan to Cairo. Egypt's industries, agriculture and centers of commerce are located in these populated areas and are dependent upon a reliable source of energy.

Energy, in all its various forms, has held a prominent position in the history of civilizations and is considered essential for achieving a country's social and economic development and the exploitation of a country's indigenous resources. As the population seeks a higher standard of living, labor intensive manufacturing and service industries are being replaced with energy intensive processes that convert nature's raw materials to goods and services that improve the quality of life.

Of the various forms of energy available to meet the needs of the population, electricity has become the predominant form of energy for industry, commerce, agriculture and household use. Electricity constitutes a fundamental element of a nation's progress. All sectors of a nation rely on electricity. Without electricity, industrial production would stop, agriculture would be crippled, and all vital utilities, i.e. water, sanitary drainage, communications, lighting and commerce, would cease to function, and basic human services, i.e. housing, health care and education, would come to a standstill.

Electricity is the simplest and most economic form of energy exploitable today, has the least impact on the environment, and is the foundation for all processes to improve and protect the environment. Hence, electricity constitutes the fundamental bases for industrial and agricultural development and production as well as for construction and public utilities and contributes to the achievement of elevating the standard of living. Due to the significance of this sector and its direct effect on production, the economy, public utilities and the well being of people, nations have afforded electric power a priority second only to defense. Studies worldwide have demonstrated a direct correlation between a nation's Gross National

Product and energy consumption. On a per capita base, electricity consumption has become an indicator of a nation's economic development and its social and economic growth.

The function of an electric power system is to provide a reliable and continuous source of electricity on demand. Unlike other manufacturing industries, electric energy must be produced the instant it is needed since it cannot be stored in reserve to meet future demands. Therefore, the reliability of the electric power system is dependent on the planned additions of generating capacity to meet the forecast demands of customers and the coordinated expansion of the transmission and distribution networks to provide the vehicle to deliver the energy to customers at an acceptable level of reliability. These facilities and networks have large capital requirements and large economic inertia, and they require long lead times to procure and construct to assure a reliable supply of electric energy.

The Egyptian electric power system has evolved from a number of isolated power systems that met the energy needs of customers located in close proximity to the source of generation. These isolated systems were eventually joined together (interconnected) on a regional basis and then nationally to form the existing power system. Facilities to supply Egypt's electric energy requirements consist of electrical generating facilities installed at strategic locations in the Nile Valley, the Delta and along the Suez Canal that are integrated by a complex network of transmission lines. Areas outside the reach of the power system are supplied from gas turbines and diesel driven generators with a total installed capacity of less than 300 MW. These facilities are state owned and are the responsibility of the Ministry of Electricity and Energy (MEE) and five operational and executive authorities. Legislation restricts the sale of energy to customers to that energy produced or supplied from the national utility system and therefore prohibits private generation.

The Egyptian Electricity Authority (EEA) is responsible for the planning of the bulk power supply that includes generation and transmission at high voltages. EEA sells energy to large industries supplied at high voltage and to nine Distribution Company's that distribute and sell energy at medium and low voltage to residential, commercial and small industrial customers. The Rural Electrification, Nuclear, Hydro Power Plant and Renewable Energy Authorities are responsible for the planning and construction of rural distribution lines, nuclear and hydro power generation facilities and renewable (solar and wind) energy developments respectively. All generating facilities regardless of their type are operated and maintained by EEA.

In 1977 when AID provided initial funding for the sector, the bulk power supply facilities were not sufficient to meet customer demands. Service curtailments occurred frequently and generating capacity was not sufficient to permit necessary scheduled maintenance. As a result of maintenance deferrals, generating unit failures occurred more frequently, further hindering scheduled maintenance. The bulk power supply system was managed by an obsolete computer that was not of sufficient capacity to monitor the network or perform the necessary computations which would form the basis of economic operation. The distribution facilities were deteriorated and subject to frequent failures. Organizationally, the Egyptian

Electricity Authority was overstaffed and undermanaged with all decision making centralized in the Chairman.

Fourteen years later, as a result of nearly \$5 billion equivalent in financial assistance by AID, the World Bank, and numerous multi-lateral and bi-lateral financing agencies and LE 2 billion provided by the Government of Egypt, the electricity sector has, for the time being, closed the gap between customer demand and available generating capacity, provided a reliable bulk power transmission network and initiated a long term program to rehabilitate the distribution system.

The moment to moment scheduling of generation to meet customer demands most efficiently and reliably is centrally controlled from the National Energy Control Center located in Cairo. The same center also monitors the bulk power transmission network to assure maximum reliability. The growth in the bulk power system has exceeded the center's capacity to manage the collected data and the center's capacity is being expanded. EEA has only limited information on the regional networks supplied from the bulk power system and is not able to effectively manage these networks. EEA is embarking on a program to construct and staff these regional centers that will collect, process and display system performance data essential for efficient and reliable operation. One center is in operation in Upper Egypt and USAID is financing a center in Alexandria.

Egypt's 157 generating units have a combined nameplate capacity of nearly 12,000 MW. The mix of capacity is: 51 percent steam turbine generation; 22 percent gas turbine generation; and 23 percent hydro generation. EEA is rehabilitating 350 MW of steam turbine capacity, originally financed by AID in the 1960's, through USAID financing, and plans to utilize financing from the World Bank and possibly USAID to rehabilitate 700 MW of gas turbine capacity and add 350 MW in steam cycle additions to produce combined-cycle plants. EEA is constructing 3300 MW of capacity to be in service between 1992 and 1997 and is planning an addition 2900 MW that could be in service prior to mid 2000. EEA plans to retire some 600 MW of aged generating capacity prior to 2000. This additional capacity should be sufficient to meet customer demands at least to 2001, and a sustained period of load growth of less 7 percent per year would defer the need to commit additional capacity.

The recent droughts in the Nile River catchment of East Africa, which had reduced the level of the High Dam lake, limited the output of the generating units at the High Dam hydroelectric power station. The risk of repeated prolonged droughts and of their effects on the generating capacity is a factor that must be considered in long term capacity planning.

The peak demand for electric energy, which occurs annually in December, was 7,214 MW in December 1991. The total energy generated to meet customer requirements in 1991 was 44.5 billion KWHr. Sales to customers totalled nearly 37 billion KWHr. Energy losses during transmission and distribution was nearly 7.5 billion KWHr or nearly 14 percent of

the energy sales. On a well designed, operated and maintained system, losses should not exceed 7 to 8 percent. The high level of losses are due to the uncorrected effects of induction motors on the distribution network, improperly sized conductors and transformers, deteriorated components and improper metering.

Both the peak demand and energy production in 1991 marked a sharp decline in growth rates from previous years and are attributed to the government's program of economic reforms in electricity pricing and a general downturn in the Egyptian economy resulting from the 1991 IMF and World Bank initiated economic reform program. A recently completed Energy Pricing Strategy Study, financed by USAID, is expected to provide the government with the pricing strategies to reach full economic pricing of electricity in mid 1995.

Since 1977, USAID and the Government of Egypt have jointly implemented a total of ten projects consisting of 22 subprojects in the electric power sector totalling nearly \$1.4 billion, of which ten subprojects were successfully completed and the other 12 subprojects are proceeding on schedule. These projects provided financing for: (1) consultant services and technical assistance covering specific aspects of power system planning, construction, operation and maintenance, and utility arrangement; (2) expansion and rehabilitation involving 4800 MW of generating facilities; (3) rehabilitation of transmission facilities; (4) rehabilitation and expansion of distribution systems; and (5) establishment of computer centers to monitor, supervise and direct the operation of the bulk power supply network and the network serving Alexandria.

USAID has also provided nearly \$190 million in Commodity funding for the electric power sector for equipment and spare parts for gas turbines, boilers, cables and work equipment. The total project and commodity funding for the sector is nearly \$1.6 billion.

The World Bank has provided four loans totaling \$841.6 million for technical assistance, regional electrification and major equipment or services packages for the construction of the Shoubrah El Kheima Thermal Power Station and the Aswan II Hydroelectric Power Station. The World Bank has approved a fifth loan of \$220 million for the El Kureimat Thermal Power Station and associated facilities.

The African Development Bank and the African Development Fund have provided nearly \$1.1 billion for 12 projects in the Power sector for rehabilitation and expansion of distribution systems and construction of power stations at Shoubrah El Kheima, Damietta, Cairo West and El Arish.

Other bilateral agencies have collectively provided more than \$1 billion equivalent for generating facilities, transmission expansion, control centers and distribution system rehabilitation and expansion.

The EEA has provided nearly LE 2 billion in local currency for the procurement of local construction labor and locally manufactured equipment and materials. Many items of

electric distribution equipment are either manufactured or assembled in Egypt. Companies owned by the Ministry of Electricity and Energy manufacture transformers, switchgear, low voltage capacitors and cables. Private sector companies manufacture cables and several joint ventures of Egyptian and foreign firms have recently begun to manufacture solar panels and connectors and repair large power transformers. Other firms, in cooperation with the MEE are considering assembly of equipment for power stations. The state-owned Electro Cable Company, attached to the Ministry of Industry, produces conductors and underground cables for medium and low voltage distribution.

III. SECTOR CONSTRAINTS

The Egyptian electric power sector currently faces a number of constraints which if uncorrected will increasingly impede the sector's overall efficiency. Broadly, these constraints involve: policies related to economic pricing of electric energy; institutional issues relating to the training of middle management staff; transmission and distribution networks; and technical issues involving imbalanced allocation of financing to generation, energy losses, capacity deratings, and lack of facilities to manage the regional systems. In many instances, technical constraints are exacerbated directly or indirectly by the policy and institutional constraints.

POLICY CONSTRAINTS

■ SUBSIDIES:

Government subsidies to the sector have kept electric energy prices far below economic prices and as a result customers had no incentive to control their consumption and industries utilized obsolete and inefficient processes. In recent years, the government has implemented a program of annual increases in the tariffs and reduction in the sector subsidy with the target of economic pricing by mid 1995. While economic pricing of electric energy is the initial objective, of equal concern is the economic pricing of energy for each class of consumer so no one class of consumer benefits at the expense of another class of consumer.

INSTITUTIONAL CONSTRAINTS

■ MANAGEMENT DEVELOPMENT:

The middle management ranks of the various authorities under the Ministry of Electricity and Energy are the source of future management within the sector. These middle level managers have had little or no exposure to effective management techniques or management functions in managing the utilities operations. An initial series of training programs was presented in the late 1970's to the then middle management, today's senior management. Subsequent training was not rigorously pursued until 1991 when USAID was requested to finance an Executive Management Training program for the present senior

management. An introductory program in management will meet the immediate needs but a more extensive assessment of the Ministries training goals, objectives and course content, considering the cultural environment to management change, must be performed. As a result, today's managers remain ill equipped to manage this major utility effectively.

TECHNICAL CONSTRAINTS

■ **UNBALANCED FINANCING OF SYSTEM FACILITIES:**

On a well planned power system, investment in generation facilities is generally equal to the combined investment in transmission and distribution facilities. EEA is responsible for generation and transmission planning and securing of financing for system expansion. The Egyptian Distribution Authority is responsible for distribution planning and securing of financing for distribution expansion. As a result, there is a tendency to treat generation/transmission and distribution as separate and competitive systems rather than balanced complementary systems of one integrated power system in which capital expenditures for generation are nearly equal to the combined capital expenditure for transmission and distribution. This bifurcated planning and financing has resulted in nearly 70 percent of the total sector financing allocated to generation and 30 percent for transmission and distribution. This unbalanced financing has encouraged over-investment in generation and under-investment in the combined transmission and distribution facilities.

■ **HIGH ENERGY LOSSES:**

Energy losses on the transmission and distribution system are 65% to 70% higher than should be reasonably accepted. The bulk of these losses are on the distribution system. The losses are caused by improperly sized equipment, lack of compensation for the effects of induction motors and the undesirable physical characteristics of the circuit, improper or deteriorated connections at terminal points and improper metering. EEA is installing equipment to compensate for the adverse effects of induction motors on the transmission system, and the Alexandria Distribution Company is adding compensation to the distribution system to likewise correct for the induction effects on the distribution circuits, thereby reducing energy losses. The Egyptian Distribution Authority is studying the sources and causes of high energy losses in all components of the distribution system and will be developing a nationwide program to reduce losses to reasonable levels.

■ **LACK OF NETWORK MANAGEMENT FACILITIES:**

The National Energy Control Center is responsible for the economic dispatching of generation and the reliable operation of the 500 KV transmission system. EEA has a Regional Control Center for the Upper Egypt Zone, and is proceeding with a Regional Control Center for the Alexandria network. There is no centralized control of the electrical networks serving the various other operating zones, which are themselves fair sized utilities. Effective management requires the collection and presentation of data on system

performance that alerts the center management to undesirable trends or abnormal conditions.

■ **HIGH LEVEL OF UNAVAILABLE GENERATING CAPACITY:**

EEA is normally only able to dependably produce 8,500 MW due to system or equipment constraints. Of the nearly 3,100 MW that is normally unavailable, nearly 600 MW is not obtainable due to atmospheric or hydro constraints. Scheduled preventive maintenance would require an average of 700 to 1000 MW to be out of service at any given time. The balance of unavailable capacity represents capacity in excess of 25 years of age, provided from eastern Europe, that is subject to frequent breakdown and when operated is at the high end of the spectrum of production costs. Capacity nearing the end of its useful life may not be an appropriate rehabilitation investment, but this judgment cannot be made until the root cause of the capacity unavailability is known. USAID's recent experience in rehabilitating generating capacity would indicate that there is considerable opportunity to recover substantial capacity with a relatively small investment. Since rehabilitation includes substantial replacement of worn or damaged parts, access to the manufacturers' drawings and specifications is critical.

IV. USAID STRATEGY

To achieve its goals of increased productivity and an improved standard of living for its citizens, the GOE has embarked on a major economic reform program designed to stabilize its economy, remove distortions, and give a newfound impetus to the private sector as a central element in its growth strategy. The availability of reliable sources of electric power is crucial to Egypt's development.

By removing the most serious constraints to growth, Egypt hopes to make the policy climate correct, one in which the playing field is levelled and where both the public and private sectors can fashion appropriate roles in furthering the development of the country. Together with making the policy environment favorable, the GOE has engaged its judicial machinery in a serious effort to dismantle a legal framework that has given concrete expression to and reinforced old policies.

To meet the electric power needs of both the public and private sectors that will depend on a reliable supply of electric energy, the Egyptian Electricity Authority has developed an investment plan, for the period 1993 - 1997, based on the priorities and objectives of the Ministry of Electricity and Energy. These priorities in turn reflect and support the development objectives of the Government of Egypt. The investment plan provides for adding generating capacity, developing renewable resources, rehabilitating and refurbishing capacity, reducing losses on both the transmission and distribution networks, expanding transmission and distribution networks to serve population growth and strengthen the networks, constructing regional control centers and developing the management staff within the Ministry. The plan addresses all the technical constraints discussed above.

The Ministry has requested USAID assistance for a number of these projects for 1992 and 1993 and will seek additional assistance in subsequent years. The specific projects would be identified well in advance of each year's funding authorization and would be linked to the government's progress in meeting previously agreed upon reforms. The reform agenda will be dynamic, based on the results and recommendations from the recently completed Electricity Pricing Strategy Study, a Policy Reform and Institutional Development Assessment and subsequent studies directed to loss reduction on the networks and efficiency improvements compatible with the operating system. Reform targets, linked to future funding, will be agreed upon by USAID and the MEE. Compliance with the targets, in the context of reform and schedule, will allow for the authorization of tranching funding.

USAID's electric power sector program fits within the Mission's overall program and seeks to contribute positively to the GOE initiative to achieve successful economic transition in Egypt. The goal of USAID's overall program is "enhancement of Egypt's role as a model of stability, democracy, free markets and prosperity in the region." The Mission's Program Subgoal II is "enhanced human resource productivity and quality of life" and Program Subgoal I is "increased economic growth." USAID's power sector program is organized under Strategic Objective No. 6 of this Program Subgoal, "increased access to, and efficiency and reliability of public utilities in urban target areas" and Strategic Objective No. 1 of this Program Subgoal, "increased macroeconomic stability and market pricing".

Program Outcomes and Activities

The Mission's electric power sector activities are structured to meet three Program Outcomes that contribute to efforts to increase access to an efficient and reliable electric power network in urban targeted areas and increased macro-economic stability and market pricing. These desired outcomes are presented below, along with a description of projects and activities -- both current and planned -- that fit within this framework.

- o Program Outcome No. 6.2: Improved performance of existing electric generation and distribution facilities.

USAID, under the \$391 million economic reform based Power Sector Support project, is financing the rehabilitation of the 350 MW Cairo West Thermal Power Station; the relocation and refurbishment of gas turbines at Hurghada; the installation of a 150 MW combined-cycle plant at Cairo South; consultant services and two turbine-generators for the 1200 MW El Kureimat Thermal Power Station; upgrading and expansion of the computer system and data collection network for the National Energy Control Center; a wide range of studies looking at the reduction in energy losses and future capacity options; and procurement of commodities essential for the continued reliable operation of the utility.

USAID will provide an additional \$40 million in 1992, in the Power Sector Support project, for further rehabilitation of the National Energy Control Center and the Cairo West Thermal Power Station. Initial funding will be provided for the Cairo Regional Control Center which will be a major step forward in managing the utility system serving Cairo. Additional funding will be provided for studies and commodities.

One of the studies to be financed will be the Policy Reform and Institutional Development Assessment, a comprehensive examination and assessment of the EEA and the MEE (as appropriate) to determine the political, legal and financial impediments that, if corrected, would enhance the performance of EEA and the MEE through greater efficiency, flexibility, overall system reliability, cost savings, and increased revenue generation. The assessment would recommend a structured, time-phased plan for, but not limited to, improvements in overall financial performance; changes in accounting systems; changes in policies/regulations; tariff structures, tariff collection; organization structures; operating procedures; profitability of various services.

Project financing will be in tranches that will be authorized annually following the GOE's compliance with previously agreed upon reforms. USAID funding will finance:

1. Loss Reduction:

USAID is financing Technical Assistance for an Egyptian Distribution Authority sponsored Loss Reduction Study of distribution facilities. This study is identifying the cause of the distribution system losses and will target Distribution Companies and those elements of the distribution system that are leading contributors to distribution losses. Since substantial distribution materials are manufactured in Egypt, USAID's role in loss reduction programs may be limited to consultant services and procurement of equipment or materials not manufactured in Egypt. USAID will review the study and determine the most effective form of assistance to accomplish our goal of substantial loss reduction.

USAID will also finance a study of transmission network losses to identify those improvements to the network that would result in a reduction of the energy lost during transmission. USAID would review the study and determine the most effective form of assistance to accomplish our goal of substantial loss reduction.

2. Energy Efficiency Improvements/Capacity Rehabilitation:

USAID will finance the rehabilitation of existing gas turbine generating facilities and addition of steam cycles to produce combined cycle plants that produce 50 percent more energy for no increase in fuel. The initial rehabilitation will include the relocation of eight gas turbines scattered around Egypt onto the El Nuberia site in the West Delta Zone of EEA, their refurbishment and addition of two steam cycles, one steam cycle per four gas turbines.

USAID will finance the construction of a Regional Control Center which will collect and display operating data for the Cairo Zone. The EEA Control Center staff will utilize the information to more effectively manage the operation of this complex network. Effective management will contribute to reduced losses, enhanced quality of service and insure utmost reliability for customers depending on continuous service.

3. Energy Efficiency Improvements/Loss Reduction:

USAID will finance two transmission substations, one in the Karmouz district of Alexandria and one in the Abu Rawash district of Cairo. These two substations are essential to relieve overburdened facilities in the surrounding areas that will be overloaded by the mid - 1990's. Overloaded facilities contribute to losses and jeopardize reliability of service to customers.

o Program Outcome No. 6.4 Enhanced GOE capacity for utility management.

USAID is financing an Executive Management Development Program for the senior management of the Ministry of Electricity which is addressing the perceived requirements of the Ministry. Equally important is the development of the middle management who will be the future manager of the Ministry and its Authorities. A more extensive assessment of the longer term management development goals, objectives and course content needs of the Ministry is warranted and will be financed from the present training funds . The design of longer term training should reflect the cultural environment in which managers must operate. To be most effective, the content of the management development program must be custom designed to meet the specific needs of the Ministry taking into account the cultural realities. USAID will review the design of the longer term training to determine the most effective role for USAID in the development of the Ministry.

o Program Outcome No. 1.2 Improved market pricing and cost recovery .

USAID has financed a comprehensive electricity pricing strategy study that provides the foundation and methodology for energy pricing in the future. The study addressed the economic reform objectives of the IMF and World Bank of annual increases in the average price of electric energy to reach long run marginal cost (economic pricing) by mid-1995. The study also provided a strategy to implement user class specific rates based on long run marginal costs and recommended that all EEA sales be based on time-of-day rates with required metering installed over a period of three years. Implementation of the studies recommendations will constitute a portion of the economic reforms.

The specific indicators and targets which are intended to measure progress towards outcomes will be contained in an auxiliary document.