ENERGY POLICY IN EGYPT

By

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Abstract

Energy issues are becoming increasingly central to the Egyptian economy, and the country's energy sector is regarded by many analysts and policy makers as holding one critical key to Egypt's future. However, sound management is required so that the country's scarce resources are optimally utilized. These concerns provided the basis for a collaborative research project on Egyptian energy issues undertaken jointly between Cairo University and MIT.

A comprehensive picture of energy in Egypt is necessary in order to determine the policies needed, their tradeoffs, and their implications for the use of petroleum and natural gas for generating electricity and for the overall energy «mix» of the country. This project focuses on the role of petroleum and natural gas in the Egyptian economy, looking at both the demand and supply sides. The policy issues involve production, end uses, and possibilities for substitution.

The Energy Policy Project of the Cairo University/MIT Technology Planning Program has developed a set of analytical models to provide a comprehensive view of policy issues and performance in the energy sector. The analytical models are of three types and can be characterized as follows :

1. Egyptian Petroleum Model (EPM) to examine oil production and the impacts of investment and extraction decisions;

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* Prepared by Cairo University — Massachusetts Institute of Technology, Technological Planning Program.

2. Egyptian Natural Gas Model (E-GAS) to identify the best uses of natural gas and the socially optimal prices for these uses;

3. Short-Run Energy Macro-Economic Model for Egypt (E-MACRO) to explore, identify, and understand the uses of energy within the different sectors of the economy, and the ways in which policies in one sector (such as raising gasoline prices in transportation) can affect other sectors (such as industry) and influence their overall output.

Scholars, policy makers, and the educated public in Egypt must be aware of the approaches to analysis that are useful in understanding how the country's energy system interacts with the rest of the economy and the types of contributions scholars can make to policy analysis. In addition, Egypt is one of the few developing countries where such analytical models exist and for which there are now sophisticated methods for analyzing energy issues.

ENERGY POLICY PROJECT IN EGYPT

Energy issues are becoming increasingly central to the Egyptian economy, and the country's energy sector is regarded by many analysts and policy makers as holding one critical key to Egypt's future. However, sound management is required so that the country's scarce resources are optimally utilized. These concerns provided the basis for a collaborative research project on Egyptian energy issues undertaken jointly between Cairo University and MIT. This report summarizes the nature of the project and the specific results to date. [1]

I. OBJECTIVE : ANALYSIS OF THE ROLE OF ENERGY IN THE EGYPTIAN ECONOMY

A comprehensive picture of energy in Egypt is necessary in order to determine the policies needed, their tradeoffs, and

(1) Nazli Choucri (MIT) and M. Zaki Shafei (Cairo University). «Resource Development and Policy in Egypt : Petroleum and Natural Gas : Summary and Conclusions». TAP Report 83 - 3. January 1983.

their implications for the use of petroleum and natural gas for generating electricity and for the overall energy «mix» of the country. This report focuses on the role of petroleum and natural gas in the Egyptian economy, looking at both the demand and supply sides. The policy issues involve production, end uses, and possibilities for substitution.

Petroleum has made a substantial contribution to the Egyptian economy over the past five years. In fiscal 1981/82 oil exports contributed approximately $2.76 billion to the country's balance of payments, in contrast with approximately $53 million in 1971/72, a decade earlier. However, unless specific policy measures are undertaken, this favorable picture cannot persist. There is rising consumption domestically and geological uncertainties about reserves and the possibilities of future production. Changes in either the supply or the demand side (or both) must take place if domestic demand is to be met and oil exports maintained.

An initial report prepared for this project indicates Egypt's energy profile according to the source of energy and its uses in the economy.[2] The industrial sector outweighed all other sectors with respect to its consumption of petroleum products in 1975, accounting for 19.6 percent of total demand. The transport sector ranked second, consuming 18.7 percent, followed by the household sector (17.9 percent) and the electricity sector (16.4 percent).

The relative use of energy sources changed by 1979/80. The electricity sector became the major user of commercial energy (31.8 percent), followed by the transport (19.7 percent) and industrial (18.6 percent) sectors. Mazot is the major petroleum product consumed by the industrial sector, constituting 91.4 percent of all products in 1975 and 77 percent in 1979/80. Kerosene is the major petroleum product used by the household

(2) Abdelmohsen A. G. Ibrahim. «Highlighting the Main Features of Egypt's Petroleum Sector Plans». TAP Report 83 - 4. Cairo : Ministry of Planning, September 1982.

sector, accounting for 82 percent of total household petroleum demand. Both mazot and kerosene are highly subsidized by the government.

Recent developments suggest that the Egyptian economy has entered a transitional phase in its growth process and is now moving towards a new equilibrium. Clearly, the most significant contribution to the recent economic upsurge has been provided by the petroleum sector, which is strong, well-managed, and provides a steady stream of revenue for the government. The contribution of the petroleum sector to GDP at factor cost increased from 3 percent in 1975 to 16 percent in 1979 and export earnings jumped almost six times during this period. By 1982 oil exports provided close to $3 billion to the economy.

In our detailed analysis of the Egyptian economy for two years (1977 and 1979) we have identified critical changes. Today, four years later, the changes may be even greater. These changes are as follows :

First : The focus of activity within the energy sector has reflected a marked shift towards international markets. In 1977, 42 percent of the total sales of the crude oil and mining sector were in terms of exports and 15.6 percent for that of the oil refining sector. By 1979 the share of crude oil exports to total sales increased to 90.2 percent and that of the oil refining sector rose to 42.7 percent. Exports of crude grew from 8.1 percent of Egypt's exports in 1977 to 46.2 percent in 1979. Exports of refined products rose from 3.5 percent of 1977 exports to 7.6 percent of 1979 exports. By 1979 exports of petroleum came to account for over 50 percent of Egypt's foreign exchange earnings. **This means that Egypt's oil role internationally is increasing, but it also means that it is very vulnerable to world oil prices.** Egypt cannot influence these prices, but it can gain and lose depending on world supply and demand.

Second : There has been an enormous increase in the output of the petroleum sector. The gross sectoral output level

for crude oil increased by more than six times and that of refined products almost doubled. These changes reflect an increase in production and capacity of the oil extraction industry from 1977 to 1979. Thus, **expansion in both production and refining occurred, significantly strengthening the country's energy sector.**

The problem today is whether the increased earnings from the petroleum sector can be maintained in the face of the two obstacles : a highly subsidized domestic price of oil which is encouraging domestic consumption and a large degree of uncertainty that prevails in reserve generation and the future production possibilities of oil. 1981/82 estimates of the reserves of petroleum in Egypt are around 660 million tons. Government officials have recently suggested that by 1984 both consumption of petroleum products and output will rise by 11 to 12 percent and the exportable surplus of domestic petroleum production over consumption may be eliminated completely.

Oil Minister Ahmed Hilal, who expects oil production to reach 1 mb/d by 1985, says that output is now approximately 750,000 b/d. Since domestic consumption is increasing rapidly, a high production rate is needed to keep exports well above domestic demand. Current statistics show that after taking account of domestic consumption and foreign companies' contractual shares only about 200,000 b/d is available for export from current production.

We do not here suggest a drastic change in domestic prices, for our analysis, as indicated below, suggests that this would be counterproductive, but we note that the current situation requires rectification and the specific steps to be taken require careful analysis. In addition, natural gas is also assuming greater importance in the Egyptian economy. Government programs call for more than a threefold increase of gas production between 1981 and 1985. Already we have seen a dramatic expansion of this sector from .50 billion cu-m in 1977 to 2.19 billion cu-m in 1980 and increasing sectoral uses. Natural gas output in 1982 totalled about 2.6 billion cu-m. Proven reserves of non-associated natural gas are about 250 billion cu-m.

II. PROCEDURES AND RESULTS : ANALYTICAL MODELS AND STUDIES OF EGYPT'S ENERGY SECTOR

The Energy Policy Project of the Cairo University/MIT Technology Planning Program has developed a set of analytical models to provide a comprehensive view of policy issues and performance in the energy sector. The analytical models are of three types and can be characterized as follows :

1. Egyptian Petroleum Model (EPM) to examine oil production and the impacts of investment and extraction decisions;

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A brief description of each of these models is presented below. Scholars, policy makers, and the educated public in Egypt must be aware of the approaches to analysis that are useful in understanding how the country's energy system interacts with the rest of the economy and the types of contributions scholars can make to policy analysis. In addition, Egypt is one of the few developing countries where such analytical models exist and for which there are now sophisticated methods for analyzing energy issues.

1) EGYPTIAN PETROLEUM MODEL

The first model developed is for the Egyptian oil sector itself, drawing upon a set of simulation tools developed at MIT for analyzing production possibilities in oil exporting countries.[3]

(3) Nazli Choucri with David Scott Ross. **International Energy Futures : Petroleum Prices, Power, and Payments.** Cambridge, Mass. : The MIT Press, 1981.

The objective is to simulate oil production for Egypt — parametrized to Egyptian data — over the next twenty years. The model is in the framework of a dynamic simulation that incorporates and makes use of geological data for the four petroliferous provinces of Egypt.[4] The EPM model is used to generate information about future oil production and oil potentials as a result of increases in exploration activities. It enables us to estimate how financial investments will result in oil production, given the geological configuration of the country.[5]

The main driving forces for the model are domestic and international crude prices. International prices influence the level of exploration investments made by oil companies, which determine reserves and, ultimately, production, as well as setting the value of exports. Domestic prices influence domestic consumption, which helps determine how much oil can be exported if domestic consumption continues to grow.

The main results of the model, based on existing information on reserves and on Egypt's geological conditions, are as follows :

First : The peak in the production of oil in Egypt will be 300 million barrels by around 1987. This is indicative of the success in the exploration efforts of the 1970s which occurred as a result of the world oil price increases in the 1970s which resulted in the low cost deposits discovered and exploited.

Second, domestic production in Egypt does not depend on world oil prices, however the level of exports is extremely sensitive to world oil prices.

The EPM model has been utilized to examine the effects of alternative assumptions of future price behavior. It is diffi-

(4) M. Gaber Barakat (Cairo University). «General Review of the Petroliferous Provinces of Egypt with Special Emphasis on their Geologic Setting and Oil Potentialities». TAP Report 83 - 1. June 1982.

(5) Nazli Choucri (MIT) and M. Zaki Shafei (Cairo University). «Energy Policy Project : Petroleum and Natural Gas in Egypt : Final Report». TAP Report 83 - 11, June 1983.

cult to forecast world oil prices; however, «high» and «low» prices have been used as the basis for the different scenarios. One critical result is that Egyptian oil production does not depend too much on world prices, given the magnitudes involved, and the relative size of the domestic market. The following is an elaboration.

Effects of Alternative World Oil Prices on Egyptian Oil Production :

To examine the sensitivity of Egyptian oil production to world prices we tested two scenarios that differ from a base case :

- high world oil prices, and
- low world oil prices.

For the low price scenario production of oil peaks in 1987, levelling at 290 million barrels per year, and gradually declines to 260 million barrels per year. For the base case production rises to 300 million barrels per year, levels off until the mid 1990s, and increases slightly to 320 million barrels by the year 2000. The high price scenario and the base start to diverge from 1992 and the high price scenario reaches a maximum of 420 million by 2000. The above is evident from Figure 1. This means that as resources are depleted over time and marginal costs rise, their international prices become an important factor in determining the level of production.

Effects on Exports :

Both for the base case and the low price scenario the model shows that Egypt's oil exports decline because of rising domestic consumption. In the low price scenario, exports get totally wiped out by 1996 when domestic consumption uses all of Egypt's production. However, even in the base scenario we find that exports decline from a level of 80 million barrels per year to 20 million barrels in 2000. This is a dramatic cut in exports which indicates the vulnerability of Egypt's export potential. Unless domestic consumption is curbed, meeting the country's oil demand will lead to a total elimination of exports

(in one scenario) and a dramatic decline in another (the base case).

In the simulation runs where the price of oil follows a high price scenario, exports level off at 80 million barrels per year from 1983 to 1993, after which they begin to climb to a value of 100 million barrels per year in 2000. Figure 2 depicts the Egyptian government exports over time. The rising price of oil (in the high price scenario) encourages oil extraction, whereas there are no incentives for domestic consumption to rise — hence the additional production can be diverted to exports.

Validation :

The results of the model have been compared to actual data in order to determine the validity of the model behavior. Table 1 shows some of these comparisons. For production, the comparison between the EPM results and actual production is quite informative. The discrepancies between actual and simulated results occur during 1973 to 1976 because the model does not simulate the severe production decline in the Morgan field due to technical factors. The differences between actual exports and the simulated figures in the first half of the 1970s merely reflect the shortfall in production which was not simulated owing to its unique nature.

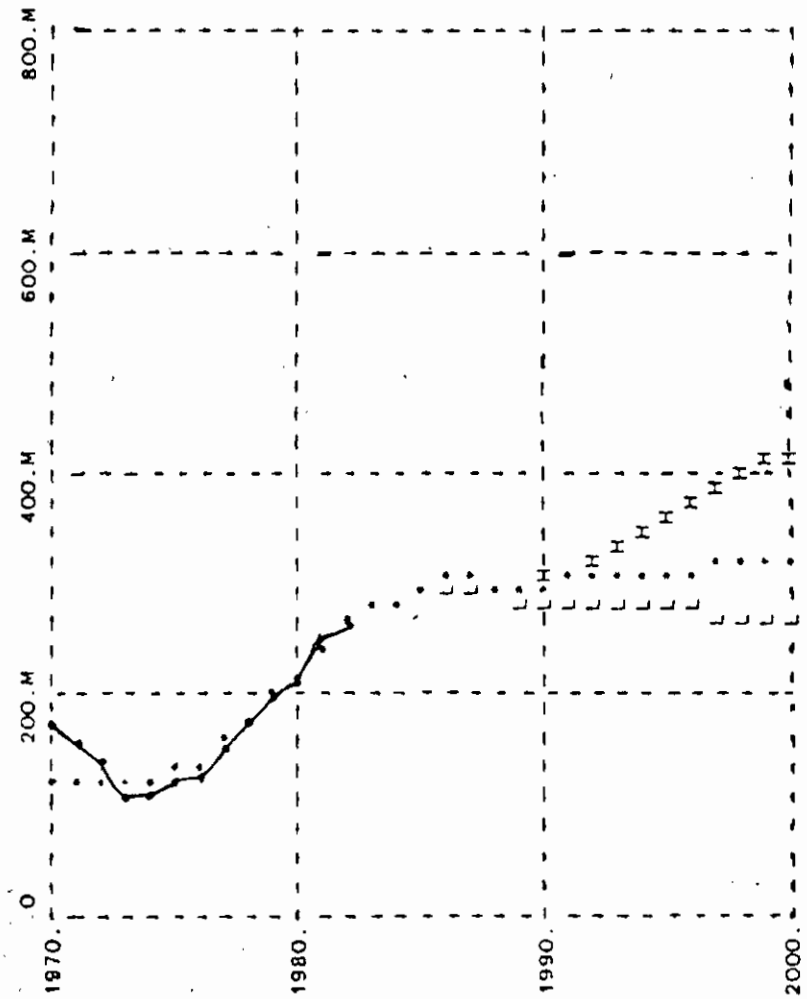
Comparisons with Egyptian Government Assessments :

Utilizing the Egyptian Petroleum Model to make forecasts of future possibilities has also helped us to analyze the current projections and assessments of the oil sector that have been made by government officials in designing Egyptian energy policy. For example, on March 22, 1983, the **Middle East Economic Survey** conducted an interview with Egypt's Deputy Prime Minister for Production and Minister of Petroleum, Ahmed Ezzeldin Hilal, in which the following assessments were made. Minister Hilal stated that production for 1983 is estimated to be 263 million barrels per year. Comparing his estimates with those of the EPM model, we note that our forecasts are slightly higher, indicating an annual production for 1983 of nearly 275 million barrels per year.

FIGURE 1

Total Oil Production. 1970 - 2000

(million barrels/year)

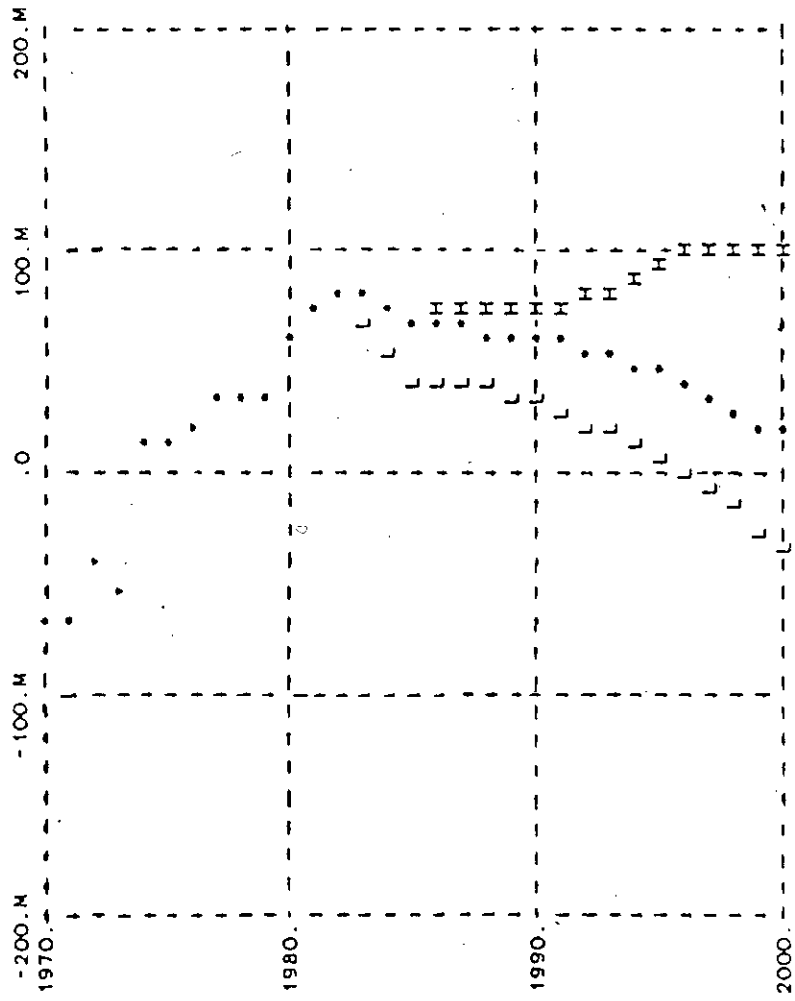


— = actual production
* = base scenario
H = high world crude price
L = low world crude price

FIGURE 2

Egyptian Government Oil Exports, 1970 - 2000

(million barrels/year)



* = basic scenario
H = high world crude price
L = low world crude price

Note : Egyptian government oil exports are obtained by taking the residual between the Egyptian government's share in oil production and domestic consumption.

TABLE 1

Actual and Simulated Values of Total Oil Production and Exports in Egypt

(million barrels/year)

	Total Oil Production		Total Oil Exports [1]	
	Actual	Simulated	Actual [2]	Simulated
1970	170	118	70	69.0
1971	151	119	63	67
1972	128	117	26	62
1973	93	118	14	59
1974	84	122	2	59
1975	108	129	26	63
1976	119	138	52	68
1977	151	163	71	88
1978	175	175	99	96
1979	192	194	112	110
1980	215	217	128	127
1981 [3]	252	241	151	147
1982	259	264	149	164

1) Total oil exports are much larger than Egyptian government oil exports depicted in Figure 2 because of the nature of contractual agreements with foreign oil companies.

2) Export figures in real terms have been obtained by taking the residual between oil production and oil consumption.

3) 1981 and 1982 data are from **International Energy Annual**, 1982, Energy Information Administration.

Sources : **B. P. Statistical Review of the World Energy Industry**, 1980, 1982; **Oil and Gas Journal**, «Oil and Energy Trends»; **Statistical Review**, 1981, 1982; and EGPC.

In addition, Minister Hilal projected that oil production in Egypt by 1985 will be one million barrels per day. The EPM model estimates 800 thousand barrels per day for that year. This is slightly lower than government estimates, but we consider the EPM results cautious and conservative. Minister Hilal estimated oil revenues in 1984 to be 2.3 billion dollars. The EPM model estimates revenues to be slightly lower at 1.8 billion dollars.

Finally, the **Middle East Economic Survey** quoted Minister Hilal's investment figures in the oil sector in Egypt as $ 300 million per year in exploration and 800 million for development. The EPM results are based on $ 342 million on investment in exploration and $ 859 million on development expenditure.

These comparisons indicate that Minister Hilal's projections are essentially robust. They are entirely consistent with the results of a robust simulation of oil production processes in Egypt and responsiveness to investments in exploration and development. [6]

2) NATURAL GAS MODEL

Natural gas has important potentials for Egypt's energy mix. An initial model examining uses and pricing of natural gas has been completed. [7] This study is based on a linear programming framework to determine the best uses of natural gas to improve Egypt's foreign exchange position and to identify the price that should be charged to users. These are two important issues. Since the domestic price of natural gas is essentially independent of the world price, determining the optimal price is important. Also, increasing uses of natural gas will enable diverting petroleum from domestic uses to exports, thereby contributing to the country's foreign exchange earnings.

(6) Nazli Choucri and Michael C. Lynch (with the assistance of David Woodruff). Egyptian Petroleum Model (EPM), in preparation.

(7) David Woodruff (MIT). «Linear Programming Analysis of the Use of Natural Gas in Egypt : Energy Project : Petroleum and Natural Gas in Egypt». TAP Report 83 - 5. November 1982.

The «optimal» price reflects the «shadow price» or scarcity value of natural gas to the Egyptian economy, given the objectives of that economy (as reflected in the «objective function»). The objective function specified in the natural gas model tries to minimize foreign exchange costs to the economy by choosing fuels for use in production in such a way as to meet exogenously-specified demand for goods. There are constraints to this fuel «switching» since natural gas cannot substitute entirely for oil.

Using the E-GAS model we have identified the shadow prices for natural gas in Egypt as $.112/cu-m (for Abu Chaadiq gas) and $.115/cu-m (for Abu Madi gas) which express its value in displacing other fuels.

The shadow prices of production capacity for processes which use natural gas have also been identified. These prices provide an understanding of how valuable the use of natural gas is for each particular industry in improving Egypt's foreign exchange position. The shadow (or real) price depends on the particular industry in question, with a larger shadow price indicating a more valuable application for natural gas for the economy as a whole. The natural gas model reveals that the most important application of natural gas is the manufacture of cement. The use of natural gas in the iron and steel sector is of little importance if we assume that coal is priced at $35/tonne. If the price of coal were higher than $107/tonne, gas would be an important substitute in this sector.

In short, the linear programming model of natural gas industry in Egypt can be used to assist in decision-making about the allocation of natural gas. The natural gas shows therefore that this resource is most valuable in cement and fertilizer production and any increase of the use of natural gas in electric power generation must be met by a large expansion of production.

3) SHORT-RUN MACROECONOMIC MODEL FOR EGYPT

The Egyptian macroeconomic model (E-MACRO) is built around a social accounting matrix (SAM) for the Egyptian economy in the national accounts year of 1977, a year chosen

specifically for its use as a «base» for analysis.[8]. The model incorporates a complex set of general equilibrium interactions in the price and quantity-clearing sectors in the commodity market. The E-MACRO model is designed for the short-run to assist in understanding the immediate economic adjustments, rather than longterm consequences, as in the case of examining production possibilities via the Egyptian Petroleum Model (EPM) described above. This short-run model of the economy is built specifically around a base year to understand the immediate responses of the economy to specific policy changes. Investment has been modelled as a component of aggregate demand and the long term capital accumulation process of investment has not been incorporated. Thus the longer run adjustments to short-run interventions are beyond the scope of this analysis.

E-MACRO Model Focus

Since the petroleum sector does not exist in isolation from the rest of the economy, the analysis of its effects takes into account the strong two-way linkage with the economy. This means that we examine and identify how the petroleum sector impacts upon the other sectors of the economy and, on the other hand, how the other sectors of the economy influence output and productivity of the petroleum sector. The crucial policy issue addressed in this context is to change the domestic price system of petroleum products away from an entirely administered price toward a more viable domestic price structure. The problem to resolve is to determine whether price induced conservation is likely to occur, and also to determine what the macro consequences of an overall reduction in petroleum use are likely to be for the economy as a whole.

The critical questions to which answers are required include the following : what will be the effects of rising energy costs on the other sectors of the economy ? Will the economy be able to adapt to this change ? To some extent the adjustments

(8) Nazli Choucri and Supriya Lahiri (MIT). «Short-Run Energy-Economy Interactions in Egypt». TAP Report 83-7. May 1983.

will depend on the flexibility of energy use in the consumption pattern of households and in the production functions underlying industrial sectors. These questions imply, of course, that the structure of energy-economy interactions depends to a large extent on the critical role that petroleum plays both in consumption and as a factor of production (i.e., on the values of the relevant elasticities).

In a macro-economic context, therefore, if substitution possibilities exist in production processes, it is important to determine whether the negative macro-economic impact of rising energy prices can be reduced through appropriate price policies or if other constraints in the economy will need to be recognized as well. In addition, given Egypt's energy profile, it is useful to examine whether the production possibilities in the natural gas sector impose significant constraints on the economy's adjustment process.

Policy Results

The results of the E-Macro model for analysis of short run energy/economy interactions indicate the following :

First, an increase in the domestic price of oil will encourage the curtailment of petroleum use and induce some amount of conservation of oil resources. This conservation may be redirected to exports or conserved for future use.

Second, the reduction in petroleum use, however, will impose painful adjustment problems for the economy in terms of an increase in inflation, fall in the share of wage income, and sharp output losses. A gradual increase in price of oil would be less painful than a «quantum jump» rise and would not necessarily induce more conservation of petroleum use in relative terms. An increase in aggregate demand through expansionary government expenditure policies may help to restore some of the lost income and stimulate the economy.

Third, the popular emphasis in macro-economic policy for counteracting the negative economic effects to date has been effective energy-demand management policies. Since household

consumption forms a very small portion of total petroleum demand in Egypt, the demand effects will have to operate through interfuel substitution in the industrial sector. Our analysis suggests that a high elasticity of substitution in the production processes between petroleum and natural gas will not bring about the desirable changes in terms of conservation of petroleum use and amelioration of the negative macro-economic impacts **unless** efforts are made to increase the short-run supply of natural gas as well. In other words, for the price of oil to provide the right signal for resource allocation in the economy the other institutional and structural constraints need to be recognized and analyzed as well.

Fourth, the macro-economic implications of domestic petroleum pricing strategies in Egypt are extremely important and should be considered carefully. Simply suggesting lifting of domestic subsidies, increasing domestic energy prices to world prices, will not have the intended effects unless other measures are adopted as well. Treating the energy sector in isolation from the rest of the economy will be counterproductive and lead to adoption of measures that may even have detrimental effects. **An overall energy/economy strategy is required in which adjusting domestic prices toward international prices is only one element.**

The next phase of analysis entails expanding the static macro-economic model of the Egyptian economy completed so far into a dynamic multi-sectoral macro-economic model in order to trace energy-economy interactions over time. The dynamic macro-economic model will be a useful tool to map out appropriate trade-offs between potentially conflicting objectives, such as growth, equity, unemployment, and conservation, and make appropriate policy recommendations for the future course of the Egyptian economy.

III. IMPLICATIONS OF THE FIVE-YEAR PLAN (1982/83 - 1986/87) FOR THE ENERGY SECTOR

The Egyptian government has issued an ambitious five-year plan with development targets and associated investments which has major implications in terms of overall growth of consump-

tion, energy use by sector, and energy mix by fuel type and sources of energy.

The demand for investment goods from the construction and housing sector (or investment by origin) is more than 40 percent of the total value of investment in the current five-year plan. This will lead to an increase in activity in the construction sector and since the linkages between the construction sector and other energy-intensive industrial sectors like steel, cement, glass, gypsum, and brick-building are strong, the demand for energy use will increase substantially.

Major emphasis has also been put on building the infrastructure of the economy, hence substantial investments are being made on the transportation sector. Twenty percent of the total investment (by destination) has been allocated to the transportation sector. These investments will also have serious implications for petroleum and electricity consumption.

The current five-year plan allocates 13.4 percent of the total investment (by destination) to the energy sector, out of which the petroleum sector accounts for 2.4 percent and the electricity sector's share is 11 percent. The foreign component in these sectoral investment allocations for the electricity and petroleum sectors is 57 percent and 72 percent respectively. The five-year plan document does not indicate explicitly the allocation of investment to the natural gas sector.

In order to increase the productive capacity of the economy and to keep the economy on a self-sustained growth path, the industrial demand for energy might grow more rapidly in the future than in the past.

The detailed frame of the Five-Year Plan for Economic and Social Development prepared by the Arab Republic of Egypt, Ministry of Planning, foresees that available sources may not be sufficient to satisfy future demand for various types of energy. Therefore, an overall energy/economy strategy is required, in terms of increasing efficiency of energy use, various incentives and appropriate pricing to encourage energy conservation and inter-fuel substitution, and development of various

conventional energy sources through exploration, to maintain adequate petroleum reserves which may satisfy expected increase in the demand for energy entailed by the dvelopment plans and adoption of appropriate technology for the development of alternative renewable sources of energy.

IV. PROJECT TEAM

The research team includes participants from Cairo University, Egyptian government agencies, and MIT. The Cairo University research team is under the direction of Dr. M. Zaki Shafei. The team includes Dr. Gaber Barakat, Professor of Geology, Cairo University; Dr. Gouda Abdel Khalek, Associate Professor of Economics, Cairo University; and Dr. Sakr A. Sakr, National Institute for Planning. The graduate students from Cairo University include Ahmed Niazy Elbarkouky, Nader M. Salama, and Ola el Khawaga.

Dr. Hussein Abdallah, Senior Undersecretary, Ministry of Petroleum, remained in contact with the project throughout, highlighting the government's concerns. From the Ministry of Planning, Dr. Abdel Mohsen Abdel Ghani Ibrahim, Undersecretary, contributed the Ministry of Planning's perspective.

From the Egyptian General Petroleum Corporation, Dr. Mostafa Ayouti, former Vice Chairman, collaborated in the formulation of the supply-related issues and discussion of the geological surveys for petroleum bearing potential. Dr. Gamal Hantar, Manager, Exploration Department, collaborated in discussions of geological potentials. Mr. Ibrahim Radwan, Manager, Agreements Department, provided insights into the structure of contracts and concessions in Egypt. Mr. Raouf Fayek, Vice Chairman for Gas Affairs, reviewed with members of the research team the natural gas prospects in Egypt. Dr. Hamed Amer, Chairman of AGIBA Petroleum Company, collaborated throughout the analysis as an advisor and guided discussions of natural gas prospects.

The MIT team, directed by Professor Nazli Choucri, included Dr. David Woodruff, Department of Electrical Engineering,

Mr. Michael C. Lynch, Research Associate, Energy Laboratory, Professor Lance Taylor, Department of Economics, and Dr. Supriya Lahiri, Research Associate, TAP. Mr. Peter Haas, Ph.D. candidate, provided basic and extensive research assistance. Ms. Phoebe Green assumed full responsibility for typing and final preparation of this and all reports of the Project.