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USAID/EGYPT: ELECTRICITY SECTOR ASSESSMENT

PART II

THE ENERGY PROBLEM

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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	1349.64	8702.69	6.35
Nag Hamadi Aluminum	3044.46	17075.77	5.61
Sumed 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
Kalania 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 Qir Fertilizer	5.25	46.88	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 Reclamation	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 millieme 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 milliemes 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	8.08	40.00	47.20	55.70	65.72	77.55	91.51	104.00
Katania Cement Co.	30.53	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	54.56	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 milliemes 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 milliemes per KWH (assumed to be the LRMC of electrical energy).

1/ Tariffs for 1984/85 and 1985/86 are in current milliemes. Others are in constant milliemes 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	353.18	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	670.69	694.73	725.56	757.76	791.39	826.51
Land Reclamation	15.53	16.62	17.21	17.67	18.30	19.11	19.96	20.84	21.77
Batra Broadcast (Government)	27.44	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	39880.41
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 1.35 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	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	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	148.44	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	582.05	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	69.75	75.62	77.73	81.20	86.06	92.50	99.43	106.87	114.87
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	27136.71	24626.40	25484.52	26658.48	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
Soned Co.	1450	2154	2282	2324	2527	2716	2919	3139	3373
Assuit Cement	49	73	78	81	86	92	99	107	115
Subtotal - Very High Voltage	27278	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	996	1479	1567	1637	1735	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 (Mirater)	796	1182	1252	1309	1387	1491	1602	1722	1851
Irrigation and Drainage	4977	7393	7833	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	28364	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	686	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	533526
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	14794
Nag Hamadi Aluminum	17076	23394	121778	0	0	0	0	0	0
Soned Co.	1456	2154	6251	10604	12305	15351	19151	23891	29814
Assuit Cement	49	73	110	134	165	206	256	320	386
Subtotal - Very High Voltage	27278	37543	184925	74785	88753	105571	30029	36745	43444
Kalania 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	2261	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 Nairia Textiles	1528	2270	3693	4477	5507	6870	8571	10693	12896
Egypt-Iran (Miratex)	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
Batra Broadcast (Government)	264	392	1202	1458	1793	2237	2791	3482	4199
Subtotal - High Voltage	16533	24557	67629	81565	99456	122872	151625	186778	221592
Suez Cement	3899	5791	8084	8445	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	4677
Salhia Projects	652	969	1583	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