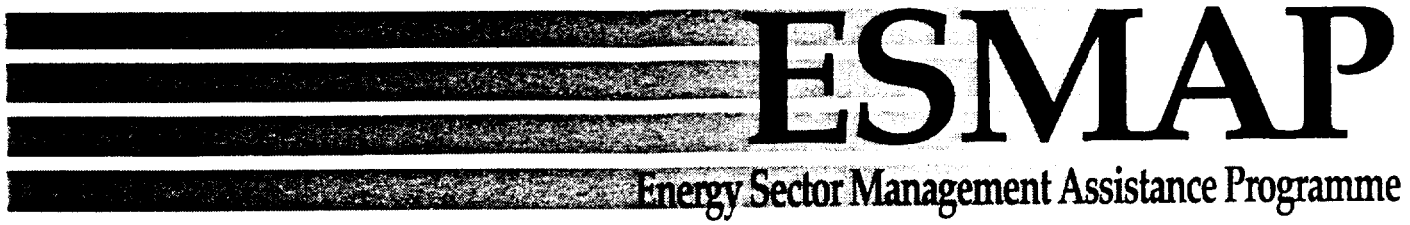

ESM189

Arab Republic of Egypt
Energy Sector Assessment

Report No. 189/96

JOINT UNDP/WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance program run by the World Bank's Industry and Energy Department. ESMAP provides advice to governments on sustainable energy development. Established with the support of UNDP and 15 bilateral official donors in 1983, it focuses on policy and institutional reforms designed to promote increased private investment in energy and supply and end-use energy efficiency; natural gas development; and renewable, rural, and household energy.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (ESMAP CG), composed of representatives of the UNDP and World Bank, the governments and other institutions providing financial support, and the recipients of ESMAP's assistance. The ESMAP CG is chaired by the World Bank's Vice President, Finance and Private Sector Development, and advised by a Technical Advisory Group (TAG) of independent energy experts that reviews the Programme's strategic agenda, its work program, and other issues. ESMAP is staffed by a cadre of engineers, energy planners, and economists from the Industry and Energy Department of the World Bank. The Director of this Department is also the Manager of ESMAP, responsible for administering the Programme.

FUNDING

ESMAP is a cooperative effort supported by the World Bank, UNDP and other United Nations agencies, the European Community, Organization of American States (OAS), Latin American Energy Organization (OLADE), and public and private donors from countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

FURTHER INFORMATION

An up-to-date listing of completed ESMAP projects is appended to this report. For further information or copies of completed ESMAP reports, contact:

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Washington, D.C. 20433
U.S.A.

ARAB REPUBLIC OF EGYPT

ENERGY SECTOR ASSESSMENT

October 1996

Power Development, Efficiency &
Household Fuels Division
Industry and Energy Department
The World Bank
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Preface

This report has been prepared by an Egyptian Task Force, assisted by an ESMAP working group. The report incorporates debate and dialogue with key Egyptian decisionmakers that took place during a two-day workshop in Cairo in June 1995 and subsequent discussions between senior sector officials in October 1995. The Egyptian Task Force is using this report in mapping out the next steps: vision, strategy, and an agenda for action for the energy sector.

The Government of Egypt (GOE) requested technical assistance from the Energy Sector Management Assistance Programme (ESMAP) for mapping out an agenda for the future. After high-level technical discussions, the Government decided to develop, with ESMAP assistance, an inventory of the most important elements of its medium- and long-term strategy for the energy sector. The inventory would be based on the findings and the recommendations of an Energy Sector Assessment (ESA).

The objectives of the ESA are to: (a) study and analyze the major policy and operational issues confronting the sector; (b) identify options for proposed actions related to economic and environmentally efficient supply and end-use of energy for the short- and medium-term scenario; and (c) identify options for proposed actions leading to long-term sustainable development in the energy sector as a whole.

The modalities to carry out the assessment were discussed and agreed upon between the GOE and ESMAP. The ESA was carried out under seven core topics: (a) institutional development, (b) power sector development, (c) petroleum sector development, (d) natural gas utilization and development, (e) energy conservation and environmental protection, (f) new and renewable sources of energy, and (g) economic linkages and financial resource mobilization.

An Egyptian task force was set up through the issuance of a ministerial decree. The head of the Egyptian task force is Dr. Mustafa Swidan (Chairman, EEA). Other members of the task force include Mmes./Messrs. M. El-Desouki (First Under Secretary, MEE); H. Younes (Vice Chairman - Operations, EEA); S. Radwan (Vice Chairman - Financial and Economical Affairs, EEA); F. Abou-Neima (Managing Director - Planning and Economic Studies, EEA); S. El-Banna (Under secretary for Technical Affairs, MOP); M. Tawila (Vice Chairman - Natural Gas, EGPC); S. Fahmy (Vice Chairman - Planning and Projects, EGPC), and R.F. Ragy (Director of Study and Research, NREA).

The ESMAP working group that assisted the Egyptian task force in carrying out this assessment was headed by Mr. A. Ferroukhi (IENPD). Other members of the working group with their respective responsibilities include Mmes./Messrs. U. Chandra (power and overall coordination); R. Vedavalli (economic linkages); A.

Mekkawy (petroleum); B. Svensson (natural gas); T. Nayar (refinery); V. Sirohi (environment) from the ESMAP; and international consultants Messrs. F. Lecaros (power); A. Aly (refinery); R. Turner (institutional development); R. Shock (energy conservation); B. Gillett (renewable energy); M. Schultz (natural gas); G. Adams (economic linkages). The working group was assisted by local consultants, Messrs. N. Gohar (legal) and H.A. Hassan (financial).

The outcome of the assessment includes development of energy companies operating as commercially viable corporate entities in an enabling environment under an independent and transparent regulatory framework, with the option for private sector involvement in the energy sector operations; improved overall efficiency of sector operations; elaboration of a strategic approach to sector planning and development; and enhancement of overall energy sector-economy linkage.

The findings of the assessment is presented as two independent outputs: one, a concise overview (the Executive Summary) that serves as a briefing note to energy policy decisionmakers; and two, a structured discussion by core topic (the Main report) that identifies the major issues confronting the energy sector and corresponding options.

Abbreviations and Acronyms

ARC	Agricultural Research Center
BREEPP	Bulk Renewable Energy Electricity Production Programme
CEC	Commission of the European Communities
CFL	compact fluorescent lamp
CIDA	Canadian International Development Agency
CNG	compressed natural gas
DC	distribution company
DONG	Danish Oil and Natural Gas Company
DRTPC	Development Research and Technological Planning Center
DSM	demand side management
EC	European Commission
ECEP	Energy Conservation and Efficiency Project (until Sept. 1993)
	Energy Conservation and Environment Project (from Sept. 1993)
EDHC	Electricity Distribution Holding Company
EEA	Egyptian Electricity Authority
EEAA	Egyptian Environmental Affairs Authority
EGEAS	Electricity Generation Expansion System
EGPC	Egyptian General Petroleum Company
EREDO	Egyptian Renewable Energy Development Organization
ERSAP	Economic Reform and Structural Adjustment Program
ESA	Energy Sector Assessment
ESMAP	Energy Sector Management Assistance Programme
FCC	Fluidized Catalytic Converter
FEI	Federation of Egyptian Industries
GDP	gross domestic product
GEF	Global Environment Facility
GOE	Government of Egypt
GOFI	General Organization for Industrialization

GOHBPR	General Organization for Housing Building and Planning Research
IPP	independent power producer
£E	Egyptian Pounds
LPG	liquefied petroleum gas
LRMC	long-run marginal cost
MEE	Ministry of Electricity and Energy
MOP	Ministry of Petroleum
MPMR	Ministry of Petroleum and Mineral Resources
NRE	New and Renewable Energy
NREA	New and Renewable Energy Authority
NRES	New and Renewable Energy Sources
ODA	Overseas Development Administration
OECP	Organization for Energy Conservation and Planning
OEP	Organization for Energy Planning
PV	photovoltaic
R&D	research and development
RE	renewable energy
REA	Rural Electrification Authority
SAL	structural adjustment loan
SAMP	Structural Adjustment Monitoring Program
SEC	Supreme Energy Council
TIMS	Tebbin Institute for Metallurgical Studies
TOU	time of use
UHV	ultra high voltage
UNDP	United Nations Development Programme
UPS	Unified Power System
USAID	United States Agency for International Development
WASP	Wein Automatic Simulation Package

Currency Equivalents

Currency unit = Egyptian Pound (LE)
1 LE = 100 piasters
Exchange rate: US$1.00 = LE 3.39 (June 1995)

Units of Measure

Fiscal Year
July 1 to June 30

Conversion Factors

1 bcm	=	35.3 bcf
1 cubic meter	=	264 US gallons
1 toe	=	42 GJ
1 metric ton (1,000 kg)	=	2,205 pounds
1 mtoe	=	1.5 million tons of coal
	=	1.111 bcm of natural gas
	=	39.2 bcf of natural gas
	=	12,000 GWh of electricity
1 tonne	=	1.1 short ton

Weights and Measures

bcm	billion cubic meters
b/d	barrels per day
boe	barrel of oil equivalent
Btu	British thermal unit
GW	giga watt
GWh	giga watt hour
kW	kilo watt
kWh	kilo watt hour
mmcf	million cubic feet
mmt	million metric tonnes
mtoe	million tons of oil equivalent
MW	mega watt
ppm	parts per million
tcf	trillion cubic feet

Executive Summary

Introduction

1. Egypt is at a crossroads in its transition from a centrally planned, inward-looking economy to a free-market, outward-looking economy. The country has been pursuing a reform program driven by deregulation, restructuring, and privatization since 1991. Macroeconomic stability has been achieved. As a percentage of GDP, the overall fiscal deficit was reduced from about 17.0 percent to 5.0 percent in the period 1991-93 (down to 2.5 percent in 1994), and foreign currency reserves have increased to US$18 billion, an equivalent of 12 months of imports of goods and services. Several government expenditure-reduction and revenue-enhancing measures were and are being applied. As a result, over the past two years, total government expenditures fell by about 11 percent (to about 40 percent of GDP in FY93), and total government revenues increased by about 3 percent (to about 35 percent of GDP in FY93).

2. The key to sustained stability and enhanced growth is to follow the directions indicated by the stable macroeconomic framework and move toward reforms at the sectoral level. Public sector restructuring, including public divestiture and other reforms, should continue to enable rapid and sustainable private sector-led-growth. The challenge for the government lies in adopting and implementing policies and institutional changes that will capitalize on the efficiency gains of the reform programs. The energy sector is thus on a challenging path in an economy undergoing protracted reform.

The Government's Objectives in the Energy Sector

3. The government's National Five-Year Plan, covering the period 1992-97, reflects a turning point in the development process through a systematic move into a market-oriented economy. The Plan aims to adjust the public sector toward greater autonomy and to increase private sector participation in energy operations. Within this broad framework, the government's main energy sector objectives are to:

- Meet domestic energy needs in a cost-effective manner.
- Overcome major impediments to improving overall sector efficiency.
- Maximize exportable surpluses to earn valuable foreign exchange.
- Increase the role for the private sector in energy sector operations.

Energy Sector Achievements

4. Over the years, Egypt's energy sector has seen several notable achievements, including the following:

- A 30 percent improvement in thermal efficiency of power generation from about 24 percent in 1982 to about 33 percent in 1994.
- Reduction in system losses (technical and non technical) from about 18 percent in 1984 to about 14 percent in 1994.
- The unbundling of power distribution by placing the eight distribution companies (DCs) under a separate holding company (HC) with the objective of privatizing the DCs.
- An increase in private sector participation in natural gas upstream operations stemming from revision of the gas clause (with the producer's share of gas transferred at 85 percent of crude oil parity).
- A stepped increase in weighted average of electricity tariffs as a proportion of average long-run marginal cost, from below 50 percent in 1990 to about 80 percent (based on marginal input fuel cost) in 1994 and closer to about 90 percent now (based on an economic value for natural gas).
- A stepped increase in weighted average of petroleum products as a proportion of import parity prices (based on comparing retail prices with border prices), from below 25 percent in 1990 and closer to about 100 percent now.
- An increase in the role of private retail distribution (franchises) of petroleum products from minimal participation to over 95 percent now.
- The initiation of discussions with potential independent power producers (IPPs) for power generation; and
- Ongoing discussions for two private sector export-oriented refineries.

5. These achievements demonstrate that the energy sector is gearing itself to operate in a market-oriented environment. However, if Egypt is to take full advantage of the potentials of reform, the sector will also have to make further adjustments to the more open energy market, higher level of competition, and new opportunities for private sector participation.

Need for Change

6. The rationale for making further changes in Egypt's energy sector is that the current institutional framework of the energy sector is inadequate to meet the government's objectives for the sector. Key institutional actions include the following:

- A systemic move from public sector involvement to private sector participation in energy sector operations including investment, with a limited role for the government in energy policy initiatives (e.g., innovative financing mechanisms and guarantee programs)

- Corporatization and commercialization of energy sector enterprises
- Institutionalization of an independent and transparent regulatory process that sets the basis for a competitive and market-oriented operation
- A sustainable and dynamic energy policy synergistic with the macroeconomic performance of the economy.

7. Policies in the energy sector should encourage less dependence on state directives and resources and instead create conditions for market mechanisms to prevail and promote investment. Recent developments in the economy and policy directions in the energy sector, demonstrate commitment to developing a comprehensive reform agenda to meet the challenges ahead.

Road Map

8. The presentation of the reform agenda is organized under three broad headings: (a) the sectorwide context, which has a direct bearing on macroeconomic performance; (b) subsector specific elements, which are directly related to power, petroleum, and natural gas; and (c) overall sector policy, which includes energy conservation, environmental protection, and new and renewable sources of energy.

9. Under each heading, a brief review of major issues is followed by a discussion of options and then a section on conclusions and recommendations. The recommendations or preferred options (shown in italics) are based on a two-day workshop held in Cairo in June 1995 under the theme "Challenges for the Egyptian Energy Sector." The workshop forum was organized to facilitate discussions amongst the senior managers of the energy sector enterprises of the various options for restructuring and reform.

Sectorwide Context

Energy-Economy Linkage

10. Egypt is well endowed with energy resources in oil and gas and depends heavily on the River Nile for its hydro power resources (for a summary, see Box 1). Concomitantly, the energy sector plays an important role in the Egyptian economy. Thus, at the end of the Second Five-Year Plan (FY92), the energy sector accounted for about 12 percent of GDP, 22 percent of total investment, 56 percent of commodity exports, 7 percent of total public revenues, and 1 percent of total employment. The linkage between the energy sector and the economy affects macroeconomic growth and development. The impact of the energy sector on the economy is best illustrated by the fact that crude oil and refined-product exports accounted for nearly 60 percent of merchandise exports and about 7 percent of total current account revenues.

11. Whether the Egyptian energy sector can maintain this high profile in the economy is presently uncertain, primarily because of the projected decline in the level of

crude reserves and the high consumption of petroleum products. Domestic oil production is expected to decline gradually by about 2.3 percent annually, resulting in an expected 50 percent reduction in exportable surplus between 1995 and 2003. Export earnings from petroleum are expected to decline by about US$0.5 billion per annum during the same period, tightening the balance of payments situation probably leading to a probable financial constraint to future growth.

Box 1 Egypt's Energy Sector: Basic Data

Energy resources	Oil, gas, hydro power, some coal and good potential for wind and solar
Proven oil reserves	4 billion bbls
Oil production, export	44 mt/year, 20 mt
Proven natural gas reserves	22.3 tcf
Production, Consumption	0.49 tcf/year, 0.43 tcf/year (1993)
Refining capacity	28 mt/year
Crude production	25.6 mt/year
Petroleum products:	
Production, consumption	24.6 mt/year, 17.2 mt/year (1993)
Electricity	
Available capacity (of which Hydro)	10,323 (1,750) MW
System peak	7,500 MW
Gross generation, sales	47 TWh, 42 TWh (1993)
Electrification rate (1993)	92 percent
Per capita energy use (1992)	586 kgoe
Average growth rate of energy consumption (1980-92)	6.1 percent/year

12. However, prospects for development of additional new gas discoveries and the recent expansion of the gas industry have encouraged an increasing shift from oil to gas, thereby mitigating the loss of export earnings. Doubling of gas production and an increase in its consumption would release additional oil exports of between 7 and 10 mtoe by the year 2000. In addition, the increased domestic use of gas would entail radical changes in the output profile of the refineries and thereby affect the export profiles of petroleum products including natural gas.

Mobilization of Financial Resources

13. The energy sector is a major applicant for investable funds from state resources. It also plays a major role in maintaining stable relationships between the key

macroeconomic variables, because of the need to keep government spending and borrowing under tight control. Estimates of investment requirements over the next eight years indicate that more than US$14 billion are needed to meet the growing demand for electricity and petroleum products. In the electricity sector, EEA estimates that more than US$4 billion (about US$3 billion in foreign exchange) is required to increase supply and meet the needs of the consumers. In the oil and gas sectors, EGPC estimates that in addition to private sector investments in exploration (about US$5.6 billion), public sector investments of about US$600 million per year are required to strengthen and develop infrastructure and facilities.

14. Competing sectors and tight-budgeted state resources limit the available funds for energy sector development; therefore, alternative financial resources must be sought and mobilized. It will be necessary to seek and access private funds from both the domestic capital markets and private foreign sources, to meet future investments needs. Attracting private investment into the energy sector will require creating an institutional framework that enables energy enterprises to operate on commercial principles. In particular, a transparent regulatory process is needed to provide an environment that fosters competition, efficiency, and private investment.

Institutional Restructuring and Development

15. The institutional restructuring of energy sector operations is at the core of the challenges ahead. The entities with primary responsibility for power (Egyptian Electricity Authority; EEA) and petroleum including natural gas (Egyptian General Petroleum Corporation; EGPC) are fully controlled by the government. They lack autonomy in management and commercial focus in their operations and essentially institutionalize policies established by the government. For example, prices for electricity, petroleum products, and natural gas are set by the government and administered by EEA and EGPC. Not surprisingly, EEA and EGPC exhibit typical command-and-control type of relationships with the other participants in sector operations.

16. The other energy operating entities, such as the power distribution companies, refineries, wholesale petroleum product distribution companies, and gas pipeline and distribution companies, are directly controlled by EEA or EGPC and thus indirectly controlled by the government. No formal agreements or contracts exist between any of the operating entities, and although such contracts are now being initiated, they are not easy to put into operation. For example, the other companies operate on the basis of an average profit margin (percent of net profit): about 8 to 10 percent (for 1993) in the case of the power distribution companies; and about 2 to 4 percent as in the case of refineries, petroleum products, and the natural gas pipeline and distribution company. These arrangements mean that in general the sector operating entities lack the motivation to operate efficiently, because they are assured of predetermined agreed returns regardless of the outputs and results of their operations.

They thus have insufficient incentives to control costs; enhance revenues; improve customer services; or operate on the basis of efficient, technical, economic, and financial principles.

Energy Pricing

17. Historically, the abundance of petroleum, natural gas, and hydropower resources permitted the government to supply energy to the population at below-market costs. In retrospect, it can be said that the government took it upon itself to maintain energy prices below economic levels.

18. The government has been taking steps to correct the costly subsidization, including stepped increases in energy prices over the last three years. In early 1994, the weighted average electricity tariff as a percentage of LRMC was about 80 percent and currently the ratio is closer to 90 percent (based on an economic value for natural gas pricing). The weighted average of petroleum product prices was at about 100 percent of their internationally traded equivalents (based on comparing retail prices to fob international prices). The gas tariffs are also closer to the 90 percent level of their economic costs (based on international consultants' computation in 1994). Although the energy pricing reform progressed steadily, the micro-level pricing structures have not been addressed adequately, and subsidies and cross-subsidies have not yet been completely eliminated. For example, low LPG prices are preventing natural gas prices to residential customers from increasing, and LPG sales to commercial customers are still not competitive.

19. The government is committed to adjusting energy prices to economic levels. However, reaching economic levels on average would not correct the situation. Prices should be based on costs, i.e., cost of providing service, with a steady elimination of subsidies. Where actual or potential competition exists, operating companies should enter into commercial transactions for buying and selling of energy based on contractual relationships. A market-based pricing policy would accelerate energy price liberalization. It would also enhance the financial viability of operating enterprises and facilitate the entry of new suppliers.

Cross-Sectoral Impacts

20. The challenge of overall institutional development lies in adopting policies that address the specific concerns about cross-sectoral impacts and in developing an appropriate institutional framework for implementing the required changes. The key cross-sectoral impacts on energy policy are related to the discovery of large gas reserves:

- Magnitude of available gas reserves and consequent impacts on crude availability and exports, as well as power generation investment

- Price of gas and its consequence on electricity pricing policy and displacement of fuel oil in power generation, which would in turn influence surplus fuel oil available for export
- Change in refineries' product output profile and impact on crude and product exports
- Presence of IOCs in upstream oil and gas operations and the impact of deregulation on downstream operations
- Value of gas exports in relation to the domestic market.

21. To implement market-oriented policies, there will be a need to issue revised laws; develop new regulations for rate setting and automatic tariff adjustment mechanisms to ensure financial viability of sector institutions; establish standards of supply; protect consumer interests; and create an enforcement and appeals process. These actions require a regulatory body that is credible and that has the confidence of all stakeholders in the sector.

Regulation

22. Regulation is needed to avoid monopoly abuses, enable competition, efficiency and entry of cost effective producers in the sector. It must cover equally private and public enterprises in the sector. However, in undertaking its role as impartial regulator of the energy markets, the government must avoid a conflict with its other objectives, as a policymaker and custodian of the state's ownership of major assets in the sector. This conflict can be resolved by institutionally separating the regulatory functions from policy and ownership functions. In particular, the regulatory body should be autonomous from the government executive agencies, and the regulatory mechanism should be transparent to all concerned parties—producers, distributors, and consumers.

23. The new regulatory mechanism should be (a) sufficiently flexible to adapt to evolving changes in the market, yet have a sound legal basis to prevent arbitrary manipulation; (b) responsible for promoting economic efficiency, sound technical standards, and the interests of public safety; (c) non-intrusive and backed by a legal framework for dispute resolution, with the regulatory body given the quasi-judicial authority to adjudicate complaints or disputes and to enforce regulatory judgments.

Subsectoral Analysis

Power Sector

24. The power sector has been operating with gradual improvements in technical performance such as improved thermal efficiency, reduced line losses, improved capacity and availability, gradual buildup of combined-cycle plants, over the past decade. However, operational efficiency is below potential because of transmission network constraints and dispatching limitations. The economic dispatch merit order is

skewed by transmission network constraints that force suboptimal operation of generating plants: that is, less efficient plants gets preference in the merit dispatch order. Also, investment planning is hampered by a demand estimation process which hitherto has not included actual field surveys for residential and industrial consumers, who account for about 70 percent of electricity consumption.

25. However, the technical improvements have not been matched by improvements in the sector's financial performance. Two major issues have had a direct bearing on this problem: (a) the process of administering and maintaining electricity prices, and (b) the lack of accountability in the collection and payment system for customers, including the transfer of funds to the state treasury. The government sets electricity prices, and EEA administers them. Hitherto, there have been no formal contracts between EEA and the distribution companies (DCs) for buying and selling power, although a contractual process has now been initiated. Government determination of electricity prices provides subsidies to consumers to address social concerns. These subsidies are targeted so broadly that most consumers benefit regardless of their need. EEA or the DCs have no control over non-payment of bills, particularly from government customers and public sector enterprises. The sector self-financing ratio for 1993 was about 10 percent compared with an international typical standard of 30 percent. Average bill collection was about 180 days compared with a target of about 60 days. A more recent development that has affected the financial performance is the ad-hoc contribution claimed by the government for its budget reserve purposes from the revenues of the power sector.

26. On the institutional development aspects of the power sector, there is general acceptance that a new business environment is mandatory for increasing competition in the electricity supply business. High on the agenda for the government is the acceptance for setting up an appropriate regulatory framework to provide a level playing field for all concerned parties—producers, suppliers, and consumers. On the distribution side, in line with the policies for enterprises under public holding companies, the distribution companies are expected to be privatized eventually. However, the government and sector operating officials have expressed a clear preference for a gradual approach that would corporatize and commercialize the distribution companies before their ultimate divestiture.

27. In the ongoing debate on electricity pricing, although progress has been achieved, there is scope for further improvements. Average power tariffs have been increased from less than 20 percent of long-run marginal cost in the 1980s to about 90 percent now. The more recent improvement in gas reserves, specifically the near-doubling of the proven reserves, signals an era of gas-driven strategy for the energy sector. Although the doubling of gas reserves has lowered the marginal cost, and as a result brought tariffs comparable to marginal costs, cross subsidization among consumers still exists. In addition, the tariff levels are inadequate to generate sufficient financial resources for future investment needs.

28. The *challenge for the power sector is to transform the existing enterprises into commercially oriented operating entities working in an environment governed by a transparent regulatory process.* This would give enterprise managers clear incentives for efficiency and encourage new entrants from the private sector. With incentives to maintain financial viability, the operating entities would be encouraged to prudently invest, create a competitive environment for fuel procurement and for buying and selling energy. Steps are under way to create a commercial focus both in generation and distribution functions. It is important that the subsequent steps be accelerated and progress be made toward commercial working. The restructuring efforts of the power entities should lead to private sector participation both in generation and distribution functions. The government has indicated that there would be private sector participation for all new generation beyond 2000, either through BOOT, or its residual arrangements.

29. Allowing private entry into generation can be the first step in decentralizing the sector and paving the way for increased supply competition. In that sense, it is the first step in sector unbundling and structural reform. Although initial private investments can be regulated by concession contracts, a necessary condition for sustained power sector investments by the private sector is the arms'-length restraint in government involvement that is achieved through an independent regulatory mechanism. Nonetheless, there would still be a role for the government in key areas such as facilitating innovative financing mechanisms such as guarantee programs, promoting local private sector involvement through domestic capital markets development, indicative sector planning, ensuring availability of fuel, monitoring and enforcing compliance with environmental regulations, protecting poorer sections of society during the reform process, developing of worthwhile hydro projects that are too risky for commercial financing, enhancing service to remote rural areas, and protecting national strategic interests.

Petroleum Sector

30. The petroleum sector is characterized by internationally competitive production-sharing arrangements in the upstream sector and integrated operations in the downstream sector. In the upstream sector, Egypt has a successful record of attracting foreign contractors to participate in oil and gas exploration and production activities. The upstream sector has been able to sustain an increasing level of participation of IOCs in exploration and drilling agreements (at present, 23 exploration agreements are in force, and a successful bidding round was closed at the end of 1994). The current committed exploration agreements call for the drilling of 148 exploration wells at a cost of about US$600 million. Factors supporting an optimistic view of a moderate increase in future production are the reporting of several new developments in Sinai and the Western Desert; this should lead to at least maintaining current levels of production at 880,600 barrels per day. A more-likely scenario is production to be maintained at a level of around 750,000 barrels per day into the year 2010. However, a less-likely scenario is that

oil production is expected to taper during the early years of the next century to about 615,000 barrels per day by 2005.

31. In the downstream sector, core issues are effectiveness of refinery operations and competitiveness of petroleum products distribution. All seven local refineries are in reasonably good condition and are fairly well maintained, but they are of hydro-skimming type and are comparatively small in crude distillation capacity. The refineries are not run as cost/profit centers in a competitive environment. In some cases, the refineries suffer from a combination of inappropriate designs and inefficient yields. They operate with low economies of scale and give rise to environmental concerns (in particular, the Mostorod refinery, near Cairo). The absence of cracking facilities has resulted in loss of valuable foreign exchange earnings, because low-value products (like fuel oil) are exported, whereas high-value products (like jet fuel and gas oil) must be imported given that the facilities cannot produce upgraded middle-distillates. Options for installing cracking facilities are now being evaluated by the Ministry of Petroleum and EGPC. In order to facilitate private sector participation in the refinery sector, two export-oriented refineries are being planned with the participation of foreign counterparts.

32. For petroleum product distribution, the integrated nature of EGPC's operations has kept a tight control on prices as well as the nature of participants. The public sector companies MISR and COOP have monopoly control of the market, and end-user prices are determined by the government. The pricing mechanism is not transparent, although private dealers at the retail level (through franchises for IOCs, i.e., Mobil, Exxon, and Shell) seem to have a majority share of the market. The commission/margin system for distributors of petroleum products and the control of licenses by EGPC for retail outlets have created distortions in the petroleum product supply and in distribution efficiency. The weighted averages of domestic petroleum product prices are below their real import parity levels and cross-subsidies still prevail.

33. The *challenge for the petroleum sector is to introduce transparency and competition in its operations.* The key issue to address is how to make the downstream industry benefit from the experience of the upstream sector by reducing the role of the government in sector operations, pursuing free-market principles for expansion, and introducing efficiency measures into the industry. The refining sector should be geared toward improving its utilization and toward adopting a product output profile that maximizes returns. With international technical assistance, EGPC is planning to correct the lack of optimization/rationalization in the production pattern by upgrading and modernizing facilities.

34. The options currently being considered should lead to the rapid implementation of specific measures and the preparation of a long-term strategy rationalization of the refinery sector. The first set of options would improve refinery efficiency by lowering costs and undertaking economically justifiable investments (e.g., utilization of upgraded units and refinery instrumentation and improvements in

productivity). The second major option EGPC is evaluating is the introduction of cracking facilities (at Suez or Alexandria) to upgrade heavy fuel oil to premium distillates. The economic advantages of different cracking options (hydrocracker vs. fluid-catalytic cracking; FCC) are being evaluated by international consultants; in either case, these are capital-intensive investments with relatively long payback periods. The questions are whether EGPC should undertake such major investments, how these investments could be carried out under nonmarket conditions, and whether a private sector operator would be willing to undertake them. The third important option/opportunity under discussion with the international oil industry is the introduction of private, export-oriented refineries into the market. The small refineries in Egypt would find it very difficult to survive in free-market conditions and may face closure when the products from larger upgraded centers are sold at competitive prices in the domestic market. The Alexandria and Suez refineries in particular would need to adopt several upgrading procedures in order to survive.

35. For petroleum products distribution, the challenge is to deregulate operations to facilitate full liberalization in the near future. There seems to be a consensus on the objective of liberalizing the market. However, an interim operating mechanism still must be developed that allows market-based operations and competitive market conditions to emerge incrementally. As a first step, the petroleum product downstream sector should be deregulated. Wholesalers should be able to buy petroleum products at the refinery gate; ex-refinery price is the basis for an efficiency indicator in refinery operations. Wholesalers and retailers should have commercial agreements or contracts for the exchange of products. A follow-up to deregulation should be EGPC's withdrawal from the wholesale distribution function. Wholesale and retail marketing and distribution should be in the hands of private operators. However, the government (initially) and a suitable regulatory body (subsequently) should be responsible for maintaining product specifications and ensuring safety and environmental standards. Another option to consider is permitting private operators to import petroleum products into the local market, thereby facilitating competition.

Natural Gas Sector

36. The recent developments in the projected availability of natural gas could become a turning point in the Egyptian energy sector. The policy adopted by the government of encouraging IOCs to explore for and produce gas has stimulated natural gas production and use, particularly in the power and industrial sectors. The reserves position has also improved from the new findings: proven reserves are of the order of 22.3 tcf; probable reserves are of the order of 8.8 to 9.8 tcf; and additional prospective reserves, of about 40 tcf. Although the reliability of these estimates is under heavy scrutiny, it can be argued that the increasing availability of natural gas plays a leading role in shaping the future direction of the energy sector. However, the integrated nature of EGPC which, along with its subsidiaries, controls the level of commercialization in

downstream activities, reflects that equitable distribution of risk, reward, and responsibility is not transparent.

37. The supply/demand balance has been the focus for developing a consensus on energy sector policy. The availability and price of natural gas determines the future for power plant operations and refinery product output profile. In the case of power generation, the availability and price of gas has an impact on the type of plants that will be built (dual-fired steam turbines vs. open/combined-cycle) and on the type of fuel that will be used (fuel oil vs. natural gas). In the case of refinery output, a lowering of demand for fuel oil would alter the product profile significantly, leaving surplus fuel oil available for export. This situation will eventually lead to a trade-off between exporting crude (and fuel oil) and processing crude to produce higher-value products, which in turn would necessitate additional investments in upgrading facilities.

38. The supply/demand balance consequently influences natural gas pricing. Currently, the target for natural gas prices is based on the equivalent cost of the fuel that gas displaces (i.e., fuel oil). In the petroleum product price formula, natural gas is priced on the basis of the cost of fuel oil with an increase of about 20 percent for greater conversion efficiency. Using that formula, the price of natural gas is 7.55US¢/m^3 based on a 12-month average of international fuel oil prices ending February 1995. However, with the projected improvement in gas reserves shift from fuel oil parity towards LRMC plus depletion premium may be argued. The British Gas study (1994) computation of the LRMC of gas is 3.36US¢/m^3 (for the base case of demand) and 3.51US¢/m^3 (for the most likely case of demand); however, British Gas has not identified the need for use of depletion premium. The value of the depletion premium is directly linked to the natural gas reserves and hence its true value is uncertain. Accordingly, natural gas prices can be specified as international fuel oil equivalent with a discount factor, to arrive at a price related to marginal cost plus depletion premium, that would encourage natural gas utilization and development.

39. Downstream natural gas operations are structured similarly to petroleum downstream operations. EGPC's subsidiaries, PPC and Petrogas, have a monopoly in the transmission and distribution of natural gas, respectively. They receive a commission or margin of up to 4 percent based on their operating costs. Egypt Gas has a national monopoly in gas installations, gas connections, and gas maintenance. Thus, EGPC and its subsidiaries have monopoly control of the downstream gas sector. The current institutional arrangement should be replaced by independent private operators in order to generate competition in the downstream operations. The newly established gas transport joint venture between EGPC and two foreign companies is a step in the right direction.

40. The *challenge for the natural gas sector is to adopt a sustainable policy based on the improved proven reserves situation, to produce more gas, and to encourage efficient utilization.* The main users of natural gas are the electricity sector (about 65 percent) and the industrial sector. Natural gas policies have a direct impact on the energy

transformation efficiency of the electricity sector. Thus, flawed natural gas policy could hurt the energy sector significantly, particularly power sector operations. Not only would efficiency improvements in the power sector be lost, but also, foreign exchange earnings would be reduced through foregone substitution of gas for exportable petroleum products, as well as lower gas exports. With the renewed confidence in the proven reserves situation, the natural gas sector should move toward setting up an appropriate regulatory framework for providing a competitive environment for the producers, service companies, and users.

41. The regulatory framework should facilitate the rapid and efficient development of the gas industry by ensuring that (a) producers are willing to explore and develop new reserves; (b) transactions take place at market prices so that gas be sold both to domestic and export buyers without subsidization much like the practice of most current major gas-exporting countries; (c) access to pipeline transportation be open to private firms on a nondiscriminatory basis; (d) the current monopoly practice in which Petrogas is responsible for competing products, LPG, and natural gas sales be changed to allow entry of new suppliers and marketers; (e) transportation (currently the monopoly of PPC) be based on contracts and new transporters allowed into the market; (f) private operators be encouraged to participate in gas downstream operations; and (g) competition be introduced in gas marketing and distribution.

Energy Conservation and Environmental Protection

42. Egypt has become increasingly interested in energy conservation initiatives. The main energy companies are now actively involved in conservation programs and have initiated and financed several programs through internal funds as well as grants, dominated by a USAID grant of US$50 million. Despite these concerted efforts, the real benefits realized by the ongoing energy conservation programs as well as the sustainability of such programs remain to be seen.

43. Environmental protection and how it affects the energy and economic polices in the country has also been of increasing concern. However, environmental protection programs presently in place are in the early development stage. It was not until December 1993 that the government passed the National Environmental Law. The immediate focus is to develop subsector-specific (i.e., power, petroleum, transportation, and industry) environmental protection programs and the government is taking necessary steps to do this.

44. The *challenge for energy conservation and environmental protection is to improve the efficiency of operations and reduce emissions and other impacts on the environment through well-defined policies and appropriate guidelines.* Because the need for energy conservation reduces pollution at the level of energy supply, as well as produces direct economic benefits, a coordinated effort should put in place an appropriate institutional framework for effectively managing the several efficiency improvement programs already in place and those being planned.

45. A broad consensus has emerged, based on the current institutional working arrangements, that an updated vision and action-oriented strategy should be developed by all stakeholders for promoting energy conservation through the Organization for Energy Conservation and Planning (OECP) and linked to the overall national energy strategy. The strategy should consider a wide range of programs in three key sectors: industry, buildings (residential and commercial), and transport (private and public). It should also take into account the barriers to enhanced energy conservation. A consensus seems to have emerged about two key areas that need further scrutiny: (a) strengthening the institutional framework, including streamlining the role and interface between the numerous entities currently involved in energy conservation; and (b) introducing innovative techniques for financing energy conservation programs, including private sector involvement and suitable payback mechanisms.

New and Renewable Sources of Energy

46. New and renewable sources of energy in Egypt have tremendous potential. Several renewable energy projects are under way (dominated by the US$13 million EREDO project) funded from both internal and external sources. However, as the current programs are operating with a "dispersed" strategy and lack agreed priorities, the target for renewable energy contribution established in 1980 (i.e., 5 percent of primary energy demand for the year 2005) should be reassessed.

47. Current evaluations indicate that photovoltaic (PV) applications, small wind farms, domestic solar water heaters, and industrial process heat have had fair success in selected locations. In light of the ongoing worldwide development of renewable energy technology, an enhanced strategy linked to the overall national energy strategy is to be developed that could be regularly updated in the future. Institutional building and strengthening, along with innovative financing techniques, are key areas for improvement and development. Opportunities for large scale implementation of renewable energy that have a major impact on the sector (e.g., large commercial wind farms and solar thermal power generation) should be vigorously exploited through partnerships of government, private sector and specialized agencies (like the Global Environment Facility).

48. The *challenge for new and renewable sources of energy is harnessing appropriate technologies and suitable schemes which measurably supplement the energy supply of the country*. Such schemes should be actively pursued, and suitable renewable energy policies should be integrated into the overall national energy policy framework. Solar and wind energy could play a useful role in the energy sector, provided a "niche" focus is identified. Large scale wind farms, solar-thermal power generations, and dispersed off-grid PV power generation for rural communities have already been identified as prospective projects for near-term implementation. Because renewable energy schemes require large investments in the initial stages of development, selected

projects will be based on the comparative advantages of non conventional supply sources over traditional options.

Conclusions

49. The current status of the energy sector is in conformity with the economic transition of the country: movement toward a market-based economy. Several reform and restructuring actions have been taken in line with the macroeconomic reform agenda. The future objectives of the energy sector are to have commercially viably energy enterprises, operating in an independent and transparent regulatory framework; competition induced through an increasing role of the private sector in energy operations; and the government's role limited correspondingly. To realize the full benefits of a market-oriented economy, the energy sector liberalization currently being pursued should be sustained. Naturally, the reform path and pace of reform should suit the overall macroeconomic development strategy of the country.

50. The following recommendations of the working group are presented in the context of restructuring and reform actions already under way and in line with government's objective of moving toward a market-oriented economy. The thrust of the options is to provide greater autonomy to the energy sector and to facilitate an increase in private sector participation in energy operations.

51. With the objective of strengthening the energy-economy linkage, the following policy guidelines have been identified:

- The energy sector is a leading sector that will continue to create economic growth
- Liberalization of the energy sector should have no adverse employment impact on the economy, but will instead create an environment for improving productivity, efficiency of operations and job creation; and
- Energy sector liberalization measures should create the right environment for promoting natural gas utilization and development and for increasing the role of private sector participation in energy operations.

Strengthening the Restructuring Process

52. With the objective of strengthening the restructuring process in the power, petroleum, and natural gas subsectors, the following specific measures are recommended:

- Commercialization is the first step toward improving efficiency of operations
- Contractual arrangements should be introduced at all levels of operations

- The private sector should be introduced into new power generation, new refinery operation, wholesale petroleum product distribution, and natural gas transmission and distribution.

Promoting Competition and Introducing Regulation

53. With the objective of promoting competition in power, petroleum and natural gas subsectors and introducing regulation in power and natural gas subsectors, the following specific measures are recommended:

- Price liberalization should continue with the aim of recovering full-cost of service, eliminating subsidies, and minimizing cross-subsidies
- A regulatory body should be instituted that governs a transparent process addressing sector structure, dispute resolution mechanisms, and with the power to enforce judgments; and
- The regulatory body will be responsible for promoting technical efficiency, financial health of the operating enterprises, suitable performance standards, and safety.

Building a Strategic Role for Energy Efficiency

54. With the objective of building a strategic role for energy efficiency (energy conservation, environmental protection, and renewable energy), the following policy guidelines have been identified:

- An updated vision and action-oriented strategy for energy efficiency activities and linkage to the overall national energy strategy by all stakeholders (i.e., power, petroleum, and natural gas operating entities and consumers) should be prepared and submitted to the cabinet for approval.
- Energy conservation strategy should concentrate on three key sectors: industry, buildings, (residential and commercial), and transport (public and private).
- Environmental protection measures should concentrate on specific regulations and incentives for power, petroleum, and natural gas subsectors and should be integrated with the national environmental protection laws and regulations
- Renewable energy strategy should concentrate on promotion and development of large scale applications of solar-thermal power generation, large-scale wind farms, and off-grid photovoltaic applications with an added responsibility for rural electrification and/or isolated power generation.

1

Energy Economy Linkages and Financial Resource Mobilization

Macroeconomic Reform Content

1.1 An assessment of Egypt's energy sector comes at a time when the country is refocusing its macroeconomic policies to realize the potential for export-led growth by year 2000 and beyond. In the last few years, structural readjustment and debt relief programs have produced a positive balance of payments and a buildup of foreign exchange reserves. However, progress on fiscal and monetary reforms and privatization of parastatal companies has been much slower. The slow progress could potentially hamper the future capital inflow and direct foreign investment in the energy sector.

1.2 The country is geared to achieving a faster growth through conservative macro policies and liberal approach to trade and private/public enterprise management. Growth rates of GDP are projected at about 4 percent annually over the remainder of the decade. However, some key issues must be considered with regard to the coming years. Egypt has had a substantial trade deficit, which widened in 1994. The current account balance remained positive, at about US$2 billion in 1994. Workers' remittances, Suez canal fees, tourism, and petroleum are the key contributors to export earnings. Based on the expected growth in GDP, the policies affecting both local supply and demand need to revisited. Particularly, the outlook for exports is constrained by declining availability of petroleum for exports and by problems of export competitiveness. For the future, ensuring a reliable and efficient energy supply and use (energy balance) will be an important consideration in trade and capital flow policy.

Sector Reform Objectives

1.3 The energy sector is an important base for Egyptian economic development. The power and petroleum sectors, including natural gas, form the driving mechanism of economic growth. The sector development policy from a macroeconomic view seeks to make the most of petroleum and natural gas resources to maximize export potential. This calls for introduction of several institutional and financial restructuring measures and macro

or sector policy initiatives. The government has initiated some reform objectives through the Economic Reform and Structural Adjustment Program (ERSAP)—energy pricing reform and planned privatization for the distribution companies. The assessment indicates that the existing reform program does not adequately address the broader issues confronting the overall sector: state-monopoly and control through EEA and EGPC; sector investment decisions; price controls, barriers to entry and exit; heavy dependence on state resources; and lack of efficiency, autonomy, accountability, coordination, and control among sector operating entities. With these objectives in view, moving toward commercialization of electricity tariffs, liberalization of petroleum product prices to eliminate relative price distortions, putting in place a regulatory framework and institutional reforms to implement restructuring measures, and seeking of private sector participation in power and petroleum/gas downstream operations are high-priority policy issues that the government must address.

Energy-Economy Linkages

1.4 At the end of the second five-year plan, (1991–1992) the energy sector accounted for 12.2 percent of GDP, 22.2 percent of total investment, 56.1 percent of commodity exports, 6.8 percent of public revenue, and 1.0 percent of total employment. Future energy-economy linkages are in principle bi-directional. In practice, the direction in the shortrun is from macro economy to the energy economy. Adjustments from the energy economy to the macroeconomy take time to become effective, as improved energy availability's and efficient energy prices have impacts on industrial development, on energy intensity, and on costs and competitiveness over time.

Role of the Energy Sector to 2000 and beyond

1.5 As the Egyptian economy grows at about 4 percent annually in the second half of the 1990s (base forecasts), total energy requirements are estimated to increase at annual rates ranging from 3.7 percent in 1995 to 4.4 percent in 2003 (i.e., about 1:1 income effects). Electricity consumption growth projections range from 5 percent annually in the mid 1990s to more than 6 percent annually early in the next decade, resulting in rapidly growing needs for energy inputs into electric power generation. Even with annual growth of natural gas production of 8 percent (used largely in production of electrical power), needs for oil in power generation will rise at about 2.5 percent annually to year 2000. In the face of gradual decline of domestic oil production of 2.3 percent annually, the crude oil export surplus will diminish by approximately 50 percent in quantity terms between 1995 and 2003. Crude oil export is projected to decline from 20.5 MTOE in 1995 to 10.3 MTOE in 2003. Consequently, export earnings from petroleum decline by $0.5 billion per year during this period, tightening the balance of payments and imposing a financial constraint on future growth. Alternative simulations considering variations of GDP growth rates, variations in level of natural gas development, and other improved efficiency scenarios were carried out and its summary results are presented below.

1.6 Even moderate assumptions about Egyptian growth and energy demand elasticity's indicate that energy consumption in Egypt will tend to outrun production. The consequence will be a reduction by approximately one-half in Egyptian crude oil exports, from 20.5 million tons in 1995 to 10.3 millions tons in 2003 with GDP growth at 4 percent annually.

1.7 Alternative GDP simulation considering lower GDP growth rate of 2 percent annually represents a difference of 6.3 million tons (exports of 17 million tons) from the base case of about $1.1 billion in value terms.

1.8 More rapid economic growth would further reduce crude oil exports by 5 million tons in 2003, putting into question whether more rapid growth is possible without simultaneously modifying energy utilization or supply patterns.

1.9 Improved energy utilization efficiency through modification and better utilization of refineries and improved electrical power transformation efficiency offer the potential for allowing faster economic growth and higher energy use. These efficiency gains, which call for substantial investments in refining and power plant equipment, yield sufficient improvement in energy use to allow a modest increase in the exportable crude oil surplus.

1.10 Assuming that substantial financial resources for more rapid gas development can be obtained, the expansion of energy supplies would be consistent with more rapid growth of the Egyptian economy with a small reduction in the available crude oil for export.

The Interaction of Macroeconomics and the Energy Sector

1.11 Key issues in the relationship between macroeconomic performance and energy sector development include the following:

- How can long-run needs for energy and the crude oil export surplus be satisfied given the limits of Egypt's oil resources? To what extent can the shortfall be bridged through the expansion of natural gas production and/or through improved utilization efficiency?
- What are the implications of financial resource mobilization—for energy pricing commercialization/liberalization, for institutional and financial restructuring, and for speeding up the pace for privatization of power distribution and oil and gas downstream operations?

Reform Action Options

Power Subsector

1.12 The actions to address in the short-to-medium term include the following:

- Completing adjustment of tariffs based on economic and financial principles so as to promote financial viability of power enterprises
- Completing commercialization of power enterprises by eliminating subsidies and cross subsidies, giving them autonomy, and designing a transparent regulatory framework to attract private sector and provide open access for transmission
- Implementing, in the medium term, appropriate institutional and financial structuring measures leading commercialization of power companies; instituting an independent and transparent regulatory framework for monitoring and oversight of the power companies' operations; and putting in place a favorable environment to attract private investors to participate in power sector operations.

Petroleum Subsector

1.13 The issues to address in the short-to-medium term include the following:

- Eliminating subsidies/cross-subsidies and liberalizing petroleum product prices.
- Obtaining an improved match between the domestic consumption pattern and refinery output patterns through optimization and rationalization
- Finalizing policy and legislative measures needed to promote private sector participation in oil/gas downstream operations (e.g., open access for gas transmission and distribution, regulation for natural gas operations, deregulation of petroleum product prices, transparent entry/exit criteria for participating in sector operations).

Natural Gas Subsector

1.14 The issues to address in the short-to-medium term include the following:

- Developing an investment plan to ensure sustained development and production of natural gas resources
- Establishing a natural gas pricing policy to ensure efficient utilization of natural gas resources and to attract private investment in downstream operations.

2

Power Sector Development

Key players: the Ministry of Electricity and Energy (MEE), the Ministry of Administrative Reform, Public Sector and Environment, the Egyptian Electricity Authority (EEA), Ministry of Finance (MOF), seven Generation Zones (GZs), the Rural Electrification Authority (REA), the holding company for electricity distribution and eight distribution companies (DCs).

Overview

Responsibility

2.1 The Ministry of Electricity and Energy and the Ministry of Administrative Reform, Business Sector and Environment oversee the power sector. The principal institutions operating in the power sector are the EEA, a publicly owned enterprise, responsible for all generation through seven generation zones (GZs), dispatch (one national dispatch/control center and three regional dispatch centers), and transmission; the Rural Electrification Authority (REA), responsible for construction of distribution networks in urban and rural areas; the Holding Company for Electricity Distribution (formed under Law 203, Public Enterprise Law), which has eight distribution companies (DCs) organized as stock corporations (owned by the government) and is responsible for all electricity distribution in the country.

Capacity

2.2 Installed capacity is about 11,900 MW (1993) in the Unified Power System (UPS), which accounts for 99 percent of the total installed capacity in the country. The balance of about 1 percent is provided by isolated supply units. The breakdown of the installed capacity is 2,700 MW (about 22 percent) from hydropower; 5,900 MW (about 50 percent) from thermal (steam) units; and 3,300 MW (about 28 percent) from gas and combined-cycle units. [Refer Annex 1 for installed capacity distribution in the seven generation zones.] However, the installed capacity is much greater than the net available capacity of 10,323 MW, which includes 9,185 MW of available capacity from existing plants, 600 MW of new added capacity, and about 538

MW of accumulated retirement capacity. The breakdown for the existing 9,185 MW is 7,435 MW available from thermal capacity and 1,750 MW available from hydro capacity. The reserve margin has been maintained at about 25 percent.

Demand

2.3 The system peak demand was about 7,500 MW in 1993, with a relatively high load factor of about 70 percent. Sales by UPS amounted to 42 TWh (1993), of which 32 TWh were sold by the DCs and the balance of 10 TWh were sold directly by EEA to large industrial consumers. The market structure for electricity sales is about 46 percent industrial, 34 percent residential, with the balance of 20 percent comprising commercial, agricultural and government clients. Sales have grown by about 3.4 percent this past year (1993–94). Between 1989 and 1993, sales grew at about 4 to 5 percent, and for the period 1983-90, sales grew at about 8.4 percent per annually. Comparative statistics on average annual growth of energy and per capita energy use for a few selected countries are shown in Table 2.1.

Table 2.1: Average Annual Growth Rate of Energy Consumption and Per Capita Energy Use, Selected Countries

Country	*Average annual growth rate of energy consumption (1980–92)*	*Per capita energy use (KGOE, 1992)*
Argentina	1.2	1351
Colombia	3.8	670
Egypt	6.1	586
Indonesia	7.2	303
Jordan	4.3	813
Malaysia	9.6	1445
Mexico	3.1	1525
Morocco	3.7	278
Pakistan	6.9	223
Philippines	3.1	302
Turkey	5.3	948

Source: World Development Report 1994.

2.4 Electricity demand forecasts are generally derived from econometric models driven principally by GDP growth, population forecasts, and prices. EEA has postulated three GDP scenarios with annual growth rates of 4, 5, and 6 percent, respectively. Historic consumption statistics from consumer categories, population, population under electrification, and electricity prices are used in the extrapolation of

demand. At present, no field surveys are being carried out to determine demand by individual consumer categories. A price sensitivity of demand module has been introduced more recently in the demand forecasting process. Issues related to demand concern principally the reliability of forecasts in light of uncertain factors surrounding them (consumer behavior vis-à-vis driving variables in econometric models).

Supply

2.5 Gross generation was about 47 TWh in 1993 and has grown at an average of about 7.4 percent annually during 1981-93. Overall losses are about 14 to 15 percent for 1993 compared with 17 to 18 percent in 1983-84. See Annex 2 for variation in electricity generation, sales and system losses from 1981-93. Fuel consumption efficiency, determined in grams of equivalent fuel oil consumed for average kWh of electricity energy produced, has decreased from 346 g/kWh in 1981/82 to about 260 g/kWh in 1991/92. Thermal efficiency was about 34 percent (1993) compared with 24 percent in 1982.

2.6 System generation expansion is based on two optimization models, WASP and EGEAS. The former is the standard; use of the later is being developed under the integrated resource planning model. Current expansion plans include dual-fired thermal plants (i.e., using either mazout—heavy fuel oil—or natural gas). The tradeoff is between developing conventional dual-fired steam plants involving higher capital costs or developing lower-cost, combined-cycle plants. With the improvements in natural gas reserves, availability, albeit at high gas cost, is steadily on the rise. However, the present generation expansion plan favors conventional steam units. The new steam plants require about US$3.2 billion over the period from fiscal 1994 to 2000.

Operations

2.7 The distribution companies (DCs) purchase electricity from EEA and sell it to their respective certified areas of distribution. Tariffs for energy purchase are not uniform, and no formal contractual arrangements for power supply exists between EEA and the DCs. Purchase price (wholesale tariff) for each company is negotiated between the holding company and EEA in order to yield an average price acceptable to the DCs.

2.8 Retail tariff levels are currently at about 90 percent of economic cost. Tariffs are set by the government and administered through the MEE and EEA. [Refer Annex 3 for electricity costs, prices and taxes imposed on consumers.] Based on the existing method of tariff setting, prices do not play an economic role in signaling the cost of service, and the affected economic agents do not participate in the tariff-setting process.

2.9 Power sector finances overall are unsatisfactory: the self-financing ratio was about 10 percent (1993); debt-service coverage was below 1; and accounts receivables averaged about six months in arrears. Factors responsible for this

performance are the low tariff levels; the borrowing policy for system expansion; the large buildup of receivables from government clients; and, more recently, the ad hoc payments from the electricity sector to the state budget. Preliminary financial analysis indicates that the DCs are in a healthier position compared with EEA. The reasons are that the DCs' accounts are maintained as an extension of EEA and that EEA ensures an average yield for each DC based on its operating costs and revenue earnings.

Institutional

2.10 The management of the power sector operating companies is directly linked to the Government and to the Ministry of Electricity and Energy. The links between EEA and the Government are strong in the areas of planning, tariff setting, and policymaking; however, EEA has made progress in decentralizing decisionmaking on the operational front. The various organizations participating in the supply and distribution of electricity lack a commercial focus because of the present institutional structure and working relationships with the Government.

Issues

2.11 The main issues in the power sector are as follows:

- Weaknesses in demand forecasting procedures and process.
- Generation planning constraints.
- Long-term availability of natural gas.
- Transmission network limitations.
- Dispatching difficulties.
- Distribution companies' informal institutional arrangement.
- Low tariff levels.
- Unsatisfactory financial performance.
- Lack of formal contracts and accountability of performance in institutional framework.

Demand Forecasting

2.12 The reliability of electricity demand forecasts used by EEA depends to a high degree on future GDP growth (scenarios of 4, 5, and 6 percent). Also, the forecasting process is not being consistently carried out through actual surveys of major consumer/end-user categories. Specifically, a consistent system of actual field surveys and monitoring of consumption patterns needs to be developed for industrial (46 percent of total sales) and residential (34 percent of total sales) consumers.

Generation Planning

2.13 System generation expansion planning is primarily through optimization programs. The generation expansion plan and investment program need scrutiny on account of fuel options (oil vs. gas), variation in fuel availability linked to the reserves' issue of oil and gas and unpredictable demand growth. EEA's planned generation expansion program includes steam plants that require investment funds of about US$3.2 billion for FY94-2000. If natural gas supplies are assured, less capital-intensive plants could be envisaged for the future. The steam plants that are in the generation expansion plan have already been committed. Under the circumstances, the issue to address would be as follows: can the plant mix be altered to accommodate gas turbine/combined cycle units if the gas situation improves?

Transmission Network

2.14 Transmission investments planned for FY94-2000 are about US$1 billion and envisage the extension and rehabilitation of lines and installation of substations to strengthen and improve the efficiency of the network. Presently, large loads are connected to the UPS so that fuel costs (distillate oil) of isolated power generation are reduced. However, the same rationale may not be valid for smaller loads as in the extension of specific 220 kV lines (for example, extensions around the Sinai area) to areas currently isolated from the UPS. Transmission system extension and strengthening, which are under consideration, need economic justification and should be based on an assessment of isolated versus interconnected power options.

Dispatching Facilities

2.15 Investments in dispatching facilities (about US$70 million for Cairo and Alexandria) are planned to upgrade and strengthen the dispatch center. The evolving institutional structure of the energy/power sector, which calls for commercialization and possible further unbundling, would necessitate continuous upgrading of dispatching facilities. The generation and distribution functions should operate as independent profit centers to benefit from the move towards commercialization. Depending on the extent of unbundling, the transmission function could also operate as an independent grid company, charging a fee for its services. Therefore, any new investments in the system dispatching facilities should take into account the need for isolating and differentiating costs for the supply and distribution from each of the proposed independent business units (generation, transmission, and distribution) .

2.16 The economic merit order of dispatching is hampered by several system constraints. The first constraint is the irrigation requirements specified by the Ministry of Public Works which affect the maximum utilization of the hydro resources. Second, certain transmission network constraints necessitate operating certain units rather than more efficient and/or less costly units—for example, the 66 kV link between Cairo South and Tebbin necessitates the operation of inefficient units at Tebbin power station. Such

transmission constraints have also delayed the retirement of older units in order to keep them as nonoperating reserves. Third, the policy to maximize utilization of natural gas overrides economic dispatch. Although the use of natural gas includes environmental benefits and potential for release of more oil for export, the policy enforced has favored power stations connected to the gas grid in lieu of more efficient plants (but not connected to the gas grid). Last, constraints on hydro and thermal availability also have affected the economic merit order of dispatching.

Distribution System

2.17 The distribution companies, although under a separate holding company, operate like an extended arm of the MEE. No formal contractual agreements exist between the generator (EEA) and the distributor (DCs) for buying and selling of energy, and no transparent mechanism is in place for setting prices or performance standards for operations. The selling prices of the DCs (retail tariffs) are determined by the MEE in conjunction with EEA. The power purchase price for each distribution company is based on an average margin of about 8 to 10 percent of net profit (1993) that is decided between the EEA and the Holding Company for Electricity Distribution. Thus, the DCs have no incentive to control costs and operate efficiently with a commercial focus because of the working arrangement with EEA (i.e., the assured level of returns regardless of operating costs). The assets of the DCs are currently being revalued in line with the objectives under the ERSAP. The purpose of this step is to determine a market value of each DC, which would facilitate eventual privatization. However, the progress after the regrouping of the DCs under the HC has been slow.

Tariff level

2.18 Current tariff levels are about 90 percent of the estimated economic costs of supply and far below the financial cost of supply. The financial cost of supply has varied between 20 and 50 percent higher than the economic costs of supply. The main reasons for the high financial cost of supply are: (a) the historical buildup of long-term debt and the inability of the power companies to service the debt; (b) the lack of a prudent borrowing policy for financing new investment; (c) the low level of retail tariffs, which are far below the cost of supply; (d) high accounts receivable caused by the absence of formal legal procedures to take action against parties delinquent in payment of bills; and (e) direct and indirect subsidies to consumers, which limit the scope for revenue-enhancing measures.

2.19 The tariff structure does not provide the consumer with the correct pricing signals for promoting efficient consumption. The tariff structure is relatively simple, with a flat rate for all HV customers, a kW/kWh (binomial) rate for industrial MV and LV customers, and a blocked/stepped (regressive) energy rate for smaller consumers. Tariff levels are on the average about 3.7US¢/kWh (refer Annex 3); UHV consumers have a rate of about 3US¢/kWh; the average industrial rate is about 3.9US¢/kWh; commercial rates are about 8.6US¢/kWh; and residential rates are about 2.5US¢/kWh.

Thereby, industrial and commercial consumers are cross-subsidizing the residential and other consumers, including agriculture/irrigation consumers. In order to charge consumers based on full cost recovery (i.e., actual/real cost of supply), EEA should develop independent schemes external to the tariff structure/level targeted at appropriate consumer segments. For example, subsidies targeted to say, poor residential consumers, should be made available as an independent line item from the state budget and could be administered via the tariff system. In addition, the tariff structure does not adequately address the coincidence of the consumption pattern with the load curve. For example, the tariff structure does not provide incentives for reducing peak consumption and/or shifting from peak to off-peak load. This is particularly important for HV users.

Financial Performance

2.20 The overall financial performance of EEA and the DCs is poor. EEA's performance is characterized by low liquidity, low debt service ratios, high levels of receivables and a low (occasionally negative) contribution to investment for future expansion. EEA had an internal cash generation of about 10 percent for 1993 compared with a target of 35 percent; a debt-service coverage ratio of about unity compared with a target of at least 1.5 times; and accounts receivables over 6 months compared with a target of 3 months. For the distribution companies, the overall sales margins are about 25-30 percent, which translates to adequate profit; however, the value margin is still relatively low.

Institutional Structure

2.21 The regulatory and oversight roles are not clearly separated from the management and operations role of the power sector enterprises. Under the existing institutional structure, the power sector enterprises lack an adequate incentive to operate with a commercial focus and to maintain financial discipline. The institutional mechanism does not allow economic agents to reflect their costs in providing service. The tariff-setting procedure lacks transparency and does not involve the participating power entities in the decisionmaking process. For example, neither the DCs nor the consumers are aware of the basis for tariff setting or the level of subsidies being provided. Accountability of enterprise performance is not being enforced. The enterprises lack an incentive to adhere to performance standards and to improve financial and economic results.

2.22 Several institutional issues surface based on the existing framework and mechanism. First, the power sector enterprises should operate with on commercial principles and be incorporated under the Company Law. Second, the role of public sector financing should be minimized, and private sector financing should be encouraged. Related issues are the use of private sector funds for investments in infrastructure and facilities, the initiatives for price liberalization and improved revenue collection. Third, an independent authority should be created to regulate the operating companies based on a predetermined set of rules that are transparent and offer the same criteria for all

operators—providers and users alike. Related issues are buying and selling agreements, related contracts, price-setting procedures, tariff structure and tariff level, criteria for investment in infrastructure and facilities, and addressing complaints of all concerned parties. Fourth, the role of the Ministry should be redesigned to policy setting and preserving national strategic interests. For example, the Ministry should lay the ground rules for the network interconnection with neighboring countries. Related issues are the reliability and security of the energy supply portfolio for Egypt.

Options

Demand Forecasting

2.23 Demand forecast by individual consumer category should be vastly improved through a more direct approach (i.e., actual field surveys of major consumer categories). Field surveys, particularly for industrial and residential consumers should be strengthened; hitherto, no field surveys have been carried out. The customer data base for industrial consumers is inadequate, and preliminary steps are being taken for residential surveys. The DCs should undertake extensive field surveys of the major consumer categories, the results of which should be fed back into EEAs data base for improved demand estimation. The high electricity consumption from industrial consumers (particularly fertilizer plants and aluminum smelters) can be justified only because of the high level of subsidies enjoyed. Sensitivity analyses to minimize the effect of variation of GDP estimation to electricity demand should be explored. In the 1995 forecast, sector GDP is being used instead of total GDP. The effect of projected GDP and forecasted population should be linked to the estimated electricity demand when the latter is being used for other planning and policy purposes, especially system expansion planning. Another key variable is the price of electricity and its influence on demand. The expected modification of consumption behavior from consumers stemming from the planned price increases would normally lag behind price increases and as a result would not affect the short-term demand forecast.

Generation Planning

2.24 Generation planning takes gas availability and the price at which it would be available as a given. A more desirable approach would be to model gas use through a supply function to take into account the level of uncertainty and unpredictability in demand pattern. The generation expansion (optimization) program should be complemented by a sensitivity analysis to determine its response to unforeseen circumstances. For example, the tradeoff/risk method of strategic approach to power planning should be adopted based on the current situation in the power/energy sector. In this method, a tradeoff analysis to optimize the multiple objectives simultaneously and a risk analysis subsumed into the former to hedge against irreducible uncertainties (such as load growth, fuel prices, customer response to demand-side management programs, investment costs, technological developments, and regulatory changes) would be able to

address the desired planning objectives: economic (cost of electricity), quality of service (reliability), financial (capital requirements), environmental (emissions) and strategic/social (fuel diversity).

2.25 Three factors have a significant bearing on the generation expansion plan. First, the consumption pattern for electricity has been erratic, particularly over the last few years. Reasons for the disparity include the effects of increasing electricity prices and the introduction of demand-side management programs. Also, the parameters used in the demand estimation contribute to the variation between projected demand and actual consumption. Second, the tradeoff analysis between conventional steam units and combined-cycle plants depends on the availability of gas. As a part of the tradeoff analysis, the availability of capital for financing either option comes into play. Third, consideration needs to be given to the outcome of the second factor (i.e., the tradeoff between oil and gas as a fuel) in the light of its impact on foreign exchange earnings. If gas supply could be assured with some degree of certainty, the system expansion plan could be better balanced between conventional steam units and gas turbine/combined-cycle units. Also, consumption of gas locally would make more oil available for exports

2.26 The present generation expansion plan (up to the year 2000) calls for conventional dual-fired steam units. EEA committed to using steam units when the gas availability was much worse than now. However, the system planners should also have provided the option to correct the situation based on the expected improvement in gas supply situation. In shifting from conventional steam units to gas turbine/combined-cycle units, the system planners should take into account the extension/strengthening of the gas grid necessary to meet the planned availability of power from these units. A related concern of the present generation expansion plan is the unit sizes that are being used. For example, Kureimat (with a unit size of 600 MW) is expected to come into operation prior to Sidi Krir and Ayoun Mousa (with unit sizes of 300 MW). EEA is adopting this shift in line with the government's policy of maximizing local resources (i.e., plans to manufacture 300 MW units in the near future).

Transmission Network

2.27 The economic justification for investments in transmission system expansion and strengthening should be carefully reviewed in the future, particularly for small loads. This should be carried out on a case-by-case basis, the deciding criteria being reliability of system and investment expenditure involved. For example, in the planned transmission investments by EEA, about 60 percent of the total investment is allocated for investments in the 220 kV lines and substations. It may be necessary to reevaluate the planned 220 kV Sinai line based on the economic viability of the project. Also, other options, including renewable energy systems and other nonconventional energy sources could be factored into the analysis of the need for extending the network to remote/isolated areas. But then, on occasions social objectives of the government could overrule the economic/financial objectives of EEA. For example, in the event that

extending the network to remote/isolated areas becomes a priority for the GOE, then EEA would have to undertake the extension to meet the government's social objective.

Dispatching facilities

2.28 Future investments planned for upgrading dispatching facilities should take into account the evolving institutional structure (commercialization and possible unbundling) and the resulting operating conditions (agreements and contracts) thereof. One option would be to explore adopting modular unit systems with the flexibility to add extension units as and when the requirement arises. In the process of upgrading, it is essential to include measuring units to facilitate ease of computation of delivery costs for supply and for distribution of electricity.

2.29 Economic merit order of dispatch has been hampered by weak links in the transmission network. Of particular importance is the strengthening of the transmission network, particularly in areas where the system is forced to sacrifice the operating of higher efficiency plants. The 132 kV, 66 kV, and (to a lesser degree) 11 kV networks are the main sources of malfunctions. The scheduled maintenance of these networks should be carried out as planned to ensure that the transmission network constraint is not worsened. If the system continues to operate with major dispatching constraints, a continuous loss of efficiency may result that is reflected in poor utilization of resources.

2.30 The variations in availability of the thermal and hydro units have also been contributing to the deviation from economic merit order dispatch. In order to maintain a high level of availability, the annual planned maintenance schedule needs to be carried out diligently. For this, allocation of downtime, spare parts management, and availability of skilled personnel are important. Since the national control center schedules the maintenance at the request of the power plant, a maintenance/downtime system that minimizes deviation from the merit order of dispatch should be worked into the dispatch planning. Two related policy matters to be addressed under dispatch are (a) is system efficiency being lost because of nonallocation of funds for transmission strengthening and spare parts inventory with funds more readily available for investments related to generation and new projects? and (b) to what extent is the system suffering from management and administration constraints—specifically, interdepartmental constraints (e.g., planning and operations) and interunit conflicts (e.g., national control center and, say a power plant).

Distribution Systems

2.31 Responsibility should be divided clearly between the EEA and the DCs in terms of electricity supply and operations. The DCs should begin to operate as independent business entities, in much the same way as is expected of the different generation zones of EEA. The concept of buying and selling power should take place at the transfer of responsibility centers of the distribution nodes. As the present holding company setup is expected to be temporary (i.e., to facilitate eventual privatization, as

laid out under the objectives of the ERSAP), the management and operations of the DCs should be treated as independent cost and profit centers. Further options for DC operations would be discussed under the institutional restructuring options.

Tariff Level

2.32 The tariff level should reflect full recovery of costs of service to ensure commercial viability of the operating enterprises. The tariff structure should be reviewed and updated to address incentives/disincentives for use corresponding to system load pattern. The current operating mechanism should be modified such that contractual arrangements between the generator (EEA) and the distributors (DCs) are introduced. Likewise, it is also necessary to institute contractual arrangements between the generation zones for transfer/exchange of energy to facilitate a commercial focus in the generation function. EEA has initiated steps to setup a contractual arrangement with the DCs, and preliminary steps have been recently taken to increase transparency in the exchange of energy between generation zones.

2.33 Currently, tariffs are still being referenced only to their economic costs. The financial costs of supply should be included to put suppliers on a commercial footing and to increase the sector's attractiveness to the private sector. The structure of the tariffs should be based on economic criteria, and tariffs should be based on financial criteria if they require more revenue than can be obtained under the economic criteria. Under the ongoing energy price reform program, the tariff level was expected to move to 100 percent of economic costs by June 1995. The current position of the tariff level vis-à-vis economic cost is about 90 percent. Irrespective of the progress of the energy pricing reform program, the principles for tariff setting and administering would need to be modified. As mentioned above, the tariff level should be determined by financial cost or recovery of full cost of service. The tariff structure should be modified to take into account the following: time of use (TOU) pricing to provide incentive to the consumers to shift consumption from peak to off-peak hours; progressive rather than regressive tariffs, in which the tariff charged is based on consumption blocks/levels; and introduction of a demand charge to large consumers. The measures suggested here would require a detailed analysis based on changes/modifications in the operations of the overall power sector.

2.34 An issue under debate under the electricity pricing reform program is gas pricing, which is an input into the LRMC of electricity calculation. The Government requested a shift in the policy to move toward LRMC of gas because of the expected improved situation in gas availability from 1997/98 onward based on studies carried out by British Gas and complemented by NERA. However, ESMAP wanted further clarification on the supply situation (basis for reserves) of gas and on demand—particularly from the power sector—for gas. On the supply situation, ESMAP recommended use of proven reserves as the basis for the economic cost calculation. On the demand for gas, ESMAP considers that the demand from the power sector is

suppressed. However, a more recent update on proven gas reserves should have a significant impact on gas availability and gas consumption in the power sector. A decision will have to be made on continuing the existing pricing system (i.e., market-value concept of customer's willingness to pay the avoided cost of substitute fuel, which is currently about 7.55US¢/m³); or to resort to a new pricing system (i.e., a system that stimulates exploration, development and production of new quantities of natural gas to the extent it is economically viable, which is about 3.36US¢/m³ in the base demand case and 3.51US¢/m³ in the most likely demand case). Another alternative which can by-pass estimation of the depletion premium which is directly linked to the proven reserves issue is to continue to index natural gas pricing to international fuel oil prices with a discount factor for promoting utilization and further development of natural gas. This is discussed further in Chapter 4, "Natural Gas Utilization and Development."

Financial Performance

2.35 For the main operating entities (i.e., EEA and the DCs) to function as commercially viable business units, several financial restructuring measures need to be taken as a first step in the overall restructuring process—for example, debt-equity swaps, refinancing of portions of existing debt, sale of nonoperating assets to raise capital/reduce debt, reduced dependence on foreign loans and exchange risks, facilitate direct investment by private sector, and issue of bonds and/or new shares to raise money. Several governmental policies are also affecting the financial performance of the power sector enterprises, including pricing and subsidy policy, borrowing policy for investments in generation and distribution, bills collection policy, and ad-hoc payments to the Government for meeting macroeconomic conditionality with the IMF. The financial restructuring measures suggested here would require a detailed analysis based on changes in the operations of the overall power sector resulting from the aforementioned governmental policy decisions.

Institutional Restructuring

2.36 The discussion on institutional restructuring is introduced under the broad overall framework of the economic reform and structural adjustment program. The following are the main components under the ongoing program: (a) macroeconomic reform—aiming to control inflation, reduce the current account and budget deficits, and bring about sustained economic growth; (b) domestic price liberalization—aiming to ensure the right price signals are offered to consumers and investors so that decisionmaking reflects relative values; (c) foreign trade liberalization—aiming to ensure that imports are at the lowest cost and that gains from trade and specialization are therefore maximized; (d) private sector reform—aiming to increase economic efficiency by promoting competition between private entities; and (e) public enterprise reform—aiming to increase economic efficiency by introducing competition, restructuring public enterprises, and introducing commercialization (and where appropriate, privatization). The power sector has a key role to play in achieving these stated objectives as well.

2.37 A quick assessment of the current status of the power sector vis-à-vis the policy objectives as dictated by the country's reform program should guide the discussion on options for institutional restructuring. In the area of macroeconomic reform, tariff increases have partly contributed to the budget deficit reduction. However, the contribution from the power sector toward government budget reduction has seriously restricted the improvement of financial viability of power sector enterprises. With regard to liberalization of domestic prices, tariff levels have improved systemically, from less than 50 percent of economic cost in 1989 to about 80 percent of economic cost in 1994 and reaching the 90 percent mark now. Reaching economic levels is not in itself achieving price liberalization, however; the power industry the world over has witnessed changes wherein benchmark for tariff levels are based on the financial considerations (meeting debt service requirements, generating an adequate margin to finance a portion of their new investment and to provide a reasonable return on investment) for attracting private investment. With regard to foreign trade liberalization, the power sector makes only an indirect contribution (through imports of petroleum products) to this policy objective.

2.38 Private sector reform has no relevance to the power sector, as it is fully state controlled. But in the area of public enterprise reform, several points are worth noting. First, the DCs have been removed from the MEE and placed under a holding company along with other public sector enterprises. The objective of removing the DCs from the MEE was to put it up for sale; however, even the initial steps of asset valuation for the DCs have not been completed. With regard to introducing competition, nothing has changed. Likewise, little or no change has taken place on introducing commercialization and privatization. Therefore, if the desired policy objectives are to be met, the basic changes from the existing operating system—that is, the institutional arrangements—are still to be accomplished. In addition, the many developments in the power sector around the world call for continuing evolution of the philosophy and practices of management and operation of the sector in Egypt.

2.39 Countries that have undergone power sector restructuring have generally benefited from reform. Countries now contemplating or undertaking reform can benefit from the experience of their predecessors. Of course, power sector restructuring is still an evolving phenomenon; still, the results of previous reform may be instructive. Examples (given in no particular order of preference) of reformed economies may be cited from countries all over the world, both developed and developing: Germany, Sweden, Jamaica, Norway, Spain, Argentina, Chile, Columbia, New Zealand, the United States, England/Wales and (more recently) Morocco, Philippines, Pakistan, India, China. In addition, other countries (e.g., from the Gulf Cooperation Council—Saudi Arabia, Kuwait, UAE, Oman, etc.) are in the process of initiating reform, having realized that the "old" monopolistic practices of electricity supply are no longer tenable. Three relevant examples of power sector restructuring are detailed further in Box 2.1.

Box 2.1: Power Sector Reform and Restructuring—Why And How?

Columbia: The restructuring of the Columbian electricity industry in the early 1990s was initiated in response to a financial crisis in which the power sector had became a major burden on public resources. Issues confronting the sector included lack of corporate autonomy, accountability, clear and transparent rules, and lack of proper regulatory authority; ill-defined institutional relations between generation, transmission, and distribution; inappropriate energy price subsidies, tariff distortions, and poor financial performance; and fiscal dependency on government resources. In response, the government produced a policy paper outlining its objectives and detailing its restructuring and reform measures for the power sector. Essential elements of the restructuring strategy included increased financial discipline and introduction of associated efficiency incentives, including tariff and investment criteria; management and ownership reforms involving performance contracts between government (through a regulatory authority) and the power companies, including corporatization and commercialization of power companies; structural reforms related to private investors, involving formation of new companies (IPPs), restructuring ownership (privatization of existing facilities), and establishing a regulatory body. Columbia's reform program has been in line with the path adopted by Peru, Chile, and Argentina.

Morocco: The electricity sector in Morocco had been experiencing a number of serious problems, including: power shortages, buildup in unpaid bills, lack of autonomy from government ministries, lack of incentives for efficient operation, lack of coordination between various enterprise in the sector, absence of transparent tariff-setting mechanisms and tariff-regulation procedures, and overlapping of ministerial and power company responsibilities and control. The government had embarked upon a wider economic reform program that included sector liberalization and encouragement of private sector investment. In order to achieve this end objective, specific measurers—to address each of the identified problems—and strategic measures—to develop a long-term sustainable working relationship for all parties associated to the power business in a truly competitive environment—were introduced. Specific strategic measures were: sector structure, legal and regulatory framework and establishment of a regulatory agency. In addition, the Moroccan authorities have invited private producers and investors to participate in the power sector operations.

Philippines: The Philippines had been experiencing a very serious power crisis resulting in substantial power outages (up to 6 to 10 hours per day) and drastic curtailments in supply. In turn, these constraints affected commercial activities, industrial production and economic development. In addition, a serious financial crisis persisted in the sector due to low tariff levels, faulty investment policies, poor planning and coordination, and weak technical capabilities of the sector institutions. An Energy Sector Plan (ESP) was introduced as a cornerstone for development of the power sector. Key related ingredients of the ESP included: policy for sustained development of availability and reliability of supply; improvement of financial viability of power companies, including automatic tariff adjustment; tariff restructuring; introduction of energy efficiency standards and incentives for operations; and need for improving distribution efficiency. Key actions already completed are: tariff adjustments to yield an 8% rate of return on revalued assets; improvements in tariff structure with introduction of demand charges to reduce peak demand; implementation of a fuel purchase cost adjustment (FPCA) mechanism to compensate for variation in fuel prices and the cost of purchased energy, which would make tariff adjustment automatic; and exchange rate adjustments. Other major reform steps include the establishment of a framework for regulating the power sector. An Energy Regulatory Board (ERB) is responsible for approving tariffs and regulating energy prices under clear rate-of-return criteria. A similar route, i.e., through an Energy Sector Program/Plan is being followed in a few other countries, including Jordan.

Source: World Bank/ESMAP Reports

2.40 Some of the common ingredients of restructuring in power systems around the world are (a) breaking the hold of state monopolies on supply and distribution

through unbundling; (b) introducing competition in the supply and distribution of electricity; (c) opening access to transmission; (d) encouraging a commercial focus in management and operations; (e) introducing private sector participation in owning and operating power sector infrastructure and facilities; (f) negotiating power purchase agreements between generators and distributors/consumers; and (g) establishing regulation of price, performance, and returns. The degree and level of restructuring may vary from country to country. The relevance and applicability of restructuring may differ as well. However, the underlying reasons for restructuring and the objectives are the same. Egypt has mildly initiated power sector reform and preliminary steps have been taken to change the electricity business. The key questions to address under power sector reform in Egypt are as follows: What is suitable in the Egyptian context that is, what are the objectives for the power sector, and how can they be met?

2.41 The ensuing discussion can be broken down into specific ingredients necessary for the Egyptian power sector: (a) corporatization and commercialization, (b) role of public sector versus that of the private sector, (c) regulation, and (d) competition.

2.42 *Corporatization and Commercialization.* It is important for the power sector companies (EEC and DCs) to operate under commercial principles; this is a preliminary step to financial viability and autonomy in the management and operations. When power companies operate as corporate entities where the management is governed by a board of directors and the day-to-day running of the company is left to a managing director/chief executing officer, the role and responsibilities of management and operations are clearly separated. In this way, clear-cut responsibilities are introduced into the operations, and efficiency enhancing incentives would be built into the system to judge performance against predetermined norms and industry standards. A commercial basis for system operation would ensure that electricity providers (generators and distributors) charge the financial cost of providing service. Financial discipline would be built into the system to ensure prudent investment decisions, tougher measures for payment collection, innovative strategies for revenue enhancement/generation, and stricter control of costs.

2.43 Some options for the power companies to function under commercial principles within the present institutional structure include the following. The EEA could operate as a commercial entity and maintain the different generating zones as independent cost/profit centers with commercial transactions for the exchange of energy. The transmission grid could be treated as an independent cost/profit center, with revenues dependent on the fee charged for transmission assess. Likewise, the DCs could operate under contractual arrangements with the EEA for buying and selling of power. Such reforms in account keeping would bring about transparency in costs/profits in each of the independent operating enterprises.

2.44 The Government has initiated several steps toward transforming EEA into an efficient and commercially oriented utility. In must be noted that several studies are

under way through in-house Ministerial committees and technical assistance schemes. These include a framework for a regulatory mechanism, further institutional restructuring and development, updating of tariff, and modernizing financial and accounting systems. However, the benefits of these studies and the associated technical assistance will not be realized until implementation process and introduction of suitable policies.

2.45 *Role of Public versus Private Sector.* The roles of the public and private sectors are changing. The justification for maintaining monopolistic, vertically integrated utilities is being weakened by new ideas and experience. In particular, the power system in Egypt has clearly expanded to a level at which managing it centrally has become difficult. Moreover, the Government's operation in the power sector has been plagued by an inability to balance political and social objectives with the allocation of subsidies, by electricity prices that are set below financial costs of supply, by poor utilization of fiscal revenues, and by an inefficient system for bill collection. Resources have become scarce. Development finance institutions are also under pressure to give priority in their lending to social sectors such as health and education rather than infrastructure. This is where the private sector can play a vital role. Private participation in the sector could be facilitated if the Government provide ground rules that are clear and transparent. Private investors in infrastructure projects would require guarantees and will be willing to participate only if they have sufficient autonomy in management and operations. Hence, countries that wish to draw on private sector financing much be willing and able to make formal contracts and agreements for the purchase of resources (e.g., fuel) and for provision of service (e.g., supply of electricity). Private operators will likely insist on charging customers for the real cost of supply and will want to ensure that payments and collections are maintained under strict scrutiny and control. Thus, the need for private sector participation is clear, but the enabling conditions for the private sector in the Egyptian power sector are not entirely in place.

2.46 Private sector participation in the power sector should be viewed as a means of relieving the burden of the government of investment responsibilities, as a means of fostering competition and as a means of facilitating the shift from state controlled mechanism to free-market mechanism. In order to make this happen, the power sector should shift its focus and begin to operate in an increasingly commercial orientation. An independent and transparent regulatory or oversight mechanism should be put in place to ensure fair treatment of all operators in the power sector (see discussion below).

2.47 *Regulation in the Power Sector.* Regulation provides a substitute for the discipline of the marketplace. It is required when the level of competition is insufficient to prevent the abuse of either natural or de facto monopoly power. A state-controlled monopoly is implicitly regulated by the government. This, however, frequently leads to treatment of the utility as an agent of government policy, which often deprives it of adequate investment funds; encourages capricious interventions in price setting; and removes adequate incentives for the efficient operation of the utility. A regulatory system

creates a framework for controlling the costs, prices and performance of utilities so that they cannot exploit a monopoly position to earn supernormal profits, but are able to ensure, at least for a reasonable time, that their prices and associated performance will be protected from arbitrary interference. Under such conditions of stability and autonomy, utilities can optimize decisions over time with respect to investment and operational practices and thus achieve greater efficiency. Also, as stated above, the establishment of a suitable and independent regulatory system will become mandatory if the private sector is to be brought into the power sector, either through privatization or through other restructuring options (e.g., independent power producers; IPPs). Box 2.2 offers optional regulatory frameworks for consideration.

Box 2.2: Types of Regulation

Rate-of-return regulation: In rate-of-return regulation, electricity prices are set to reflect the embedded or historical costs of providing supply to each class of consumer. Rate increases are based on a utility's revenue requirements (i.e., to provide a reasonable return on equity). Several variations on this standard have occurred in practice. For example, utilities may opt to revalue their fixed assets on a regular basis to take account of inflation. This, in turn, increases charges for depreciation and thereby necessitates a rise in tariffs to meet rate-of-return targets. Such regulation is also called *cost-of-service regulation* or *cost-plus regulation.*

Incentive-based Regulation: Incentive-based regulation typically puts limits on prices by one of the following: indexation of tariffs to specific input costs (e.g., fuel); price capping for markets that are not competitive by means of a price index less x on regulated services; and yardstick competition for monopolistic functions (e.g., distribution companies). To develop a workable incentive-based system, governments should be prepared to accept that it would lead to price increases or decreases depending upon the nature of the market—supply versus demand surplus or deficit. Two types of incentive-based regulation are common: *performance-based regulation* and *price-cap regulation*:

- ***Performance-based regulation***: In this type of regulation, the utility's performance is closely monitored against specific measurable standards, norms, or targets. Utilities are held accountable for their performance and are penalized if their performance falls far short of agreed targets; or, they are awarded an incentive if their performance far exceeds agreed targets. The key to this type of regulation is negotiation of a performance agreement and adherence to performance targets.
- ***Price-cap regulation***: In this type of regulation, as its name implies, prices are indexed against a measure of general price increases, such as the retail price index (RPI), and corrected for a performance factor (stated as X). Usually, the price level is indexed over a period of review, say five years. Normally, the prices are assumed to decline in real terms and thus an index minus a factor is agreed, hence this type of regulation is also called RPI-X regulation.

Comparative Note: Incentive-based regulation is simpler and more flexible than rate of return regulation. It provides a basis for suppliers and providers to behave competitive. Incentives could provide—innovation, cost containment, the necessary pressure to remove cross subsidies, and tailor service to the needs of users. Incentive based regulation promotes transparency in regulation. For example, it provides the basis for 'rules-of-the-game' for involving private sector. Cost-plus regulation is tailored more to systems where the coordination, control and accounting function were effective and efficient. There is no basis for competition as utilities are being measured for their own performance improvement or lack of it. Also, there is less room for enhancing efficiency for the same reason.

Source: Consultant's Report (September 1994) and IEN Occasional Paper 1, "Power Supply in Developing Countries: Will Reform Work?" (April 1993).

2.48 In Egypt, competition at the generation level can be introduced initially at the "generation zones." It could originate from an accounting perspective with 'commercial value' being attached to exchange of energy between the zones. Independent accounts should be maintained for each zone which would determine the viability of (zonal) operations. Initially, due to the profile of plant type in each zone, the viability measure is bound to be irrelevant. However, correction factors for costs/prices could be introduced where this imbalance could be corrected. These steps can be carried out without any major changes in the law or existing operating conditions. The next question to address is, does Egypt want to solicit competitive procurement for all future generating capacity, where EEA would bid along with independent power producers (which includes local and foreign investors) for adding new capacity?. If the answer is yes, then steps need to be taken to provide a conducive environment with clear ground rules which are stable and sustainable for a reasonable period of time for entry and exit.

Box 2.3: Types of Institutional Structures in the Power Sector

Type 1: This is a typical (national/traditional) integrated model. A single entity is responsible for all aspects of electricity production and distribution (e.g., EDF France). Pros: Centralized coordination and control to capture economies of scale, scope, and coordination. It was the most common model in several countries prior to the era of reform and restructuring. Con: Worst incentive for efficiency and no competition; lack of autonomy, transparency and regulation.

Type 2: This type is similar to national/traditional model, except for competitive procurement for new generation. Pros: Incremental competition in generation; can be combined with partial or total privatization depending on extent of government ownership; government could maintain existing integrated system and offer to private (domestic and foreign) investors the opportunity to participate in new generation (IPPs) through build-own-operate-transfer (BOOT) or its residual schemes. Con: Unrealistic basis for comparing production costs between existing and new suppliers; need to balance "rules of the game" between two distinctly different providers; in all probability, transmission and distribution would remain under the integrated supplier. Additional key issues: (a) need for regulation of contract bidding, award, and implementation; and (b) sophistication needed for procuring and purchasing power.

Type 3: This type of structure would involve a combination of a core group of local integrated monopolies in transmission and generation with competitive procurement for new generation and common carrier for transmission (at least for wholesale). Beyond the core group, other companies would operate solely on generation or distribution. Pros: Mixed completion (i.e., extension of geographic competition). Wholesalers can choose any supplier, irrespective of geographic location, because of common transmission access. Potential suppliers have flexibility to exploit economies of scale in generation. Con: Not suitable if part of the integrated monopolies is government owned because this type is a major impediment to introducing subsidies. Transmission owner cannot play a fair role in providing and charging competing customers. Increased responsibilities for regulator and the process of regulation.

Type 4: Total separation of generation from transmission from distribution. Examples: England and Wales and possibly, Argentina. Pros: Role of regulation becomes all important. As more generators enter the market, there is scope for reduction of generator market concentration and thereby production prices. Could remove all barriers for captive customers, i.e., customers are free to buy from whomsoever they wish. Con: Since generator can supply directly to retail customers, the generator has advantage compared to distributor. Possible scope for generator to cream off the most profitable market segments forcing distribution to charge higher prices to captive consumers. This would be a case of deregulation without developing a basis for fair competition.

Source: "Electricity Privatization: Structural, Competitive and Regulatory Options" B. Tenenbaum et al (December 1992)

3

Petroleum Sector Development

Overview

Institutional Setup

3.1 Exploration and drilling activities are carried out by joint operating companies. EGPC is the national partner with an international oil company (IOC); this forms the basis for production-sharing agreements. Currently, some 22 companies are engaged in oil and gas exploration activities. Current exploration commitments call for drilling about 148 wells and account for expenditures of about US$595 million by the IOCs. Over the next two years, 51 wells are expected to be drilled and about US$227 million will be spent for drilling.

3.2 Oil production now stands at 880,600 bbl/day and gas production at 1,480 mmcf/day. Production is dominated by foreign operators; EGPC's share represents less than 2.5 percent of total petroleum production. Estimates of potential oil reserves additions over next 10 years could be as high as 4 billion bbl. Based on the current level of production, two scenarios for the future emerge: a less-likely scenario of 615,000 bbl/day production by 2005; and a more-likely scenario of 750,000 bbl/day during the first decade of next century.

Refining

3.3 Egypt has eight refineries (all 100 percent owned by EGPC) with a combined capacity of about 29.5 million tons per year. Crude distillation capacities of the refineries range from 1.4 to 6.6 mmt/year, which is small compared to an international average of about 10 mmt/year. At present, none of the refineries, except for a delayed coker in the Suez Oil Company in Suez, have cracking facilities to upgrade residual fuel oil to higher value products. As a result, about 70 percent of products are exported as low-value products such as naphtha and fuel oil; concomitantly, high-value products such as jet fuel and diesel fuel are now being imported, at a sacrifice of valuable foreign exchange earnings. Estimated annual losses of foreign exchange vary depending on availability of alternative fuels and the domestic consumption pattern.

3.4 The refineries intend to introduce optimization programs to reduce existing mismatches between refinery output and petroleum products demand profile. In addition, it is necessary to upgrade the petroleum product quality, as this would have a desirable impact on the environment. Therefore, EGPC should survey the existing quality specifications of the petroleum products and identify upgrade needs based on a least-cost approach. The relatively high energy consumption and losses will also have to be reduced. EGPC has commissioned a CIDA-financed study to address the rationalization of individual refineries and the optimization of overall refinery output improvements.

3.5 *Production.* In 1993, about 25.6 mmt of crude was processed to produce about 24.6 mmt of various products. The production breakdown includes gasoline/naphtha (about 16 percent), gas oil/diesel (about 19 percent), fuel oil (about 48 percent), and kerosene (about 10 percent). The balance is "other products," including bitumen, coke, and lubricants/greases.

Product Distribution

3.6 *Consumption.* In 1993, about 17.2 mmt of various petroleum products and about 8.7 equivalent mmt of natural gas were consumed. The consumption breakdown includes gasoline (about 11 percent), gas oil/diesel (about 27 percent), fuel oil (about 38 percent), and kerosene (about 9 percent). The balance comprises other products including butagas, bitumens, lubricants, and lube oils.

3.7 *Wholesale Distribution.* The two public sector distribution companies, MISR and COOP, each 100 percent owned by the EGPC, account for about 70 percent by volume of sales of petroleum products and about 60 percent by value. The balance is marketed by private oil companies including Mobil, Shell, and Exxon.

3.8 *Retail Distribution.* About 98 percent of the retail outlets are owned and operated by private dealers via franchises of the wholesale distributors. Only model stations are owned and operated by the wholesalers.

Public versus Private Sector

3.9 The public sector companies are obligated to undertake all major investments in bulk transportation, storage, and handling and operate in areas dictated by the government, resulting in higher operating costs and the need to maintain higher employment levels. EGPC and its subsidiaries bear most of the working capital required in distribution and marketing. The private sector companies can pick and choose based on relative advantages of costs and profits, avoiding bulk of major investments and working capital requirement. EGPC controls the number of outlets by being the deciding authority on issue of licenses for retail operation. Therefore, in the present institutional arrangement, incentives are lacking for improving efficiency and reducing costs through competition.

Petroleum Product Prices

3.10 All end-user prices are set and controlled by the government. The operation of marketing companies is based on commissions/margins, which vary between 2 and 4 percent, depending on the product. The margins are calculated based on operating costs and average return on capital.

3.11 The integrated nature of EGPCs operations (i.e., it is responsible for all activities from exploration and drilling to product distribution—wholesale and retail) leads to a lack of transparency in the basis and/or setting of product prices. In particular, the price-setting mechanism masks the price levels at the refinery gate, which is a key measure of efficiency. EGPC's consolidated budget does not indicate the detailed breakdown of product price structure, the level of taxation, and the mechanism involved in accruing funds to the state budget.

3.12 Under the ongoing economic reform and structural adjustment program, one of the key components is the energy price liberalization program. In 1990, at the outset of the liberalization program for petroleum products, the weighted average of domestic petroleum products was well below 50 percent of the weighted average of international equivalents. The methodology and basis for computing the comparison was agreed under the overall macroeconomic framework of the ERSAP. The liberalization program was set up such that the weighted average of domestic petroleum product prices would reach 100 percent of their international equivalents by June 1995. The program also aimed at reduction of subsidies to the sector and at eliminating cross-subsidies among products. At the time of the main assessment mission (June 1994), the domestic petroleum product prices were in excess of 100 percent of the weighted average of their international equivalents. But then quite a few important issues were left unaddressed (see below, under issues of petroleum product prices).

Issues

3.13 The main issues in the petroleum sector are as follows:

- Less than optimal utilization of refining assets.
- Refinery configuration not rationalized/optimized.
- Lack of adequate cracking facilities.
- Lack of commercial focus in petroleum downstream operations.
- Excess staffing levels.
- Government-controlled distribution and marketing of products.
- Government-controlled end-user prices, including subsidies and cross-subsidies.
- Fully integrated nature of institutional structure.

Upstream

3.14 Egypt has adopted its own system of petroleum agreements based on production sharing. The upstream activities are characterized by production-sharing agreements (PSAs) between the state-owned EGPC and the IOCs. The PSAs are characterized by variable percentages of production that match net income earned by the IOC after fulfilling its obligation toward the state. The PSA avoids the inflexibility of equality of shares and fixation of taxes. The initial arrangement was that all gas discovered should be credited to the EGPC. However, at the advent of national gas reserves, the IOCs were compensated based on a level above or below (7 tcf) a predetermined reserve level. The drop in world crude prices and the increase in domestic consumption of petroleum products forced the EGPC to offer more attractive terms to the IOCs for gas exploration and development. Under the new terms, EGPC would get 75 percent of profit gas and the price of gas transferred to EGPC was set at 85 percent parity with Suez blend crude oil. The major characteristics of the oil and gas upstream activities are a high level of exploration effort and commitment by the government, EGPC, and foreign partners; application of state-of-the-art geophysical and geochemical surveys; and continuous improvement of exploratory drilling ratio success over the last 5 to 10 years (which has been about 1:3 over the last few years in the Western desert and 1:1 in the Delta region).

Refinery operations

3.15 ***Utilization of Refining Assets.*** The refineries are currently consuming Egyptian crude mainly to satisfy local market demand for a processing fee. This operating strategy results in export of low-value residual fuel oil and import of higher-value jet fuel and diesel fuel. Although it has a contract with an international consulting company to install a linear programming model, EGPC has had no linear programming model of its refining system to optimize operations on economic factors and equipment constraints.

3.16 ***Economies of Scale of Refineries.*** The refineries' crude distillation capacity range from 0.5 to 6.6 million metric tonnes (mmt) per year. The international market is dominated by refineries with crude distillation capacity of about 10 mmt/year or more. The Egyptian refineries thus require rationalization to achieve greater operating efficiency and to reduce costs.

3.17 ***Refinery Energy Consumption and Losses.*** The refinery energy consumption and losses, including the natural gas used in El Mex, El Ammerya, and El Nasr refineries, reached 5.3 percent of the crude run in 1992. This represents 30.3 percent of the gross refining margin[1], which is comparatively very high. See Annex 6 for crude run in upgraded refineries. Without taking into consideration natural gas and

[1] The gross margin was based on a crude run of 24.258 mmt at US$11.55/bbl of crude.

purchased electricity consumed in the refineries, average consumption and losses amount to 4.1 percent of crude oil processed in 1992 and 1993. This level of average energy consumption and hydrocarbon losses in the seven refineries is relatively high, compared with about 2.5 percent for larger refineries in the international market.

3.18 ***Cracking Facilities.*** At present, none of the refineries, except for the delayed coker of the Suez Oil Company, have cracking facilities to upgrade residual fuel oil into higher-value products. For example, the surplus low-value mazout from the refineries could be converted into higher-value gasoline, jet fuel, and diesel fuel. Surplus gasoline, valued at about US$146/tonne, could be exported to earn more foreign exchange than is currently possible from exports of naphtha, valued at US$116/tonne, and mazout, valued at US$90/tonne. Addition of cracking facilities would lower/minimize imports of jet fuel and diesel fuel. Since the international market is dominated by refineries with significant cracking capacity, installation of cracking facilities in the refineries is essential for reducing delivered cost of petroleum products in the country and for enhancing export competitiveness.

3.19 ***Utilization and Upgrading of Existing Units.*** The coker in the Suez refinery is running below design capacity by about 25 percent. The lube plant in the Suez refinery is running below design capacity by about 50 percent. Phenol, one of the solvents used in the lube refining in Suez and Alexandria, is technologically inefficient and environmentally unacceptable. All the catalytic reformers are of older technology and underutilized in terms of type of catalyst employed and regeneration frequency, which has resulted in lower gasoline octane pool and overall capacity.

3.20 ***Productivity.*** Each refinery, irrespective of its size and complexity, employs more than 3000 people, compared with less than 500 in a comparable modern refinery. Separate organizations for the Suez and El Nasr refineries in the Suez area are not economically justified. because the two refineries are very close to each other and are connected by pipelines. The same argument holds for the two refineries in the Alexandria area. It is understood that the two refineries in Alexandria are developing projects to install two de-waxing units in the neighboring refineries instead of one large unit. As indicated earlier, EGPC should rationalize and consolidate its refining activities in each area to avoid duplication, improve efficiency, and reduce overall cost.

3.21 ***Crude Mix Selection.*** In 1993, EGPC exported Ras Gharib mix, Belayim mix, and Gulf of Suez mix crude at average prices of 10.81US$/bbl, 12.51US$/bbl, and 13.93US$/bbl, respectively. Crude oil selection for the domestic refineries should be optimized to maximize the added value of the products.

3.22 ***Environmental Protection.*** Energy conservation that reduces burning and release of hydrocarbons would be the main environmental protection measure to have immediate economic gains. Flue gases from the refineries burning high-sulfur fuel oil cause serious environmental damage. The use of phenol as a refinery solvent should be discontinued in favor of more efficient and environmentally acceptable solvents. The

presence of phenolic compounds, hydrocarbons, and suspended solids, in the effluent leaving the refinery should be monitored and controlled more carefully.

Petroleum Products Distribution

3.23 ***Wholesale Distribution.*** EGPC, through the public sector companies MISR and COOP, dominates the wholesale petroleum products market and is virtually the monopoly supplier of all oil products in the country. However, indications are that MISR and COOP are operating at lower levels of efficiency than the private marketing companies because of the higher costs and higher levels of capital employed. All major investments in petroleum product storage, transportation, and handling are provided by EGPC and its subsidiaries, bearing the bulk of the working capital required for distribution and marketing of products. Due to the existing operating policy (see below), private marketing companies can "cherry-pick" sites and earn supranormal profits.

3.24 ***Retail Supply.*** Most retail outlets are operated by private sector dealers with commercial land leases. The EGPC controls the issuing of licenses for retail petroleum products distribution and thereby restricts new entrants into the market. The issuing of licenses is depends on EGPC's assessment of sufficient market demand in a specific locale. The situation does not allow fair competition, which can improve efficiency and reduce cost.

3.25 ***Bunker Fuel.*** It has been reported that all the petroleum products marketing companies in Egypt supply less than 15 percent of the need of Suez canal traffic for bunker fuel. The minimal servicing of the Suez Canal traffic by Egyptian companies is a loss of valuable foreign exchange earnings. Volume of fuel oil and gas oil sold to ships in 1993 was more than 250,000 tons, and income from bunker fuel sales was close to 1 billion Egyptian pounds in foreign exchange equivalent.

3.26 ***Transportation Mode.*** The past decade has witnessed a significant change in the petroleum products consumption pattern toward higher use of lighter products. Of particular interest is the dramatic increase in the use of natural gas and its derivatives (LPG and condensates) and the reduction in the use of heavy fuel oil. In addition, more than 3 million tons of fuel oil and naphtha are exported every year from Suez and Alexandria. As the domestic refining capacity and centers are rationalized, the issue of bulk transport of liquid petroleum products, particularly with regard to the optimization of the mode of transport and the rationalization of the network, needs to be addressed.

3.27 ***Petroleum Product Prices.*** There is an ongoing petroleum product price reform program under the ERSAP. The key issues for the petroleum product price comparison between domestic prices and international equivalents are (a) the methodology adopted to carry out the comparison between domestic and international prices had a mis-match, in that end-user domestic prices were being compared to FOB Italy/NW Europe less international freight charges. What was missing from the agreed formula was the transportation cost adjustment for either the domestic price (from retail

outlet to exit port of Egypt) or the international price (from port entry port of Egypt to retail outlet); (b) cross-subsidies among the products still exist; and (c) reaching the target of 100 percent for domestic prices vis-à-vis international prices, whether it is an agreed formula or a revised/corrected formula, does not in itself constitute petroleum products price liberalization.

3.28 The government exercises control over end user prices. The final selling prices for all core products to both large and small customers, including gasoline and diesel, are determined by the government, and they are the same throughout Egypt. The distributors' margins are also determined by EGPC, and vary between 2 and 4 percent depending on the product. Well-established private distribution companies are satisfied with the protection the system offers, and some of them are reported to be relatively profitable (estimates range between 50 and 70 percent of employed capital). The margins are determined in discussion with the each of the marketing companies and are based on average operating costs and average return on capital. In order to effect a pan-Egyptian pricing policy (uniform average prices throughout the country), EGPC pays for transport costs beyond a radius of 20 km from a supply depot. The maintenance of a pan-Egyptian pricing policy leads to significant misallocation of resources, as some consumers are in effect subsidized by others. This price-setting mechanism also masks the price levels at the refinery gate—an important condition to provide transparency and a measure of the efficiency of petroleum processing and marketing operations.

3.29 ***Institutional Structure.*** The integrated nature of EGPC's operation has kept a tight control on the players operating in the petroleum sector, the nature of participants, operating policies, and procedures as well as the prices. It is a monolithic organization in which the activities of its various operating entities are not financially scrutinized individually for efficiency and profitability. As a result, a good portion of the revenue earned in the upstream activities is lost through inefficiency in the downstream sectors (refining, distribution, and marketing), and in the process a good deal of the tax revenue is also lost. Two key issues that should be addressed under institutional restructuring are (a) How can the concept of independent business units in the downstream operations be introduced? and (b) How can competition in the downstream operations be introduced?

3.30 ***Private Sector Participation.*** The government and the EGPC are encouraging private sector participation in new refining capacity. Currently, two proposals have been evaluated for two export-oriented refineries in the Alexandria and Suez area, each refinery with a capacity of about 5 mmt/year. Estimated investment for each refinery is about US$1 to 1.5 billion. The new refineries are state-of-the-art and will make a significant impact in terms of quality of output and local competition. The issue to be addressed is how the existing refining sector in Egypt would adapt in an open-market environment and compete with the new export-oriented refineries.

Options

Refinery Operations

3.31 ***Utilization of Refining Assets.*** The EGPC should maximize returns from its refining assets by producing the most valuable products from the most suitable available crude at a reasonable cost. For this reason, each refining center should be made to operate along commercial principles and as an independent profit center. In general, import of high-value products should be reduced by upgrading the low-value surplus residual fuel oil. The EGPC needs a linear programming model of the entire refining system to optimize operations and evaluate upgrading options based on economic factors and actual unit limitations. A separate model is needed for each refinery complex for optimization and evaluation on a local basis.

3.32 ***Rationalization of Refineries.*** Presently, EGPC's integrated operation does not allow its seven refineries and various transportation facilities to operate as commercial outfits. None of them operate as cost and profit centers, with the result they do not have incentives to improve efficiency and reduce costs. They do not have choice in selecting crude oils that are best suited for each refinery's process configuration and to optimize their product pattern. There will be considerable economic advantage and incentives for efficiency improvements if the refining capacity in the seven refineries is rationalized and facilities including service providing entities such as crude and product pipelines are commercialized and operate as cost/profit centers. Each one should be allowed to perform against well-defined performance criteria, prepared in line with international competitiveness. For this purpose, inputs and outputs from the refineries should be priced according to opportunity costs obtainable in the international market. Some of the possible options for rationalizing the refining capacity are as follows:

- Integrating the two refineries in Suez into one refining complex within one organization of less than 1,000 people. The same applies to the two refineries near Alexandria. This should result in two efficient refining complex in Suez and Alexandria.
- Major processing equipment from Mostorod and Tanta, if found economically viable, should be moved to other refining centers. This should improve the crude processing efficiency and reduce costs and pollution in the Cairo region. Although the Tanta refinery could be converted into a storage depot in the first phase, the refining activities in Mostorod refinery—which has the largest distillation capacity in the country—will have to be tapered down over four to five years, which is required for the proposed rationalization and installation of cracking and related facilities. Therefore, in Mostorod, no new refining facility should be planned, and the refinery should be converted into a major product storage and supply point over the next four or five years.

- Catalytic reformers in Suez and Alexandria should be modernized to employ a more efficient catalyst system that will increase production of high-octane gasoline components in these two refining centers.
- Use of highly toxic phenol as a solvent in the lube refining units in Suez and Alexandria should be discontinued by selecting more efficient and environmentally acceptable solvents and technology. This would increase production of lube base oils and reduce pollution from the refineries.
- The isomerization project from Mostorod should be moved to Alexandria, thereby raising its capacity to handle all available condensate.
- Modernize Assuit refinery with reforming and cracking facilities, preferably thermal cracking, to process 2 to 3 million tons per year of crude oil to meet all petroleum product requirements in the South that will reduce cost of product transportation in the region.
- The resulting three refining complexes in Suez, Alexandria, and Assuit—with a capacity of about 18 million tons per year—would be sufficient to meet Egypt's domestic requirements for petroleum products in a cost-efficient manner. In this way, they would be more capable of attracting financing for upgrading projects and joint venture participation by multinational companies.

3.33 ***Refinery Energy Consumption and Losses.*** Fuel consumption and hydrocarbon losses in hydro-skimming refineries should on an average be less than 2.5 percent of the crude processed. Ongoing efforts for reducing consumption and losses of hydrocarbon in the EGPC refineries need to be intensified during the coming years. When the restructuring and upgrading plans of the refineries are finalized, an energy conservation program should be formulated to reduce refinery fuel consumption and losses. Addressing energy conservation measures independently before defining the rationalization strategy for the refineries is not advisable. All new facilities should be designed to minimize energy consumption using international market prices for energy and should be energy-balanced with existing facilities.

3:34 ***Choice of cracking facilities.*** It is recommended that the refineries at Suez and Alexandria should explore the economic viability of having mild-severity fluid catalytic crackers (FCC), alkylation, and hydro-desulfurization units to process the cracker products in preference to capital- and energy-intensive hydrocracking facilities. If commitments that cannot be reversed are already made for a hydrocracker, at least the second unit should be the mild FCC. Annex 5 shows a preliminary comparative analysis between FCC and hydrocracker. Also, the FCC produces economically viable quantities of propylene that could be converted into valuable polypropylene, and butylene that could be converted to valuable alkylate. Additional revenue from this has not been included in the calculations in the attachment. Because of the high-octane gasoline production from the FCC, catalytic reformers (existing as well as new ones) could be designed to produce

aromatics (benzene and xylene) or gasoline, as required by the market. High-severity thermal cracking with desulfurization for distillates should be considered, especially at Suez, to produce bunker fuel and more valuable distillates rather than low-value mazout exports with lower investment. A similar system could be considered for the modernization of the Assuit refinery. These modernization activities are expected to take four to five years.

3.35 ***Modernization and Upgrading of Existing Units.*** Options include the debottlenecking of the coker at Suez, reformers at Suez and Alexandria, and adopting modern solvents and technology for lube plants at Alexandria and Suez.

- Debottlenecking the coker at Suez. The EGPC is currently conducting a joint study with Lummus to resolve operating problems and raise the unit capacity to design value. The joint EGPC/Lummus study to debottleneck the coker from 4 to 5 KT/day needs to be given a high-priority basis. If the delayed coker debottlenecking is found to be very expensive, the unit could be redesigned to operate as a visibreaker or thermal cracker. Surplus capacity thus obtained should be used to crack surplus residual from neighboring refineries.
- Debottlenecking the lube plant at Suez. A joint task force of experienced lube production engineers from Al Ammeriya and Suez refineries should be formed to identify the bottlenecks in the lube plant at Suez and prepare an action plan to increase its production from 40 to 80 KT/year. El Ammerya refinery has already been successful in debottlenecking the lube plant from 40 to 86 KT/year. Replacement of phenol as a solvent in lube refining with more efficient and environmentally safer solvent should be evaluated and implemented at both places.
- Debottlenecking the reformers at Suez and Alexandria. EGPC should consider debottlenecking the reformers at Suez and Alexandria with an improved catalyst system and process technology. This would allow the refineries to reduce the lead content in gasoline and replace naphtha exports with more valuable gasoline exports.

3.36 ***Labor Productivity.*** The number of employees at each refining center should be reduced without affecting morale during the difficult restructuring phase by spinning off maintenance and other services to the private sector; and providing for early retirement of eligible employees; and instituting programs to retrain skilled refinery workers to find suitable employment in the private sector. A detailed analysis/study should be able to identify the necessary costs and the resulting benefits accruing from the spinning off and retraining measures suggested here.

3.37 ***Crude Mix Selection.*** The EGPC should be encouraged to continue the study of modifying the crude handling and processing facilities to process different qualities of crude oil so that each refinery should optimize its selection of crude.

3.38 ***Refinery Instrumentation.*** The control system in the refineries should be developed to carry out advanced control of the entire refinery from one control room which leads to significant manpower and cost savings and maximizes yields of premium products. A single control room for the entire refinery should replace the existing several control rooms within the refinery. An implementation plan should be developed after formulating an operating strategy for the refining sector. Procedures for technology selection and procurement should be redesigned to avoid incompatible situations (like the one in El Mex refinery).

3.39 ***Environmental Protection.*** Desulfurization of flue gas generated in the refineries and replacement of high-sulfur fuel oil with natural gas are important, low-cost environmental measures that should be addressed via policy considerations. Monitoring and strict control of phenolic compounds in the liquid effluent leaving the refinery (two Alexandria refineries and Suez Oil Co.) and/or any kind of cracking that produces phenolic compounds should be given with high priority. In addition, phenol should be replaced as a solvent with other technologically improved and environmentally safe solvents even if it cannot be justified purely on profits. As per international standards, phenolic compounds in the effluent should not exceed 0.2 parts per million (ppm). Free release of hydrocarbons into the atmosphere or to surface area should be eliminated or minimized and facilities for immediate clean-up of accidental releases should be provided anywhere crude oil and petroleum products are handled.

Petroleum Products Distribution

3.40 ***Wholesale Distribution.*** The EGPC is virtually a monopoly supplier of all oil products in the country because of the existing integrated nature of petroleum downstream operations. MISR and COOP dominate wholesale distribution because the government obliges them to fulfill social and political obligations to provide petroleum products in remote (rural) areas. Thus, the costs of MISR and COOP are significantly higher than their private sector competitors. The structural problems within the downstream petroleum sector have arisen because of the progressive introduction of the private sector into an institutional (and pricing) structure that has been created under a state-controlled context. Fundamental contradictions in the operating principles are thus present and difficult to resolve. Specifically, price liberalization is likely to have a significant effect on the viability of MISR and COOP. Options for structural changes are discussed below.

3.41 The likely effect of simple price liberalization is for prices to rise in the rural areas as prices adjust to reflect costs and fall in the urban areas as competition erodes surplus margins. The financial position of MISR and COOP would likely deteriorate for two reasons. First, they can no longer cross-subsidize between profitable urban outlets and loss-making outlets in the rural areas. Second, they have a higher cost profile and less efficient working practices than private distributors.

3.42 If privatization of MISR and COOP is desirable, then the first step is the commercialization of MISR and COOP. This would require, among other things:

- The introduction of transparent pricing and costing mechanisms and associated benchmarking techniques to assess the efficiency of each component of the business.
- Cost reduction and changes in working practices to reflect those in the private sector.
- Reorganization and restructuring to ensure that MISR and COOP are able to respond to market signals.

3.43 As an extension of the discussion of the refinery operations above, the introduction of private sector finance into the refineries may require that a private oil company increases its access to the downstream marketing sector. One way of achieving this would be a trade sale of MISR and/or COOP.

3.44 ***Retail Supply.*** Retail outlets are essentially franchises of the operator. Therefore, to increase competition in the marketplace, the mobility of franchisees should be increased. As an interim step, consideration should be given to introducing measures that would facilitate the entry of new players (from the private sector) into the retail sector and increase competition. This should be done by:

- Removing the licensing authority for new outlets from the EGPC and placing it in the hands of the local planning authorities, or, preferably, a regulatory body (as and when formed)
- Placing the relationship between the operator of a franchise, the owner of the land, and the marketing companies on an exclusively commercial basis such that contracts will permit a change in the franchiser.

3.45 ***Bunker Fuel.*** If the bunker fuel service rate is increased to, say, 50 percent of the canal traffic (which should be reasonably achieved), earnings of foreign exchange from this activity alone could be equivalent to half the value of crude oil export. Reasons for the very low service rate for traffic passing through the Suez Canal and economics (costs vs. benefits) of vying for larger shares for the wholesale companies should be thoroughly analyzed. Price and other incentives may be considered to capture part of that market.

3.46 ***Transportation Mode.*** A master plan for petroleum products transport should be developed with a view to reduce costs and increase efficiency. Modification to petroleum products transport policy would result in an upward trend in future gas utilization and could affect the future import and export of petroleum products. In addition, the optimization of the gas transport network in itself would affect the level and extent of utilization of natural gas. The introduction of linear programming (optimization) models to refinery operations would result in a change in the output slate

of different refineries (the CIDA-funded refinery rationalization study would also provide other options to refinery operations).

3.47 ***Petroleum Product Prices.*** The petroleum price liberalization program has not achieved its desired results in full. The objective of price reform program included but was not limited to bringing the prices of individual petroleum product prices up to its international equivalent prices and eliminating cross-subsidies. Both objectives have not been achieved. As a first step, these objectives should be addressed immediately. The modification in the formula to compare the domestic and international prices should be undertaken immediately. A preliminary assessment by the ESMAP working group indicates that price levels need to be raised for all products except gasoline. The issue of cross-subsidies should be addressed when raising price levels. If subsidies are necessarily retained for social or political purposes, they should be targeted to the economically weaker sections of the society and should be administered independently of the price setting mechanism. An independent analysis should be carried out to determine the target population and to identify a suitable mechanism to administer it. However, the price reform program in itself did not address price liberalization in its entirety.

3.48 A full-scale price liberalization program should be introduced in line with the other options that are being considered in the reform and restructuring of the petroleum sector. All control on prices should be eliminated. Clear and transparent rules must be set for entry and exit for independent operators in the petroleum product distribution and marketing functions. Existing government facilities could be leased, or, if feasible, sold to private or independent operators. The public sector distribution companies such as MISR and COOP would need to compete openly with independent operators that have the option to buy products at the refinery gate or import them from neighboring countries. The government should not provide privileges to the public sector companies, and it should not create any barriers for private operators.

3.49 To proceed to full-liberalization in one step may be too much to expect given the macroeconomic implications. One option is partial liberalization of prices. However, a simple liberalization of prices without adopting suitable policies and developing necessary infrastructure would lead to problems. A number of interim and transitory steps should be taken that would mitigate these effects:

- Introduce a ceiling price for essential products such as diesel and kerosene, permitting discounting to take place.
- Continue to provide subsidies on transport of fuel to rural areas.
- Provide selected subsidies to rural outlets to ensure that supply is maintained. However, it would be necessary to remove these subsidies gradually.

3.50 ***Institutional Restructuring.*** In order to make each economic activity of EGPC cost-effective, profitable, and accountable, they should be separated as individual commercial entities with separate cost/profit centers. If such commercialized outfits have sufficient autonomy, they could attract private investments for future expansion and modernization. Going back to the issue of the need for creating independent business units in the petroleum downstream operations the first step should be to corporatize and commercialize all independent business units (IBUs)—specifically, the seven refineries and the two wholesale marketing/distribution companies. These nine IBUs could possibly be initially government-owned corporations. Subsequently, based on the level of interest among the private sector investors, these IBUs should be offered for sale or lease to private operators. A thorough analysis would be required to identify selected units to upgrade or rehabilitate first, and then subsequently put them up for sale. Since the retail marketing and distribution is already dominated by the private sector, the restructuring plans would in effect have introduced competition at each level in the downstream operations—refining, wholesale and retail marketing, and distribution.

3.51 These restructuring efforts would also facilitate the entry of independent operators that are solely interested in importing petroleum products from neighboring countries and selling them at competitive prices in the local market. Another point in favor of restructuring is the potential competition that would be introduced at the refinery level. One of the possible reasons why private sector interest in participation in the refining subsector has not materialized because wholesale marketing and distribution are also state controlled. If this level (i.e., wholesale) is freed up, potential investors would have a clear signal and an incentive to invest in refinery operations. Such investors may have an interest in the marketing/distribution function (forward-integration), or they may choose not to get involved in this segment of the market. At the same time, independent private operators may be interested only in the marketing/distributing segment of the market, or they may exercise their interest in the refining function also (backward integration).

3.52 The restructuring efforts should also be directed toward instituting an independent regulatory mechanism for the petroleum downstream operations. The regulatory body would provide the basis for carrying out commercial transactions between the various operating entities. Rules/criteria for operation will be made transparent to ensure that transactions are carried out on a fair basis. Specific roles, such as issuing of licenses and setting levels of margins and commissions, would need to be transferred from the EGPC to the regulatory authority. The start of all these restructuring efforts should be initiated by the government and the EGPC though the economic reform and structural adjustment program.

3.53 ***Private Sector Participation.*** As proposals are already being evaluated for two export-oriented refineries, as such the government and the EGPC have taken the preliminary steps towards creating competition in the refining subsector. The output of the two refineries would satisfy local demand first, and based on excess availability, they

could export to neighboring countries. At this juncture it is important for the government to set transparent rules for operations. Criteria for permitting private investment in the refining sector should be made public, and winning proposals should also be made available for public scrutiny. If the rules of the game are clear, interest in private sector participation in the refining function of the downstream operations is likely to grow. However, a more immediate question to be addressed would be whether the existing refineries can compete with the potential new entrants. For this to happen, the existing refineries would need to adopt the upgrading procedures identified above. In some refineries, the costs of upgrading would not provide a economic justification, and therefore these may have to be transformed into storage facilities over time. Again, the specific policy measures adopted by the government will lay the basis for effective and efficient handling of the restructuring measures.

4

Natural Gas Utilization and Development

Key players: the Ministry of Petroleum (MOP), the Egyptian General Petroleum Corporation (EGPC), Egypt Gas, PETROGAS, Petroleum Pipeline Company (PPC).

Overview

4.1 The recent change in the outlook for gas supply could become a turning point in the Egyptian energy sector. It opens the possibility for increased gas utilization and exports. The main institutional issues in the gas sector relate to commercializing EGPC subsidiaries and facilitating greater penetration of gas in a competitive environment.

The Gas Sector Today

4.2 ***Reserves.*** Proven reserves are estimated at 22.3 Tcf (631.21 Bcm). Natural gas was first discovered in Egypt in 1967. Since then, the number of gas discoveries has increased rapidly due to a successful upstream gas policy. This has resulted in an increased interest of foreign contractors in exploration and production of natural gas and a better understanding of the natural gas reservoirs. Egypt has a large gas potential, particularly in the Nile Delta. Egypt has a potential for more discoveries, as it is generally underexplored.

4.3 Natural gas reserves are summarized in Table 4.1. The proven reserves, as defined by the EGPC and the operating oil companies using international industry standards, are discoveries from which production is reasonably feasible under current economic and technical conditions. In addition to the proven reserves, 3.71 Tcf of gas are probable. These reserves have a good probability of being produced, but are not proven yet. As Egypt has a large potential for new discoveries, the estimate for possible reserves is very high (see Table 4.1).

4.4 The government has been successful in attracting foreign upstream investments in oil and gas exploration and production (see chapter 3, on petroleum sector development). However, the existence of reserves is not enough; the reserves must be exploited to yield benefits. The first major challenge for Egypt thus is to develop a

sustainable gas-based economy. In addition to offering a competitive gas oriented upstream package, the development of gas reserves should be expedited to match the growth in consumption and to explore potential export avenues. Several policy and technical considerations should be evaluated before full-scale development of gas reserves. The appraisal of gas reserves and subsequent production of gas—as well as future exploration trends—depend on key institutional, financial, and regulatory issues.

Table 4.1 Natural Gas Reserves, Egypt (Mid-1995)

Type of reserve	*Quantity*	
	Tcf	*Bcm*
Proven developed reserves in areas connected to the gas grid, including both the associated and non associated gas	7.86	222.60
Proven undeveloped reserves in areas connected to the gas grid but not yet producing	13.87	392.75
Proven reserves in areas not yet connected to the gas grid	0.56	15.86
Total proven reserves	22.29	631.21
Probable reserves	3.71	105.10
Proven and probable reserves	26	736.31
Yet to be discovered reserves (possible)	40	1132.70
TOTAL Proven, probable, and possible reserves	66	1869

Source: EGPC

4.5 ***Consumption.*** Natural gas has increasingly penetrated the market in Egypt since the beginning of the 1980s. In 1994/95, gas consumption reached 12.2 Bcm, up from 2.5 Bcm in 1981/82. Gas' share in total energy consumption is about 35 percent. Power generation and industry account for about 99 percent of the gas market now. Only 1 percent is used in the residential and commercial sectors. Sales to power plants amounted to 7.9 Bcm in 1994/95, corresponding to two-thirds of the total sales of natural gas and two-thirds of total fuel consumption for power generation in Egypt. Natural gas amounts to about 85 percent of the total fuel consumption of the power plants connected to the gas grid. Of the remaining gas consumed in 1994/95, 1.7 Bcm were used in fertilizers; 1.2 Bcm in industry; and 1.4 Bcm in the cement, construction, and petroleum industries.

4.6 ***Institutional.*** The development of gas in Egypt has been almost entirely managed and carried out under the auspices of the government-owned holding company, the EGPC, working with foreign partners upstream. All activities are carried out under production sharing agreements (PSAs) or joint ventures with the EGPC. A gas clause was introduced in the concession agreements in 1987. The price for the producer's share of gas at the inlet to the national network was originally set at 85 percent of the fuel oil

parity. In 1993, Egypt announced improved terms for gas producers. Under the new terms, the EGPC would get 75 percent of profit gas, and the price of gas transferred to the EGPC was set at 85 percent of parity with Suez-blend crude oil. After a discovery, the producer has agreed to undertake appraisal work, and from the time the gas is declared commercial, the EGPC has the right to buy it for the local market.

4.7 The EGPC is involved in all phases of oil and gas downstream activities through its subsidiaries—the petroleum pipeline company (PPC) is responsible for all gas transmission; PETROGAS is the sole marketer of natural gas and LPG in Egypt; and Egypt Gas (in which the EGPC is a majority shareholder) has a monopoly in gas connections and maintenance in Egypt. The prime objective is to establish safety standards for gas. Recently, the Egypt Transgas company (ETGC) was formed by two producers (AMOCO and IEOC, a subsidiary of AGIP) and Egypt Gas (see below).

4.8 The focus for the natural gas subsector under the energy sector assessment in Egypt is to evaluate the current institutional framework in its ability to enable gas producers, consumers and service companies to facilitate a higher penetration of gas in a competitive environment. The present institutional framework does not promote a commercial attitude among the players in the downstream sector, which is characterized by monopolies. A more competitive environment, one that would attract foreign investments, would benefit Egypt in the long-term.

Issues

4.9 The main issues in the natural gas sector are as follows:

- Supply-demand balance and pricing
- Emphasis on a commercial focus in the downstream gas sector
- The need to attract foreign investments in the downstream sector
- Encouraging higher penetration of gas in a competitive environment.

Supply-Demand Balance

4.10 Today, natural gas is supply-constrained. The supply situation is expected to improve significantly over time.

4.11 ***Supply.*** The projection for gas production is based on the "most likely case" based on a study by British Gas and updated with the latest production and development plans provided by the EGPC for companies operating in Egypt. Currently, natural gas is produced from 10 fields; about 50 percent is from the Nile Delta/Mediterranean Sea and about 30 percent from the Western Desert. The balance of about 20 percent is mainly associated gas, produced in the Gulf of Suez. Supply from these fields on stream is expected to reach a peak in 1997/98 at 16 Bcm and then gradually decline.

4.12 Supply from existing discoveries includes projected production from 14 new fields under development, including the following:

Nidoco:	0.3 Bcm/year (1995/96)
Port Fouad:	0.7 Bcm/year (1995/96)
East Delta:	0.4 Bcm/year (1995/96)
Wakar:	0.5 Bcm/year (1996/97)
Abu/Qir:	0.8 Bcm/year (1995/96)
Abu/Sanan:	0.2 Bcm/year (1996/97)
Gulf expansion:	0.7 Bcm/year (1996/97)

4.13 Development plans for the following fields are expected to be issued in 1995:

El Temsah:	3.5 Bcm/year (1998/99)
Baltim:	3.5 Bcm/year (1999/2000)
Western Desert, including Obayed, Tarek, Matruh:	3.9 Bcm/year (1999/2000)

4.14 The reserves/production ratio could be summarized as follows (Table 4.2):

Table 4.2 Natural Gas Reserves/Production Ratio, Egypt (Reserves as of Mid-1995)

Reserves (Bcm)	*Production (Bcm)*	*Reserves/production ratio (years)*
Proven reserves: 631	1993/1994: Actual production: 12.2	52
Proven and possible reserves:	Plateau production: 33.0	19
Proven, probable and possible reserves: 1869	Plateau production: 33.0	56

4.15 ***Demand.*** Two alternative demand scenarios have been developed by the EGPC and British Gas—"base case" and "most likely case." In the base case, demand projection is based on the continuation of the current 80:20 gas fuel-oil mix in power generation connected to the transmission system. This case implicitly assumes a constrained demand for gas. In the most likely case, the demand projection is based on complete displacement of fuel oil in all power stations connected to the grid. If gas

supply can satisfy the most likely case demand projection, then a potential gas surplus situation exists. However, the critical issue is when Egypt would reach such a situation of gas surplus. To address this question, the projected demand from power and industry is vital.

4.16 *Power Plants.* The power sector takes 57 to 60 percent of the future gas consumption in the two cases. Both cases include the connection of more than 15 new power plants to the grid (Kureimat, Sidi Krir, Ayoun Mousa, Mersa Matruh, Del North, Suez Gulf, Cairo North, and a number of smaller plants, including Mahmoudia 1 and 2). The difference between the two cases of demand projection relate to differing expectations of when the new power plants would be put on stream and also, differing estimates of how much gas each power plant consumes.

4.17 According to the EEA, the gas demand forecast for power generation has been reduced to take into account the new, higher-efficiency power plants coming on stream, the demand-side management measures, and the impact of electricity price increases. However, the average load factor for gas plants is comparatively low. EEA estimates the volume of gas required in power plants show that requirements for gas in the period 1996/97 to 2000/01, are higher than in the most likely demand case. Moreover, after 2000/01 some of the newer high-efficiency power plants could use more gas than projected. Kureimat, for example, is now planned to be operated at a 62 percent plant capacity factor, compared with 70 percent in the original plans.[2]

4.18 *Fertilizer.* The demand projections for fertilizer and other industries would be revised downward if gas is used more efficiently. About 15 percent of the natural gas is currently used for feedstock in fertilizer production, and all of nitrogenous fertilizer production is based on natural gas. In the two demand cases, it is assumed that fertilizer production in Egypt would continue to be 100 percent gas based, and about 13 to 14 percent of the demand for gas is projected to be used in fertilizer production in the forecast period. The main difference between the two forecasts is the buildup period; eventually the two forecasts reach the same plateau level. Only two new fertilizer plants are expected to be connected to the grid. After 2000, the gas consumption for fertilizer production is assumed to be almost constant, with annual sales reaching about 2.9 Bcm in 2012/13.

4.19 *Industrial Demand.* The industrial demand accounts for about 5 percent of gas demand, of which cement plants consume about one-third. During the forecast period 11 major new customers, of which 2 are cement plants, are planned to be connected to the gas network in the two scenarios before 2000, based on current plans for construction. After 2000, no additional major industrial plants are planned to be connected to the grid. The industrial sector is expected to consume about 20 percent of gas demand in the two

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[2] Kureimat Power Project.

scenarios the difference being that the unit consumption of each customer generally is about 40 percent lower in the base case than in the most likely case.

4.20 *Other Sectors.* No new petroleum sector customers are expected during the forecast period, and sales are expected to stabilize at about 1.5 Bcm per year (7 percent of future demand). Gas sales to the residential and commercial sector stay around 1 percent. No exports are included in the forecast.

4.21 *Exports.* With the prospects for a larger production of natural gas in the future, projects for gas exports to neighboring countries are in the planning phase. Both LNG and pipeline projects are discussed, including an export pipeline across the Sinai to Israel. Although no agreements are in place yet, gas exports of 2 to 4 Bcm per year have been assumed in the analyses for illustrative purposes.

4.22 There seems to be a general consensus among the Egyptian authorities and international operators that this supply-constraint situation will last until about 1998/99. Based on the projections for domestic demand, a surplus of gas would emerge after this year. The demand projections, however could be underestimated—in part because of the potentially greater demand for gas in power generation (see discussion above), and, beyond the turn of the century, because of demand from other sectors as well. The demand projections, however, would be sensitive to the pricing policy assumed for natural gas. A discussion follows in the next section.

Netback and Pricing

4.23 Gas pricing policy has played and will continue to play a key role in the implementation of Egypt's gas development strategy. The policy issues of gas development are directly linked to the gas pricing and utilization strategies.

4.24 The major user of gas in Egypt is the power sector. All future thermal fuel requirements are targeted to natural gas as the mainstay fuel with fuel oil as a backstop. In addition, fuel oil (mazout) is projected to be used in those plants not connected to the gas network throughout the projection period until 2013. In the late 1990s, annual consumption of mazout in power plants is projected to be around 1 to 3 million tons (1 to 3 Bcm of gas), depending on the demand scenario. There is some indication that new power plants could be used at a higher plant capacity factor so that more gas could be used in the power sector.

4.25 An ESMAP study carried out for the EGPC (in 1993) recommended a new gas pricing policy based on an analyses of the economic netback of gas in different market segments.[3] For example, the economic netback value of natural gas used in a

[3] Gas Distribution Pricing Study - July 1993.

power plant is the price that the power plant can pay for the gas and remain indifferent between using fuel oil or gas. Capital and conversion costs were not taken into account because the comparison is between using more gas and less fuel oil for power generation in stream plants (from 1996/97); only differences in operating costs, fuel costs and efficiency were considered. The netback value of gas is based on the economic price of fuel oil at the power plant calculated as agreed under the ERSAP; i.e., the export price ex-refinery plus distribution costs plus and an additional 20 percent to take account of efficiency considerations.[4] Using fuel oil prices in the 12-month period including January 1995, the netback value for gas is 25.4 pt/m^3 = US$2.10/MMBtu. However, the netback value for new power plants would be higher because it would include the effects of lower capital and operating costs for gas-fired plants than for oil-fired plants.

4.26 The economic netback value of gas exports replacing fuel oil (traded at international prices) in existing power plants in other countries would be lower than this figure because of costs of long-distance transmission. Therefore, natural gas obtains a higher economic netback from replacing fuel oil in the domestic power stations than in replacing fuel in existing power plants in export markets. However, gas exports to new high-efficiency combined-cycle power plants would result in a higher netback than would replacing fuel oil in the same export markets.

Table 4.3 Estimated Gas Netback Values for Power Plants and Large Industries (1994 Prices)

Customer	*Alternative fuel*	*Economic value of alternative fuel (piaster/m^3)*	*Lower operating costs (piaster/m^3)*	*Netback (piaster/m^3)*
Power plants	fuel oil	25	3	26
Large industries	fuel oil	25	1–3	26–28

Note: Calculated for existing plants at the burner tip. International fuel prices are based on the period Feb. 1994 to Jan. 1995.

4.27 The economic netback value for residential, commercial, and industrial uses was calculated by a consultant in 1993.[5] To be comparable with the netback value for gas used in power, the netback value for these gas uses is calculated at the city gate (i.e., market value less distribution and conversion costs). Table 4.4 shows the following netback values for gas in different uses: using average international petroleum product prices for 1994, the economic value of gas in residential and commercial sectors, where it

[4] Petroleum Product Price Increase Formula, Kureimat Power Project.

[5] Gas Distribution Pricing Study - July 1993

replaces LPG; in small industries, where the substitute fuel is gas oil; and in medium-sized industries, where the main alternative fuel is fuel oil.

4.28 The current prices for gas supplies to different customers are shown in Annex 7. It shows that residential prices are very low when compared with economic costs.

4.29 The gas distribution pricing study recommended pricing of gas at market value (i.e., prices related to the economic value of alternative fuels). For smaller consumers, specific tariffs were proposed, whereas for large customers (such as power plants and major industries consuming more than 30 million m^3 per year) prices were proposed to be negotiated individually. Some 99 percent of the gas is consumed in power generation and industry, where the main alternative is fuel oil. The value of gas varies among customers depending on how efficient the process is compared with the process involving fuel oil. In the power sector, gas would have a higher value in combined cycles than in steam plants because of the higher efficiency. In a combined-cycle plant, therefore, gas would have a higher value, and the power plant would be willing to pay more for the gas.

Table 4.4: Estimated Gas Netback Values for Residential, Commercial and Small and Medium Industrial Customers (1994 Prices)

Customer	*Alternative fuel*	*Economic value of alternative fuel (piaster/m^3)*	*Costs of gas distribution (piaster/m^3)*	*Conversion costs (piaster/m^3)*	*Netback (piaster/m^3)*
Residential	LPG	70	87	-	–17
Commercial	LPG	70	15	10–25	30–45
Small industries	gas oil	47	15	10–25	7–22
Medium-sized industries	fuel oil	25	2	2–5	18–21

Note: The netback value is calculated for new customers at the Cairo city gate. It is assumed that gas oil is imported, whereas fuel oil and LPG are exported. International fuel prices are based on the period Feb. 1994 to Jan. 1995. (Platt's Oilgram Price Report)

Source: "Gas Distribution Pricing Study," July 1993.

4.30 The ESMAP working group approached pricing issues differently. It was assumed that as long as the gas supply constraint continues in Egypt, the value of natural gas should be the opportunity cost of the alternative fuels, and gas prices should be set according to the market value of the alternative fuels (see Tables 4.3 and 4.4). When the supply constraint improves to the point where there is long-term excess supply of gas, the pricing principle would warrant change. The value would no longer correspond to using opportunity cost of alternative fuels; rather, it would correspond more closely to the economic cost of producing gas at the margin. In this situation, the best estimate of the

opportunity costs would be the long-run marginal cost (LRMC). The estimation of LRMC should take into account discovered but not yet developed fields and should include a depletion premium to recognize the exhaustible nature of the resource (whereas the British Gas study does not include a depletion premium). However, assuming gas is priced at LRMC for large customers at the level it is calculated in Table 1 of Annex 8, EGPC's and the government's revenues would be lower (because of lower end-user prices—upstream arrangements under the PSCs would not be affected) than the existing situation. The benefits of lower prices would go to domestic consumers and would help to lower the prices of energy-intensive products thereby promoting (price) competitiveness of Egypt's exports.

4.31 Instead of using different principles for gas pricing according to whether or not gas supply is deemed to be in a surplus situation, gas-pricing principles should be based on economic cost in a consistent fashion whatever the supply-demand balance. In a supply-deficit situation, to balance supply with demand, gas prices should incorporate a rationing premium on the top of the pure production cost. In general, the magnitude of this premium is difficult to estimate. However, the equivalent thermal cost of energy from using fuel oil can be used as an approximation of the rationing price for gas in Egypt because this market accounts for a major share of gas utilization in Egypt.

4.32 Where gas market segments can be opened to competition from other fuels or for particular segments of the energy market, such as bulk power supply by independent power producers, the price of gas in these segments, in principle, should be freely negotiated. The investors would then take the risk of future price developments caused by changes in supply and demand. As suggested above, gas has a higher value for some customers than others, and some are willing to pay a higher price for gas based on individually negotiated contracts. This would be the case for some of the large industrial customers, future exports, and IPPs. Negotiations would result in market prices reflecting the value at the burner tip. Gas should be used where the economic netbacks are highest. Table 4.4 shows that this is the case in the commercial sector, power, and industry. The introduction of market prices would help to achieve this. End-user taxes could be considered as a means of providing incentives (or disincentives) for the use of gas in certain sectors. The institutional framework, however, would need to change to provide producers with the ability to sell to and negotiate prices directly with large consumers. The use of heavy fuel oil with high sulfur content could be discouraged through the judicious application of taxes. In the long term, when prices are fully liberalized, the market price and the opportunity costs should eventually converge.

4.33 Based on the calculations in Annex 8, LRMC can be estimated about at 13.65 pt/m^3 prior to inclusion of a depletion premium. This is higher than the current tariff (12.25 pt/m^3, see Annex 7). The LRMC value is, however, much lower than the estimated netback value of about 25 pt/m^3. Therefore by pricing gas at its economic value, EGPC is receiving less revenue than it would if it priced gas at the netback value. And by pricing gas below its economic value, i.e., at its current price, besides the

foregone additional revenue the consumers stand to benefit from the low gas price which gives the wrong signals in the demand forecasting process.

Institutional Issues

4.34 Egypt enjoys significant potential reserves. Therefore, a consistent policy should be developed to achieve sustainable growth in gas utilization and development. Egypt has a successful track record of attracting foreign oil companies to participate in gas exploration and development. The increased gas production projected for the future would need to be channeled to users willing to pay prices reflecting the value of gas. To achieve this, the institutional framework needs restructuring so that producers have access to sell gas directly to customers and commercial contractual relationships are permitted in transmission and distribution so that competition is introduced in the downstream operations.

4.35 Under the current institutional arrangement, the EGPC and its subsidiaries, the PPC and PETROGAS, have a monopoly in the downstream gas sector. Introduction of competition and commercialization of the downstream gas sector are important institutional issues.

4.36 ***Introducing Competition into the Downstream Gas Market.*** Ownership of the EGPC and its subsidiaries is not an issue in the oil and gas sector in Egypt. However, a policy not to expand the activities of the EGPC and its subsidiaries and to introduce private participation in future projects would reduce the monopoly of these companies and would work in the direction of enhancing the competition and the efficiency and performance of the sector. The demand potential for gas is good; the upstream pricing policy is favorable for gas development. The challenge for the gas sector thus is to provide a conducive environment for rapid expansion; policies should combine encouraging continued exploration and the effective marketing and utilization of the gas discovered. To expedite the expansion of the gas network, the downstream operations should be commercialized, new players be permitted to participate in downstream operations and competition introduced among the operating companies. The priority issues to consider are the current institutional/marketing structure of gas sector and the institutional framework regulating the sales and transport of gas in Egypt.

4.37 **The EGPC and its subsidiaries.** The EGPC's two subsidiaries, PPC and PETROGAS, with monopolies in transmission and distribution of natural gas and LPG, receive a commission from the EGPC covering their annual costs, mainly operating costs. Capital expenditure is financed by the EGPC. The commission is estimated each year and is calculated as a margin between the sales and purchase price for each customer class. This system does not provide sufficient incentives for the two companies to operate with a commercial focus in their operations; that is, incentives to reduce costs are absent because any reduction would lead to lower commission in the following year. The system does not provide incentives for expanding sales to high-value customers and for PETROGAS and the PPC to self-finance their investments.

4.38 ***Organization of Sale to Large Customers.*** Despite its monopoly, PETROGAS's relations with large customers are reduced to reading meters and billing. The PPC delivers gas to large customers, handles the daily operations, connects new customers, and is responsible for metering together with PETROGAS. The EGPC is responsible for the long-term planning of sales to large customers. Such a division of responsibilities lacks efficiency; the company selling gas to a customer should have full responsibility for all technical, marketing, and financial aspects.

4.39 ***Legal and Regulatory Framework.***. The present legal and regulatory framework is minimal. The upstream sector is governed by production-sharing contracts and the downstream sector by laws and decrees that determine the rights and obligations of the key players (see Annex 9). The EGPC has the role of both a regulatory body and an operating agency. To facilitate continued growth of natural gas in energy markets, the institutional framework needs modifying to respond to future needs. This change should facilitate the adoption of new policies, a shift to commercially based operations, introduction of competition in the downstream gas sector, and encouragement of private sector participation in gas sector investment and operations.

Options

4.40 This section discusses the options for changing the institutional framework and commercializing the gas sector. The preferred approach to reform in the gas sector as well as in other sectors in Egypt has been to change the framework step-wise rather than introduce major institutional reforms. The first step in this approach could be to introduce private investments into specific projects rather than change the present institutional setup. The options for the commercialization of the sector would include an improvement of the balance between risk, return, and responsibilities in the EGPC and in subsidiaries that the present commission system does not provide for. Finally, the options for a pricing policy are discussed.

Pricing and Netback

4.41 ***Demand-Supply Balance and Pricing.*** Subject to a gas-supply constraint in Egypt, gas prices should be set according to the market value principle (i.e., pricing gas according to the economic value of alternative fuels). Upon continuing to enhance the gas supply potential and reaching a level of long-term excess supply of gas, the pricing principle should move toward using LRMC, as a basis for the pricing policy. A surplus of gas is expected from about 1998/1999 because of the advancement of development plans by the EGPC and foreign operators. The projected plateau level for production is higher than earlier expected in both existing fields and future fields coming onstream.

4.42 A shift to LRMC would imply a price increase in relation to the current tariff for gas to the power sector (12.3 pt/m^3). The LRMC has been calculated to 13.65 pt/m^3 by British Gas (see Annex 8). This is, however, lower than alternative fuel prices (26 to 28pt/m^3, Table 4.3). The range between the prices based on these two methods is

very large. Accordingly, to develop the market for gas and bearing in mind that in the short-term there is no export of natural gas, it should be priced lower than fuel oil, say at international fuel oil price with a discount factor for promoting natural gas utilization and development. However, to operationalize this policy and arrive at an appropriate discount factor, the ESMAP working group suggests equating international fuel oil price less discount factor to LRMC plus a depletion premium plus a resource tax, if necessary, based on the desired policy of the Government. Also, if the gas price is marginally lower than oil prices, it would still be attractive for the power sector compared with the alternative fuel. As suggested above, some of the large industrial customers, future export customers, and IPPs would be willing to pay a higher price for gas based on individually negotiated contracts.

4.43 An important factor is to find outlets for the expected large potential supply. After a discovery, the producer has two years to undertake appraisal work, and from the time the gas is declared commercial the producer and the EGPC have five years to negotiate a long-term contract for the local market. If they fail to reach agreement, the gas could be exported. Therefore, the development of additional markets locally and for export opportunities would provide incentives to oil companies to explore for gas and to appraise new gas discoveries so that they would be declared commercial at an earlier date.

4.44 The netback analyses (Table 4.4) show that more natural gas should be used in the commercial sector, where it displaces LPG, and in industries, where it displaces fuel oil and gas oil (depending on the conversion costs). The present low end-user price of LPG in Egypt is an obstacle to the penetration of natural gas in this market. The major uses of natural gas are the power generation market and parts of the industrial market, where gas replaces fuel oil. Both sectors provide a high netback value. The netback value for gas exports could be lower than the calculated value in Table 4.3 depending on the market value at the export point and the costs of transmission. Natural gas supply to the residential sector is not economically viable at netbacks based on current international LPG prices because of the high distribution costs for natural gas and the small unit consumption levels. In the absence of tariff reform, distribution companies would not be able to recover costs of gas distribution to small customers, and the objectives of commercializing and privatizing these companies would not be realistic. In conclusion, natural gas has the highest economic value in the commercial sector, where it replaces LPG, and in the power sector and industries, where it replaces fuel oil. The government should implement the recommendations of the gas distribution pricing study, (i.e., pricing both gas and LPG according to market value).

4.45 ***Future investments in Gas Transmission.*** The EGPC performed a gas network analysis to identify the need for reinforcements of the high-pressure transmission system and to determine system capability to transport future quantities of natural gas (based on the base case and the most likely case demand projections). On the basis of a precise identification of each major customer and such customer's connection point to the

transmission, grid reinforcements on the transmission system were calculated. The result of the Gas Master Plan was an identification of reinforcement and expansion of pipelines to be constructed between 1993/94 and 2012/13 for US$252 to 329 million. The ESMAP working group finds the Gas Master Plan a good strategy for future investments in the network updated to the latest demand forecasts.

Institutional Issues

4.46 ***Introducing Private Capital into Specific Projects.*** Recently, two new gas transportation companies with private participation were formed. The Egypt Trans Gas Company (ETGC) has been formed under the existing Investment Law. Its shareholders are Egypt Gas (34 percent), Amoco (33 percent), and IEOC (33 percent). The company is a gas transport joint venture company and will be responsible for new transmission pipelines, including possible export pipelines. This implies that future expansion of the transmission pipeline system will not be under the responsibility of the EGPC but under the responsibility of this or similar companies. Other projects suitable for private participation are the pipeline from gas fields in the Western Desert to the network and a pipeline to Upper Egypt. The other company is the Natural Gas Vehicle Company, owned by Egypt Gas, Amoco, and ENPPI. This company has established to promote gas utilization in transport. This is a first step toward opening the downstream gas sector and introducing private sector participation. Also, it will introduce new players (in addition to Egypt Gas) in the downstream gas sector and diversify ownership.

4.47 ***Introducing Access to the Transmission Network.*** Opening the downstream sector to competition could be the next step in institutional reform. An option would be to increase competition through open access to the transmission network. Opening access to the transmission network for producers and making it possible to sell gas directly to major customers would allow for competition and would enable the producers to develop the gas market and provide alternatives to selling the gas to the EGPC. The new customers could be power stations and major industries, including BOOT projects. For this option to work, in practice, the EGPC cannot be the sole buyer of gas from producers as today under the production-sharing agreements.

4.48 The transmission pipeline should be able to transport gas for third parties on a nondiscriminatory basis and charge a published tariff for the service. This charge could be either on rate-of-return basis or on a price-cap basis and should be regulated by an independent and transparent regulatory mechanism (see Legal and Regulatory Framework, para 4.51). The transmission pipeline could be the PPC transporting gas for the EGPC as well as for producers charging the same tariff for all users, or it could be an entity separate from the EGPC (assuming that the ownership of the transmission network would be separated from the EGPC). This would have the advantage that the vertical integration in the gas chain would be reduced, and the owner of the transmission company would not control other elements of the gas chain.

4.49 ***Introducing Competition into Other Areas of the Downstream Gas Market.*** In other areas of the downstream gas sector, competition should be introduced by opening the distribution of LPG, opening the market for gas installations, and allowing construction of connections by interested investors from the private sector. Today, Egypt Gas has a monopoly in gas installations, gas connections, and gas maintenance in Egypt. Expected benefits of competition include lower costs of these services, reduction of lead times, and consequently lower gas distribution costs.

4.50 ***Organization of Natural Gas and LPG Sales.*** As these products are naturally competitive, their sale should be separated into two companies, each responsible for the marketing of one product based on commercial agreements and transactions. This would be a first step toward bringing about a competitive market between the two products. However, prices for LPG are still low and prevent natural gas from being sold to the commercial sector. To achieve a competitive market, prices for both products need to be deregulated.

4.51 ***Legal and Regulatory Framework.*** The regulatory framework should be modified so that companies wishing to get involved in the downstream gas sector will understand the regulatory environment in which they will operate. To promote a market-oriented environment, the government should give a clear indication of how it will attract private investments. The changes should be carried out in line with the institutional restructuring measures under the public enterprise reform of ERSAP. Many countries developing their natural gas industries have introduced a Gas Act (i.e., a national legislation). The Gas Act should be applied nationally to new entrants as well as to the existing industry. The Gas Act or Gas Law establishes the policy objectives for development, competition, and performance of the downstream gas sector; sets criteria for granting franchises, licenses, or authorizations; and defines the pricing methodology and the rights and obligations of the suppliers, transmission companies, and distribution companies in the sector. Several of these acts include provisions to establish gas regulatory agencies—either a single regulator or a board/commission. The Gas Act is the framework for the day-to-day operational work of the regulatory agency. If it is decided to introduce a regulatory agency, the agency needs to instill confidence in consumers and investors that they will be fairly treated. The agency can accomplish this by establishing a record of objectivity in its assessments, transparency in its decisionmaking, and independence of political interference. Developing such a reputation will require the agency to attract quality personnel, publish well-reasoned decisions, and follow appropriate operating procedures.

4.52 The introduction of a new gas act and the institution of an independent regulatory agency, including a transparent process, would be a major step in the direction of preparing for private investments in the downstream gas sector. The main duties of the regulator should include the following:

- Enforce a Gas Act and its regulations.
- Issue permits authorizing construction and operation of pipelines.
- Regulate the tariffs and other conditions of service for open-access pipelines.
- Regulate end-user tariffs for supply to captive customers, such as small residential customers.
- Enact regulations governing safety, technical and environmental standards, and billing.
- Ensure that the gas supply companies maintain their systems in good order.
- Prevent abuse of monopoly.

EGPC and Subsidiaries

4.53 ***Distribution.*** A preliminary step should be to revise the present commission system by introducing a purchase price for gas for each customer category, negotiated for an agreed period with the EGPC, long enough to give incentives for PETROGAS to expand sales and reduce costs. The purchase price should be escalated with the market prices in the end-user market. The difference between purchase and sales prices would leave a margin for PETROGAS' operations. For this system to work, the nonpayment problem (i.e., accounts receivable) needs to be solved; otherwise, PETROGAS, as the company dealing with the customers, would take the revenue loss. The longer the revised commission system is agreed for the greater the benefit for PETROGAS (i.e., the longer it would be able to keep potential efficiency gains). This system would give PETROGAS a better control over its finances and thereby allow it to benefit from a higher profit margin based on its performance.

4.54 The introduction of long-term contracts would be the next step in the commercialization of the companies. A true commercial relationship between the EGPC and PETROGAS should be achieved by introducing a long-term commercial contract (15 to 20 years with a renegotiation clause—a so-called price reopener) for PETROGAS' purchase of gas from the EGPC. PETROGAS' financial results, including financial costs, would then depend on its performance in relation to the contract.

4.55 The pricing formula in the contract should be based on a netback concept, whereby gas is priced to compete in each end-user market. Fuel oil, gas oil, and LPG are the main competitive fuels in most industrial and residential markets. The weights for gas oil and fuel oil in the price formula should be negotiated based on the size of the markets for these fuels. The price should be linked to the end-user prices of these fuels, and the formula should separate the base price from the escalation of the price (i.e., how future price adjustments in the end-user market would be shared; (reviews of base price and escalation formula should take place every three years).

4.56 Another possibility would be to open the market to private investors and to introduce more distributors and thereby increase the potential for future competition. New distributing companies in cities outside Cairo should be separate commercial entities. It would be in PETROGAS' (and other distributors') interest to introduce long-term contracts with major customers, such as EEA and major industrial customers. If distribution is carried out by separate commercial companies in the future, comparison of service and costs between companies would then be possible.

4.57 ***Transmission.*** The commission for the PPC, at a minimum, should be based on a charge covering all operating and financing costs, including new investments. There are two main options for setting pipeline charges.

4.58 ***Rate of Return (Cost-of-Service).*** The key features of rate-of-return regulation are as follows:

- The pipeline company files a tariff proposal, and for an agreed test period the company calculates costs, capital employed, and cost of capital
- The regulator determines a fair maximum rate of return on capital employed
- The total revenue requirement of the pipeline is calculated based on these data and assumptions about the future business
- This determines the level of the tariff, which is then split among tariff elements.

4.59 The structure of the tariff has to avoid unfairness or unreasonable discrimination. The tariff, therefore, must be approved on a service-by-service basis, which typically requires the allocation of common costs on the company's services.

4.60 The two main problems with rate-of-return regulation are that it becomes extremely complex to administer on a large, developed system and that it encourages over investment. The return an operator can make on assets is limited by the regulation; therefore the only way the investor can increase profit is by making more investment. This encourages "goldplating" and discourages efficiency. In its pure form, the system also shelters the operator from the risk of business failure. If business falls off, the tariff is raised to generate the same rate of return. This is clearly opposite to the way a market would respond. No price risk is taken. Normally, this is overcome by only allowing the operator the permitted return at a defined level of throughput to give the operator an incentive to increase gas flows to this level. Canada is trying to create incentives for companies regulated on a rate-of-return basis to increase efficiency by sharing cost savings and increased revenue from an increased capacity between the pipeline company and its users.

4.61 ***Price Cap.*** The key feature of this form of price control is that for a specified period (four to five years), the company can make any changes it wishes to

prices, provided that the average price does not increase faster than the cap (or maximum price). This cap is usually determined as RPI-X: the rate of inflation (RPI) minus an efficiency factor (X), specified initially by the government. In the U.K., price-cap regulation was originally introduced as a price control over its final prices to residential and other smaller customers. Nongas costs for gas distribution and transmission were regulated, and the utility was allowed to pass through the full purchase cost of the gas until recently. However, the regulator went a step further by modifying the formula and placing limits on the pass-through of gas cost. Since the separation of British Gas transportation business from its other operations, this part of the business has been subject to price-cap regulation.

4.62 Price-cap regulation is less likely than a rate-of-return or a traditional cost-plus approach to lead to goldplating and over investment. Because it allows the regulated company to keep whatever profits it can earn during the specified period (and requires it to absorb any losses), price-cap regulation preserves incentives similar to normal profit maximization. The efficiency factor element forces part of the efficiency gain to be passed onto the customers. Price-cap regulation allows the company greater flexibility to adjust prices within the cap, and the regulation is simpler to operate by the regulator and the company.

4.63 Criteria for setting and resetting the efficiency factor may not be clear and may undermine the incentive element. Recent experience in the U.K. electricity sector showed these difficulties. To set and reset the efficiency factor requires many of the same considerations as for rate-of-return regulation, including determining an implicit rate of return and estimating the potential for efficiency gains. In some cases, the efficiency factor is chosen in an arbitrary way. Flexibility of pricing is also criticized for allowing cross-subsidization, which can be used anticompetitively. Price-cap regulation of the downstream gas chain is of greatest value for newly privatized companies, where significant productivity gains can be made and significant room exists for bargaining between regulator and regulated. For a greenfield project, such as a new gas pipeline, the price cap would be calculated based on the planned investment costs, along with assumptions about future business, load factor, and an assumed rate of return. The approach would thus be based on the same elements as the rate-of-return regulation with an efficiency factor of zero. The differences between the two methods are how to determine the price cap based on planned investment and operating costs for the pipeline and how often and how quickly the efficiency factor is changed.

4.64 The transmission system in Egypt has many inlet points for gas and about 60 major customers in different locations, mainly in the Nile Delta. In this configuration it would be difficult to administrate a distance-related transmission tariff because there are no definite inlet points for gas to specific customers. For new projects, delivering gas from dedicated fields to specific customers or export-distance-related tariffs could be considered.

4.65 In conclusion, for a new pipeline the rate-of-return option with incentives to share gains in cost efficiency and higher load factor with the users of the pipeline, would be the recommended option. This could be achieved by an agreement on how cost reductions and revenues from increased throughput should be shared between the pipeline and its users. The users' share would be used to reduce the subsequent periods revenue requirement and thereby reduce the transportation tariff.

4.66 The next and more radical option for transmission of gas would be to introduce open access based on transportation contracts between the PPC and its customers. The transmission pipeline should be able to transport gas for third parties on a nondiscriminatory basis and charge a published tariff for their service. As discussed above, other institutional changes and a legal and regulatory framework would need to be introduced.

4.67 ***Organization of Sale to Large Customers.*** The linkage between financial responsibility and control over earnings should be ensured for PETROGAS. For example, PETROGAS should have the option to deal directly with large customers in order to achieve full responsibility for all aspects of the sale, including daily operations and long-term planning.

4.68 The other option that can be envisaged is to merge the PPC and PETROGAS into one company. The advantage of this option is that this company would be able to undertake all aspects of supplying gas to large customers. However, such a combination would create an even larger monopoly in the Egyptian gas market instead of moving toward a more competitive gas market.

5

Energy Conservation and Environmental Protection

Energy Conservation

Key players: Ministry of Electricity and Energy (MEE); Ministry of Petroleum (MOP), Organization for Energy Conservation and Planning (OECP); Egyptian Electricity Authority (EEA); Egyptian General Petroleum Corporation (EGPC); Tebbin Institute of Metallurgical Studies (TIMS); Development Research and Technological Planning Center (DRTPC)—Cairo University; Confederation of Egyptian Industries (CEI).

Overview

Responsibility

5.1 The Ministries of Electricity and Energy and of Petroleum are responsible for all energy conservation activities within the sector. The Ministry of Industry, and the Ministry of Housing and Reconstruction play a catalytic role in the energy conservation activities. None of the ministries have the overall responsibility for coordinating all energy conservation activities in the country.

5.2 However, the Organization for Energy Conservation and Planning (OECP) plays the closest role of coordinator for all energy conservation activities at the national level. The OECP was established by a Presidential Decree in 1983, originally as the Organization for Energy Planning (OEP). It was, and remains, an independent entity responsible to the MPMR with the aim of supporting the Supreme Energy Council (comprising Ministers from all major energy producing and consuming sectors: petroleum and mineral resources, electricity and energy, industry, irrigation, transport, housing, and reconstruction and planning).

5.3 OECP is responsible for collecting and analyzing energy data and for undertaking comprehensive and integrated energy planning within the economic framework. It is also responsible for developing technical expertise in the energy planning field. The OEP was extended in 1989 to take on responsibility for energy

conservation and was renamed OECP; energy conservation represents about 30 percent of OECP activities. The Ministry of Petroleum acts as the representative of government to control the OECP; however, it operates autonomously in that it has a separate budget, its Board members are nominated by the OECP Chairman (although presented to the Minister of Electricity and then to the Minister of Petroleum for formal approval), and Board resolutions need no further approval.

5.4 The government of Egypt currently funds three OECP projects: (1) institution building within the OECP; (2) energy planning and conservation studies; and (3) demonstration of energy conservation technologies. The OECP was recently requested to take over the responsibilities of the Egyptian Environmental Affairs Authority (EEAA) for energy-related environmental matters; the Chairman of the EEAA is a member of the board of the OECP.

5.5 Another organization playing a role in the energy conservation activities in Egypt is the General Organization for Industrialization (GOFI). GOFI works under the auspices of the Ministry of Industry, although the MPMR and MEE are also represented on its board. Its primary responsibilities are for the public sector industries, but it does look after some private sector industry matters, for example, all private companies have to be licensed by GOFI, and it is beginning to include them in its energy conservation work. In the energy field, GOFI sees two main roles: initiation of ideas (for example, GOFI claims to have initiated both the ECEP and the concept of submetering in public sector industries) and preparation of data bases (for example, GOFI has a data base on all industrial boilers).

5.6 A detailed understanding of energy use across all sectors is necessary for assessing the potential for energy conservation and for proposing and prioritizing appropriate programs, including establishing the institutions to manage them.

Primary Energy

5.7 Petroleum and gas, and associated products, provide 92 percent of Egypt's primary energy consumption. Nearly all the remainder is provided by the Aswan Dam, which contribute 22 percent of generated electricity. In addition, small contributions come from other renewable sources (including wind, biomass, and solar-thermal), which are not included in overall energy statistics or in the following discussions.

5.8 Table 5.1 shows primary energy consumption in Egypt for petroleum products, as supplied by OECP, and illustrates remarkable consistency over time in the share of energy demand for the different sectors. The data for electricity are for petroleum fuels supplied to power stations. After increasing steadily from 1983/84 to 1991/92, consumption declined slightly in 1992/93.

Table 5.1 Annual Primary Energy Consumption of Petroleum Fuels in Egypt (in Thousand Tonnes of Oil Equivalent)

Year	*Industry*	*Transport*	*Electricity*	*Agriculture*	*Residential*	*Total*
1983/84	7327	4800	5627	233	2588	20575
1984/85	7931	5189	6156	240	2783	22299
1985/86	7790	5467	6380	267	2923	22827
1986/87	8431	5532	7018	244	3116	24341
1987/88	8701	6802	7749	254	3180	26686
1988/89	8593	5750	7920	261	3234	25758
1989/90	9456	6126	8033	257	3225	27097
1990/91	9726	6330	8547	231	3158	27992
1991/92	9899	6229	8968	204	2929	28229
1992/93	9766	6466	8851	175	2848	28106

Source : OECP

5.9 Primary energy consumption increased by 30 percent from 1983/84 to 1992/93, a compounded yearly growth of about 3.3 percent, exceeding the compounded population growth of 2.8 percent. Primary energy use per capita in 1992 was about 586 kg oil equivalent, which is at least 50 percent greater than for other countries at similar states of economic development (i.e., GDP/capita). See Annex 10 for primary energy consumption per unit of GDP for 1984-93.

5.10 The key factors influencing primary energy consumption by main sectors are as follows:

- Industry uses roughly half the primary energy, and the biggest contribution to industry is from electricity.
- Production of construction materials (e.g., cement, bricks, tiles and requires 11 percent of primary energy use.
- Residential use represents 22 percent of the total. A small amount of this is supplied by natural gas, but the bulk is split roughly equally between electricity and "other" fuels (i.e., 0.95 mtoe LPG and 1.81 mtoe kerosene).
- Transport represents 21 percent of primary energy use, all of which is petroleum based.

Energy Conservation Programs in Egypt

5.11 Several programs and projects (see details in supporting document) are ongoing in energy conservation in Egypt. Two examples of such programs in particular that have led to significant primary energy savings. The first is EEA power generation

improvements. Fuel use in 1992/93 was 2.9 mtoe less than it would have been at 1984/85 generation efficiency. Cumulative savings are estimated to be 13.7 mtoe, worth in the order of $1.5 billion. The second is the USAID Energy Conservation and Environment Project (ECEP), for which direct annual energy savings worth about $25 million are claimed, together with an unknown amount from replication of demonstrated technologies.

Energy Conservation Potential

5.12 A simple estimate of the global energy conservation potential in Egypt can be obtained as follows, although further work to refine the estimate should be done in preparation of any future strategy. Table 5.2 shows energy conservation potentials for industry, residential use, and transport sectors. The commercial sector potential is assumed to be the same as that of the residential sector; savings in the agriculture and other sectors are estimated roughly at of 25 percent.

5.13 The saving potential in the industrial sector ranges above the OECP estimates because this assessment considers energy consumption using the most modern plant; this is an appropriate comparison in view of the necessary expected investment in new plants as Egyptian industry expands and old, energy-inefficient plants are retired.

Table 5.2 Estimation of Energy Conservation Potential for Egypt

Sector	*Primary energy consumption (mtoe)*	*Energy saving potential*	
		(%)	*(mtoe)*
Industry	15.2	35–55	5.3–8.4
Transport	6.5	50	3.2
Residential	6.7	20	1.3
Commercial	0.3	20	0.6
Agricultural	0.6	25	0.1
Other	1.4	25	0.3
TOTAL	30.6	35–45	10.8–13.9

5.14 The total economic conservation potential, 10.8 to 13.9 mtoe, represents 35 percent to 45 percent of current energy consumption, which for simplicity can be rounded to 40 percent. See Annex 11 for final energy consumption by sector (1992/93). Based on the discussions during the main assessment mission, 40 percent seems reasonable, given the history of low energy prices and low investment in energy-saving technologies and measures, when compared with the 20 percent of energy use in developed countries estimated to be avoidable using proven, cost-effective technologies.

5.15 The above estimates refer to energy consumption at the point of end-use. A recent EEA study of greenhouse gas reduction scenarios suggested an 18 percent potential reduction in the electricity sector by 2005 though a combination of measures including end-use efficiency but also reduced transmission and distribution losses, complete phaseout of fuel oil by natural gas in power stations, increased use of combined-cycle generation, and increased penetration of renewable energy. Most of the 18 percent gain would thus be additional to the above 20 to 40 percent.

5.16 The 40 percent energy conservation potential suggests a long-term aim to be reached by a range of measures. In the developed market economies, programs employ measures divided into "sticks" (e.g. regulations) and "carrots" (e.g., tax incentives and grants, supported by information programs) to ensure that decisionmaking is based on the best information. Because of inertia and other remaining market imperfections, it is impossible to achieve all the energy conservation potential. A more realistic objective might be to achieve a proportion of the potential at a fixed target date—say, 20 percent by 2010. A program with this aim should have milestones to gauge performance, for example 3 percent of the potential by 1997, 10 percent by 2003, and the rest by 2010.

5.17 Although there is currently no overall strategy for energy conservation in Egypt, emerging economic and environmental issues reinforce the need for one to enable the government to guide the market to adapt its practices to gain the benefits currently being forgone. The following are key points on which a strategy can be formulated:

- Energy use per unit of GDP in Egypt is significantly higher than in countries at a similar stage of economic development. Broad estimates suggest long-term potential cost-effective savings of up to 40 percent of primary energy use.
- High energy use is due principally to historically low energy prices that gave the wrong signals to corporate and personal decisionmakers, leading to (a) low regard for energy costs, (b) low awareness of the potential energy cost savings and related financial and environmental benefits, and (c) low levels of investment in energy saving technologies.
- Recent increases in energy prices have helped to promote awareness of the importance and value of energy savings and the opportunities to realize the potential. However, it is not clear to what extent it has penetrated into Egyptian practice. See Annex 12 for a review of the industrial sector consumption and savings potential.
- Energy demand is expected to increase rapidly due to increasing economic growth, compounded by a rapid rise in population. Projected energy use for the year 2010 is about 82 percent above that for 1990.

5.18 The numerous benefits of promoting energy conservation activities in Egypt include increased oil surplus available for export, increased profitability of industry and competitiveness in world markets, environmental benefits, job creation, and development of local industries.

Issues

5.19 The main issues in energy conservation are as follows:

- Weak estimation of the potential for energy conservation.
- Barriers for growth in energy conservation activities.
- Weak institutional mechanism and framework.
- Lack of adequate financing schemes.
- Absence of incentives for development of local manufacturing industries.
- Shortage of energy conservation professionals and experience in Egypt.

Barriers to Energy Conservation Measures in Egypt

5.20 Growth of energy conservation activities in Egypt is blocked in several ways, including a lack of all the following: sufficient awareness of the potential for energy saving; sufficient senior management commitment to energy conservation; sufficient trained personnel within industry; a strong supporting network of consultants, contract energy management companies, and equipment suppliers; and capital available for energy saving projects combined with high duties on imported equipment.

Institutional Mechanism for Energy Conservation Activities

5.21 Several organizations and programs are working to reduce energy consumption in Egypt. However, their work needs to be coordinated to give focus and prevent overlapping; furthermore transport and buildings—major energy-using sectors with significant conservation potential—are hardly addressed at all.

Estimation of Potential for Energy Conservation

5.22 The 40 percent saving potential is a long-term figure; realistic targets for programs would be lower but still offer considerable benefits. To realize these benefits, a comprehensive strategy needs to be drawn up, agreed and implemented.

Institutional Framework

5.23 A parallel step, as important as the above, is deciding on the organization or organizations responsible for implementing the strategy. In several European countries, the most successful programs have been managed in a coordinated fashion, involving the sponsoring organizations (usually government departments), which determine the overall strategy and budget and agree targets with agencies that manage the

programs and constituent projects and work in a customer/contractor relationship with the sponsors. Different specialist agencies may work for a single department, each having one or more programs and agreeing to, and held accountable for, targets.

Options

5.24 The options are discussed under broad headings due to the encompassing nature of energy conservation activities.

Organization Options

5.25 Although no Ministry in Egypt acts as the focus for energy conservation, this role is assigned to the OECP. It does not, however, have a recognized strategy, and, until such a strategy is established and supported, the potential benefits for energy conservation are unlikely to be realized. Several options can be proposed for the framework within which the strategy should be prepared and its management established:

- Reinforce and strengthen the role of OECP as the central coordinating body.
- Expand the role of MEE to include energy conservation.
- Identify another existing organization to act as a focus for energy conservation.
- Establish a new organization to act as a focus for energy conservation.
- Take no initiatives and assume that increased prices will accelerate market mechanisms to enhance uptake of energy conservation technologies and methods.

5.26 Whichever of the above is chosen, the strategy would include ongoing activities and organizations for monitoring/auditing (DRTPC, TIMS, NREA) and for information dissemination (FEI, other trade bodies). The comprehensive strategy should include transport and building energy use, for which it would be necessary to identify suitable organizations for the above activities.

5.27 In deciding which option of the above, or any other option to adopt, the following criteria are relevant:

- Experience and expertise in the various skills required.
- Structure of the organization and previous relationships with other bodies involved.
- Focus of the organizations on technology or on market aspects.
- Compatibility of a key role in an energy conservation program with the overall aims of the organization.

5.28 The first steps in taking forward any program might be considering the list of options, and any others; appointing an interim body, probably from one of the options, to draw up a draft strategy, including program options; agreeing on the strategy, with its aims, objectives and targets; and fixing the coordinating body and agencies to manage the program. Although this set of steps is presented in a linear fashion, it would in fact require some iteration between the lead departments and the agencies before the targets and program details would be agreed.

5.29 In planning and implementing a strategy for energy efficiency it should be appreciated that a strategy is an ongoing process. The development of a comprehensive strategy is complex and would necessarily take some time to complete with the agreement of all parties concerned. However, that need not preclude an early start to some programs, and continuation of existing ones, which would gain credibility for the central focus, assist the development of the strategy by providing input from early lessons learned, and achieve early savings.

5.30 Once the strategy is in place, it requires an ongoing commitment to maintain it, recognizing that improving energy efficiency is an ongoing process. Those who participate in its management should feel that they can establish and maintain the vital good relationships with energy users and decisionmakers. Those who receive and use the information would need reassurance that GOE remained committed to energy efficiency. Furthermore, organizations which have carried out simple measures would be the obvious candidates for further investment; they too would require stability and reinforced trust to persuade them to take further steps.

5.31 In summary, the following steps would be involved: (a) assessing the short-, medium-, and long-term potential savings across the Egyptian energy economy; (b) assessing possible programs and activities to reduce energy use in Egypt, taking account of, and perhaps modifying as appropriate, the barriers identified above; (c) determining the benefits that could be gained from each program, with respect to the Egyptian economy as a whole, as well as the cost of the program; (d) determining a set of priorities based on the above estimates; (e) establishing a set of aims, objectives and targets for the strategy as a whole and for the individual programs; (f) implementing the programs, continually monitoring achievements and being prepared to adapt them following lessons learned.

Program Options

5.32 This option looks at the program elements that might contribute to a national strategy. The options presented are ones that have been proposed and, in some cases adopted, for developed country programs. The purpose of presenting them here is not to suggest that they all be part of an Egyptian strategy, but that they be considered, prioritized, and adopted as appropriate, with modifications if required, to fit local circumstances.

5.33 Several policy and program options are given, together with specific examples for the major energy-using sectors (for details see supporting document). It would be necessary on a case-by-case basis to determine both the costs of each program and its benefits. It may be appropriate to establish a benefit-to-cost ratio for each proposed program and to use it as one element in determining the order of priority for choosing from the program options.

Finance Options

5.34 No national strategy can be implemented without some cost, even if only to support the staff of the sponsoring body and the managing agencies. However, the program options outlined above include activities such as grants, tax concessions, establishment and monitoring of standards, and so on, which would require further costs.

5.35 Guaranteed core funding is needed for the program and managing agency, whether it arises from taxes, levies (e.g., on petroleum product sales) or contributions from end-users. It may also be appropriate for donor organizations to contribute to the funding of particular programs. They are more likely to do so if it is clear that the programs are well managed and cost-effective and form part of an agreed strategy.

5.36 Once a fund is established it is likely that part of it would be used to fund technology demonstrations. This could be either through grants or a rolling loan fund whereby loans are used to finance investments and are repaid at agreed levels and times. Administration could be through either an agency or commercial banks acting as agents to the coordinating body.

5.37 One aspect of the ECEP is the provision of financial support to encourage the uptake of new technologies—or at least of technologies that are new to Egypt. The provision of grants is common in market economies where the barrier to adoption of new technologies is the fact that they are not proven and that both technical and financial risks are perceived to exceed those for conventional technology. The grant thus compensates for the extra risk in investment and not only ensures that the project goes ahead but also purchases monitoring information that will verify the performance. Well-prepared information, based on the monitoring program, can be targeted to selected audiences and can help to convince others to adopt the technology.

International Collaboration

5.38 It may be expected that the focus of the strategy will be inward looking, but a number of international programs may offer valuable information and assistance.

5.39 The European Commission SYNERGY program concerns energy cooperation with developing countries in certain areas, including Mediterranean nonmember countries. Its objective is to improve the long-term world energy situation by helping other countries to take well-founded energy policy decisions; environmental impact is another important aspect. The Commission is preparing plans to reinforce

SYNERGY through a Council Regulation, allowing for a multi-annual rolling program. SYNERGY has already supported an urban energy planning study in Alexandria and is considering the feasibility of further action, focusing on energy use in small and medium enterprises, with support from ENEA (Italy). SYNERGY funding may also be available for institutional building as part of strategy development. A new comprehensive program to support growth in the Mediterranean region is currently being formulated; energy is expected to be a significant part of the program, but details of the kinds of project to be supported are not yet clear.

5.40 The GREENTIE activity of IEA/OECD was established in 1993 (with an initial life of two years but likely to be extended) to act as a clearinghouse for transfer of information on energy technologies (not limited to energy conservation). The Operating Agent is Novem (Organization for Energy and Environment) in the Netherlands. So far, requests for information, which focus on information sources, are handled free, although it is up to the contacts given to make any charges for literature or consultancy.

5.41 Finally, the excessive energy use of the Egyptian economy is not unique within the region. Neighboring countries are facing the same problems and issues; hence, prospects may be good for establishing a forum to exchange ideas and experiences. Cooperation already exists through the discussions on linking electricity grids, and this could provide a model for energy conservation cooperation.

Environmental Protection

Key players: The Egyptian Environmental Affairs Agency (EEAA), Ministry of Electricity and Energy (MEE), Ministry of Petroleum (MOP).

Overview

5.42 Recognition is growing in Egypt that many environmental problems are the direct result of heavy utilization of energy. The environmental review of the assessment was to identify industrial projects that would significantly improve the environment by reducing the pollutants. At the same time, a number of projects will improve energy efficiency. The environmental projects identified here are implementable in the short-to-medium term. A brief analysis of the environmental programs, current status, and issues and options in each sector are discussed here.

Current Status

5.43 ***Air Pollution.*** Urban air pollution is a major problem in Egypt, resulting from a combined growth in population, industry, and traffic. In Egypt, the emission of pollutants into the air, particularly within the Cairo and the Alexandria regions, has already caused serious problems of environmental and health degradation, and is projected to increase significantly over the next decade. Emissions of air pollution are closely related to industrial activities, power generation, and transportation. The areas of

severest air pollution in Egypt are the Helwan industrial areas south of Cairo; the Shoubra El-Kheima, Abuzaabal, and Mustorod industrial areas north of Cairo; and the industrial areas west and east of Alexandria.

5.44 ***Petroleum.*** Reduction of air pollution is closely linked to the efficient utilization of fuels, which is directly related to fuel prices. Now fuel prices are becoming closer to the international level, which is making some contribution toward improving energy efficiency and reducing air and water pollution.

5.45 ***Power.*** From 1980 to 1990, the rate of growth of electricity consumption was 8.7 percent per year. The total commercial energy consumption is about 30 mtoe (about 65 percent oil, 25 percent natural gas and condensates, and about 10 percent hydropower. The use of high-sulfur mazout as the major fuel for power generation is creating a significant amount of air pollution, particularly of sulfur dioxides.

5.46 ***Industrial.*** The public sector industries are heavy polluters throughout the country. The worst air pollution is in Cairo, which has 27 percent of the population and 48 percent of the industry. Air pollution from burning fuels and from other industries are high. The combination of high TSP with sulfur dioxides (primary from power plants and other industries burning high-sulfur fuel oil) poses a significant health risks to the population. Industrial production is expected to double in 10 years. Unless measures are taken now to move to cleaner technologies and improved incentives, the emissions from the industry could also double in 10 years

5.47 ***Transport.*** The transport sector comprises 1.3 million passenger cars; 410,000 diesel trucks (small pickup, medium, and large trucks; 330,000 motorcycles; and 33,000 buses. Although the number of vehicles are not large, they are poorly maintained and relatively old. The fuel consumption in the transport sector is 4.3 mtoe diesel, and 2.2 mtoe gasoline.

5.48 ***Environmental Law.*** In December 1993, the government passed an Environmental Law, in which most of suggestions discussed during the Environmental Action Plan have been incorporated. The EEAA is now seeking funds from the donors to implement the environmental programs outlined in the Environmental Law. Currently, the EEAA has neither the role nor the capability to formulate policies for protection of environment. The National Research Council has a few professionally trained staff but lacks the equipment necessary to carry out studies on air pollution control and effects of air pollutants. The Center for Environmental Monitoring and Ministry of Health have some equipment necessary to carry out air quality monitoring but lack the professional staff to run and maintain the equipment.

Issues

Petroleum

5.49 The refineries and petrochemical complexes are in the public sector, and a number of them are characterized by outdated technologies, whose byproducts are polluting the environment. Upgrading of these technologies may be a long and expensive process, but it should be done to protect the health and the environment. However, some progress has been made to reduce energy consumption and to minimize waste to protect the environment. All the existing refineries have been equipped with API and DAF units to improve the separation of oil from refinery waste water; they also have biological filter units and HDS units to minimize the sulfur content in the petroleum products. The petroleum sector is applying a gradual write-off of the older plants and processing units and replacing them with state-of-the-art technologies and processing units that comply with the environment regulations in accordance with international trends and specifications.

Power

5.50 Due to the increased availability of gas, about 90 percent of power plants are being converted to duel firing, which is contributing to a significant reduction in emissions of sulfur dioxide and particulates. The EEA has improved the electric generation efficiency up to 34 percent. Further improvements can also be made to cut transmission and distribution losses and thus to reduce air pollution. The EEA has been using air and water quality monitoring programs in all their new power plants.

Industrial

5.51 The main sources of air pollution are high-sulfur fuel oil, which is being used throughout the industrial processes along with incomplete combustion and emissions of heavy metals in metallurgical and cement plants. Fuel consumption, especially of high-sulfur oil, in stationary sources releases sulfur dioxide, nitrogen oxides, and particles to the air. The main air and water polluting industries are cement, sugar, metal, oil and chemicals, fertilizer, ceramics, asbestos, aluminum and bricks, textiles, and food and beverage industries. The chemical industries include plastics, paints, rubber, glue, organic chemicals, and inorganic chemical industries.

Transport

5.52 The high proportion of diesel and sollar (heavy fuel oil) contributes to the relatively high particulate emissions, particularly from the poorly maintained old fleet of vehicles. The use of 90 octane gasoline is 30 percent and of 80 octane 70 percent. The relatively low octane level of gasoline decreases fuel efficiency of the cars and increases air pollution in urban areas. The Ministry of Petroleum has committed to phasing out lead in gasoline by 1996. Several months ago, the Ministry of Petroleum introduced unleaded gas in Alexandria, and no complaints have been received yet about the

performance of the cars. It may be worth considering a tax on gasoline to support environmental and cost recovery for road infrastructure and maintenance programs in the future.

Environmental Law

5.53 Egypt has developed ambient quality standards for many gaseous and particulate components but lacks the monitoring and enforcement program to control air pollutants. The new law for clean air would unify all existing regulation regarding air pollution, but it would take considerable time and effort to meet air pollution requirements.

Options

Petroleum

5.54 Options for policy action include the following:

- *Total phase out of energy subsidies.* Considerable progress has been made to phase out price subsidies of fuels and it appears that the government is committed to increase fuel prices to international levels.
- *Reduction or elimination of lead in gasoline.* The government of Egypt requires refineries to produce gasoline with a maximum concentration of lead of 0.15gm/liter. The petroleum sector has made progress by reducing the lead content in gasoline from 0.4 gm/lit (80 octane gasoline) and 0.6 gm/lit (90 octane gasoline) in 1989/90 to 0.25 gam/lit and 0.23 gam/lit, respectively, by the end of 1993/94. Steps have been taken to produce unleaded gas as well. It is expected that there would be an increase in the octane level of gasolines to 90 for premium and 85 for regular.
- *Introduction of tax on gasoline.* The government of Egypt should introduce a gasoline tax, which is common to most of the countries. The introduction of tax will:
    - Provide encouragement of reduced energy use and related emissions
    - Provide funds for infrastructure programs (roads and highways) construction and maintenance
    - Provide funds to develop inspection and tune up programs, improvement in traffic management, signals and parking, land management, mass transit, and improved public service and other programs.
- Other policy actions to reduce vehicle emissions in Cairo. These include the need for lower import duties on vehicles with low emissions; fuel-

efficient vehicles and vehicles equipped with catalytic converters; and the need to reduce the use of high-sulfur transport fuels.

Power

5.56 The following options for action are recommended for the power sector:

- To start enforcing the new law to reduce sulfur dioxides and particulate matter pollution
- To develop guidelines for nitrogen oxide pollution related to the power plants
- To increase electricity prices to reflect full-cost recovery with minimal targeted subsidies provided through an independent line item from the state budget.

Industrial

5.57 The following options for actions are recommended for the industrial sector:

- The need for enforcement of new law for the industries, particularly in the public sector, because the private sector is doing a somewhat better job in reducing pollution
- Enforcement of a permitting requirement for wastewater discharge from each plant, so that the effluent can be tested for compliance with wastewater requirements
- Development of a penalty mechanism to enforce the air and water pollution requirements under the new law.

Transport

5.58 In the transport sector, options for action include the following:

- Development of incentives for encouraging the use of higher octane's gasoline in the form of differential taxes, and the need to phase out the use of lead to boost octane levels.
- The need to provide incentives to reduce import taxes on high-fuel-efficiency vehicles, buses, and trucks.
- The reduction of import restrictions and duties on vehicle's spare parts.
- Inspection and tune-up programs in all major cities.
- The expanded use of natural gas. Since most of the diesel buses in major cities can be converted to natural gas fuel, several refueling stations supplying gas for buses will be needed. Steps have already been taken on

this front. About 30 buses and 140 vehicles have been converted to run on natural gas instead of liquid fuels and plans are being made to convert more.

- The need to improve traffic management, signaling and proper land usage for major cities.

Environmental Law

5.59 The options for action include the following:

- The need for funds to buy equipment to develop baseline data in each environmental category
- The development of an enforcement mechanism and funding to meet the commitment required under the new law
- The development of mitigation action plans to meet the environmental requirements for industries, transport, and power sectors
- The development of institutional arrangements and definition of responsibilities of several ministries, institutions, and other authorities for field monitoring and enforcement requirements.

6

New and Renewable Energy Sources

Key players: the Ministry of Electricity and Energy (MEE), the New and Renewable Energy Authority (NERA), the Egyptian Electricity Authority (EEA), and the Rural Electrification Authority (REA).

Overview

Responsibility

6.1 The Ministry of Electricity and Energy (MEE) is responsible for much of the work in Egypt in the new and renewable energy sector. Overall responsibility for the new and renewable energy sources (NRES) sector activities lies with the New and Renewable Energy Authority (NREA), though activities are currently being carried out jointly by the NREA with the Egyptian Electricity Authority (EEA) and the Rural Electrification Authority (REA). For example, the EEA has a particular interest in new and renewable energy technologies that produce electricity and are connected to the grid, while REA is interested in the electrification of remote areas. The EEA is therefore collaborating closely with the NREA on plans for the development of large windfarms and solar thermal power generation; while REA in collaboration with EEA develops plans for electrification of remote and isolated areas.

6.2 The new and renewable energy sector involves technologies and issues that have important impacts not only on energy supplies but also on the environment (urban and rural), agriculture and rural development. It is therefore not surprising that other government ministries, research centers, universities, industries, and independent organizations are also involved in work on the NRES.

6.3 NREA was established by the government through Law No 102 in 1986. Its aim is to identify and evaluate new and renewable energy sources and to plan for their development. NREA has the right to certify and provide guarantee for renewable energy (RE) products and to implement RE projects, either alone or in cooperation with others, including overseas governments and authorities. NREA employs more than 360 staff, including 90 engineers and 46 technicians, and had a budget in 1993/94 of more than

US$9 million. It has technical teams in each of the following new and renewable energy sectors: biomass, photovoltaic, solar-thermal, energy conservation, and wind.

Major Donors

6.4 ***United States.*** The United States has a major ongoing commitment in Egypt, where it provides approximately US$2 billion per year in grants and aid. A little less than half of this funding is managed through USAID, which has financed a wide range of studies and projects in the energy and new and renewable sectors in recent years. USAID has funded the establishment of a renewable energy information system at NREA, a solar heating and energy conservation project at a poultry plant in Heliopolis, a PV-powered ice-making plant at a remote fishing village, and the construction of four 100 kW wind turbines at Ras Gharib on the Red Sea coast.

6.5 ***The European Union.*** The EU is the major funding source for the Egyptian Renewable Energy Development Organization (EREDO) project, which is co-financed by the government of Egypt and the Italian government, but is unlikely to commit further major funding until this project has been completed (over 75 percent of the facilities are operational the balance of which are expected to be completed and fully operational by end-1995). The EREDO project has established new offices, laboratories, and a RE test center for NREA, as well as a wide range of RE equipment and instrumentation.

6.6 ***Other Bilateral Programs.*** Ongoing bilateral programs in the new and renewable sector include funding from Italy (a participant in the EREDO project) and from Denmark (mainly in the wind sector). Other countries, including Germany and France, have also provided funds for NRES projects in Egypt.

Experience in Egypt

6.7 A wide range of RE projects have been implemented in Egypt during the last two decades, largely with grant aid from international agencies such as USAID, the European Commission, and the United Nations, and with bilateral grant aid mainly from Denmark, Germany and Italy (See Annex 13 for wind energy projects). Since 1986, most of the work on new and renewable energy sources has been coordinated by the NREA, which has built up a staff of RE specialists and now acts as the focus for all work in this sector. The NREA carries out research and development, and manages the majority of projects in the sector.

6.8 Most of the projects that have been implemented to date were in the form of pilot plants and demonstrations and were aimed largely at exploring how the different technologies can be applied in Egypt. Some were also designed to encourage the development of local manufacturing. However, future projects are likely to concentrate on expanding the use of proven renewable energy technologies for electricity production; low-temperature heating; and improving the environment, particularly in rural areas (See Annexes 13 and 14 for renewable energy potential).

6.9 For most of the renewable energy projects that have been installed in Egypt in recent years, the overall project costs have been strongly influenced by the additional costs associated with the implementation of a single pilot or demonstration system in an isolated area. However, it is possible to make more meaningful estimates (for details see supporting document) of the future costs of the electricity produced by the different RE technologies in Egypt by using Egyptian climate data together with averaged project costs obtained from the larger-scale implementation of these technologies in other countries.

Issues

6.10 Main issues in the new and renewable energy sources are as follows:

- Strategic planning and development for renewable energy
- Strengthen promotion level
- Limited financing schemes
- Constraints in availability of skilled professionals
- Minimal role in contribution to urban and rural environment upgradation
- Marginal contribution to improve energy supply situation
- Institutional mechanism to benefit from new and renewable energy sources.

Strategies for Future New and Renewable Energy Supplies in Egypt

6.11 New and renewable energy programs and projects in Egypt have been based on an ad hoc approach (i.e., project implementation based on availability of funding). Each source of funding has applied its own priorities and funded projects, with little reference to the overall national strategy. While this has been remarkably successful during the R&D and demonstration phases, such an approach is likely to be less well suited for the future commercial implementation of on a large scale.

Targets for Future New and Renewable Energy Supplies in Egypt

6.12 The government resolved in 1980 to encourage the use of new and renewable energy sources and established a target of 5 percent of primary energy consumption from such sources by the year 2005. Since that time, significant advances have been made in reducing costs and improving the performance of several of the technologies. Also, a substantial amount of work has been carried out during the last 15 years to determine the available resources in Egypt. The energy supply contributions expected from each of the technologies in the future should therefore be reviewed in the light of these advances and compared with the latest estimates of resources. The progress made to date toward this target has recently been reviewed, and further consideration should be given to refining the strategy needed to achieve it.

Awareness

6.13 An important barrier to the greater use of new and renewable energy sources could be a lack of awareness by decisionmakers and potential users.

Confidence in Long-term Performance and Reliability

6.14 Several decisionmakers are considering new and renewable technologies as at the R&D stage; they do not therefore have the confidence to invest in large-scale commercial installations. This remains one of the key barriers to the deployment of such technologies throughout the world.

Financing

6.15 Major investments will have to be made during the next decade, substantial deployment of new and renewable energy technologies is to take place in Egypt by 2005. The required levels of investment will depend on the selected mix of technologies and the strategy for their deployment. Further planning and analysis will therefore be required, as part of the development of the new strategy, to establish the levels of investments and to prepare a financing plan. Several technologies are commercially mature and have been proven in several countries. In the right circumstances, they are frequently the most cost-effective option on the basis of a life-cycle costing analysis. Nevertheless, they are still often not selected for investment.

Availability of Skills and Experience in Egypt

6.16 The future commercialization of new and renewable energy technologies in Egypt will require substantial numbers of people with appropriate skills and experience to set up businesses and establish sales, manufacturing, and installation teams. These businesses will need the support of engineers and technicians with experience in the design, manufacture and operation of components and systems. Local access to experts with research and development experience, who can provide assistance on detailed technical matters, will also be important.

Improving the Urban Environment

6.17 Approximately one-third of the population of Egypt live in the two major cities of Cairo and Alexandria, where the problems of atmospheric pollution caused by fumes from transport and industry are particularly severe. These cities are also experiencing problems with the disposal of wastes and sewage. The most cost-effective long-term solutions to these environmental problems must involve an integrated approach to the use of energy, including new and renewable sources, in the urban environment.

Sustainable Development in Isolated Rural/Agricultural Communities

6.18 Rural communities need power to improve their quality of life and to minimize the migration of young people to the cities. Among the energy needs are power

for lighting, water pumping, medical refrigeration, and TV. The environment and local water supplies in some rural areas are being polluted by agricultural, human, and animal wastes. Simple and cost-effective ways of using or disposing of these wastes are urgently needed. In order to continue its general development, Egypt also needs investments in infrastructure at isolated sites, such as telecommunications, radio and TV repeaters, cathodic protection for bridges and pipelines, and marine and aeronautical warning lights. New and renewable energy sources and technologies should be used in supplementing the conventional resources in strengthening the infrastructure capabilities in isolated areas.

Reducing the Consumption of Oil and Gas for Power Generation

6.19 If reliability of power could be assured using alternative fuels, then valuable oil and gas currently being used for power generation could be transferred to other important applications such as transport, for which alternative fuels are harder to find, or exported to bring in foreign currency, which could be used to meet other development objectives.

Reducing Peak Demand for Grid Electricity

6.20 The EEA currently experiences a substantial daily peak in the electricity demand mainly caused by residential consumption—lighting, appliances, water heaters, and air conditioners. If this could be reduced by using alternative energy from, for example, solar water heaters and passive building designs that reduce the need for air conditioning, then the future needs for investment in new grid power generating plant could also be reduced.

Firm Power from New and Renewable Energy Sources

6.21 Some new and renewable sources cannot supply power with the same degree of firmness as conventional fossil-fired power stations. For example, the output from a windfarm varies with the speed of the wind, and biomass-generated electricity may only be available from sugar factories during the sugar-processing season. Ways need to be found to ensure that consumers can continue to rely on their grid supplies, while the overall operating costs of the grid and its power generators are minimized.

Options

Strategies for Future New and Renewable Energy Supplies in Egypt

6.22 A revised national strategy for the future deployment of NRES in Egypt should be developed by the government with well-defined goals and objectives. The objectives should set out priorities for the different technologies in priority applications and sectors. All future activities related to new and renewable energy should then form an integral part of this strategy. One option is to establish a small strategic studies team, for example within NREA, to develop the new strategy and to carry out other strategic work in the future. When implementing each major project, it is necessary to carry out

independent market studies and project-specific feasibility studies, and/or to have such studies assessed. The strategic studies team should collaborate with consultants or experts in carrying out such assignments.

Targets for Future New and Renewable Energy Supplies in Egypt

6.23 The achievable potential contributions from new and renewable energy sources will depend on the available resources, the applications in which they are deployed, and the assumed future economic scenario. A comprehensive review of the available resources for each of the main new and renewable sectors should be urgently undertaken. The review should also contribute to the development of a new strategy for the implementation of the technologies and revised targets. Future targets should be compatible with the estimates for the achievable potential contributions. The 1980 target should be reviewed, refined and updated with a view to encouraging the implementation of an optimal mix of new and renewable energy sources in Egypt over the next few years.

Awareness

6.24 Many countries have implemented programs for promoting new and renewable energy sources, for example by publishing brochures, magazines, and newsletters, and by holding workshops, seminars, and conferences. Such programs should also include the production of videos, encouraging TV programmers to cover the technologies in their normal programs and even the making of special TV documentaries. Some of the technologies have received only limited exposure in Egypt to date, and might justify an ongoing demonstration program. Such a program might be carried out in collaboration with similar programs in other countries, for example in collaboration with the programs of the European Commission. This would permit the results to be monitored using the same recording schemes and would allow them to be compared with those from other countries on a common basis.

Confidence in Long-term Performance and Reliability

6.25 By increasing the use of well-proven applications in Egypt, confidence among local financiers and users in the sector will be raised. Independent (international) certification will raise confidence among consumers for technologies that are sold directly to consumers or small industries, such as solar heaters and small PV or wind generators. A wide range of testing and certification services can be provided by the new EREDO center. However, in order to raise confidence in the market and to develop the skills of staff, close collaboration might be established with organizations in other countries, possibly within the European Union, who have similar responsibilities.

Financing

6.26 An important part of the development of a new strategy for the sector should be the analysis of the associated investment requirements. Many of the existing pilot and demonstration plants have been installed using grants from aid agencies and

other governments. However, to achieve the target levels of energy supply from new and renewable sources, more conventional financing schemes will be needed. Although their running costs are typically very low or even negligible, most new and renewable energy technologies have the major disadvantage that they require high initial capital investments. Special financing schemes, including involving the local private investors should be targeted in order to promote implementation.

6.27 Few options for financing include (a) scheme currently being offered by the Global Environment Facility (GEF) to make a payment from aid funds for projects that produce significant reductions in CO_2; (b) the UNDP FINESSE scheme (Financing Energy Systems for Small-scale Energy users), which provides for a large package of loan funding to be made available by an international aid agency to an intermediate in-country institution for "retail" lending in smaller packages for new or renewable energy project; (c) the World Bank's "Solar Initiative," established in the Spring of 1994 with the aims of providing active support to its regional units for project identification and preparation and playing a coordinating, strategic, and catalytic role.

6.28 Financiers would normally expect to receive guarantees for system lifetime and performance before investing in new and renewable energy systems. Considerable experience has been obtained in the European Union with a scheme called "SUNERGIE" or "Guarantee of Solar Results," which is designed to guarantee the long-term performance of solar water heaters. This scheme is currently being developed in Europe for use with other such systems and might be further adapted for use in Egypt.

Development of Capabilities

6.29 Many components and systems for new and renewable energy technologies can be manufactured locally in Egypt, and labor costs are relatively low. Joint ventures for the local manufacture of components and systems should therefore be encouraged. Once the new industries have become well established, and quality is controlled by adhering to suitable international standards, production of products for export to other countries in the Middle East and North African regions should be facilitated. Examples of RE products that might be manufactured locally in Egypt include solar water heaters; wind generators; biogas digesters; PV system components (including controls, lighting kits, PV array mountings, and module fabrication, but excluding PV cell production for the next few years at least).

6.30 The future profitability of some of the existing agricultural industries—for example, the sugar and rice industries—should be enhanced by assisting them with investments in more efficient combustion and power generation plant, so that excess electricity is sold to the grid. The concerned industries should also be encouraged to explore options for using their generating plant all year round by burning other agricultural wastes, such as cotton straw. Alternative supply from such sources has the potential to reduce demand for investment in new generating plants.

6.31 Cooperation with organizations in the European Union and the North African and Middle East regions could bring benefits to the Egyptian new and renewable energy industry through improved commercial contacts, and this could lead to export opportunities. A new legal framework should be introduced to encourage Egyptian industries and independent private sector organizations to become more actively involved in the generation of electricity from new and renewable sources.

6.32 The proposed revised strategy should include a coordinated program to remove the remaining nontechnical barriers for implementation of commercially mature RE technologies in Egypt. Such programs in the European Union have been successful in encouraging the development of supportive legal frameworks, planning guidance, standards, and technology promotion. Some of the most well known barriers to the development of these industries worldwide are tax regimes. In many cases, the import tax regime either imposes high charges on the materials needed to produce needed components or low taxes on conventional equipment with which RE equipment must compete in the market place. A full review of the relevant taxes in Egypt should be carried out to ensure that such discrimination is eliminated.

Increase Skills and Experience in Egypt

6.33 Training as an ongoing commitment is required by organizations that are responsible for the implementation of new and renewable energy projects and for the local manufacturing of their systems and components. Cost-effective options for meeting the future needs for training should include the training of trainers and the establishment of cooperation agreements with industries, research establishments, and universities both in the local North African and Middle East regions (including Egypt itself) and worldwide (including the European Union and the United States). The working teams at NREA would benefit from collaboration (e.g., twinning, networking, and staff exchanges) with similar agencies in other countries that have experience of developing and implementing renewable energy strategies and programs. Technology transfer agreements will be important in connection with all major commitments for local manufacturing of components and systems.

6.34 Many of the new and renewable energy technologies offer ways in which political, commercial, and development objectives can be achieved with minimal impact on the environment, and technologies for employing them are therefore being developed through a number of international collaborative programs. International collaboration should permit the sharing of technical risks through joint funding of major projects and reductions in the duplication of effort though information exchanges and technology transfer activities. Substantial investments have been made worldwide in R&D on these technologies during the last 20 years, and care must be taken not to "reinvent the wheel." Nevertheless, a modest investment in ongoing R&D, focused on local issues, can be justified provided that it is well targeted. A strong team of technical experts at NREA, who are actively involved in R&D, should assist local industrialists with the development

of their products and operate the relatively sophisticated equipment needed for the testing and certification of RE products. One option to keep such a team technically stimulated is to encourage them to carry out R&D as part of international collaboration with similar teams in other countries.

Improving the Urban Environment

6.35 Clean electricity generated in the desert areas for use in the cities—for example, by means of solar generators that deliver power during the working day—would improve the environmental climate of the city. Also, this would permit a greater use of public transport systems powered by electricity (such as trams and metro systems) in the cities. The urban environment would be improved because the atmospheric pollution caused by exhaust fumes from cars, buses, and trucks would be reduced. The digestion of liquid wastes (sewage) to produce methane and the combustion of solid wastes offer the possibility of producing electricity and disposing of wastes simultaneously. By adopting such an integrated approach, planners can combine the benefits of an improved environment and quality energy generation.

Sustainable Development in Isolated Rural/Agricultural Communities

6.36 Where small communities are located far from the main electricity grid, it would be less expensive to establish local electricity generators than to extend the grid. Generators with the lowest life-cycle costs for such applications are expected to be small PV generators or PV / diesel or wind / diesel combinations. Agricultural, animal, and human wastes should be processed by means of locally built and locally maintained digesters to produce organic fertilizers and biogas. The biogas can be used for cooking and lighting. The locally produced organic fertilizers can replace costly chemical fertilizers, which consume large amounts of energy in their production and are difficult for rural farmers to afford. Water-current turbines use the energy of slowly flowing water sources to pump some of the water against a modest head onto nearby fields. These devices should be locally manufactured and locally maintained, providing opportunities for a reduced electricity consumption and reduced costs for the distribution of electricity to the fields in rural areas.

Reducing Emissions of Environmental Pollutants from Power Generation

6.37 Where industries such as the sugar industry are able to generate more power than they require, cooperation with the EEA on investments in more efficient generation plant and on the management and control of generating plant would vastly improve the overall environment. The implementation of new large-scale power generation using clean new and renewable energy technologies could be facilitated by tapping the resources of the private sector. The interest and commitment of private operators to supply power to the grid will depend very much on the terms and prices offered by the EEA for such supplies. Legislation would be needed to ensure that the quality of power supplied to the grid by private operators will meet the needs of the EEA,

particularly in terms of frequency variations, lack of harmonic distortion, and safety in the event of a temporary grid failure.

Reducing the Consumption of Oil and Gas for Power Generation

6.38 Solar heating and the combustion of biomass, biogas, and urban wastes can all be used to reduce the consumption of oil and gas for heating purposes. The use of combined heat and power (CHP) plants offers an efficient way of using new and renewable fuels for process heating in many industrial and agricultural applications, while also producing electricity. Investors must be free to sell excess electricity to the grid at reasonable prices if they are to find CHP economically attractive.

Reducing Peak Demands for Grid Electricity

6.39 Solar water heaters can be installed to replace electrical water heaters, which would otherwise be used during the period of the evening peak demand. Passive solar building design features can be used to reduce the demand for air conditioning and electric lighting in offices—for example, by providing natural daylighting with shading to minimize solar gains and direct access to thermal mass to delay overheating until after the main period of occupancy and take advantage of night cooling. The electricity demand in a passive solar building would be lower during the daytime and evening than that of most normal buildings.

Firm Power

6.40 By careful study of the whole grid system (including the flexibility of the other generating plant and the annual and diurnal variability of the loads), it is possible to determine a capacity benefit for new and renewable energy generators, and this can be factored as a firm contribution to the total installed capacity of the grid. By connecting two different forms of RE generators to a grid network, it is possible to provide a supply that has higher levels of firmness than either would be able to offer alone. For example, wind/solar and solar/hydro generators may complement each other for climatic reasons.

Annex 1 Installed Capacity by Type, Fuel and Age

EEA's installed capacity is spread over seven zones: Cairo, Middle Delta (Dammietta), West Delta (Damanhour), Alexandria, Canal, North Upper Egypt (Assiut) and South Upper Egypt (Aswan). 1300MW correspond to thermal plants over 20 years in service. The Table below summarizes the installed capacity within each zone, by type of plant, by fuel and by age.

INSTALLED CAPACITY (92-93)			
CAIRO ZONE (8 Plants)	TOTAL MW	2679.5	OVER 20YR
FUEL: MAZOUT ONLY		400	400
MAZOUT/DIESEL		350	175
NATURAL GAS		1929.5	
TYPE: STEAM		2010	575
GT		669.5	
MIDDLE DELTA ZONE (2 Plants)	TOTAL MW	1536.1	OVER 20 YR
FUEL: MAZOUT ONLY		127.5	127.5
NATURAL GAS		1408.6	
TYPE: STEAM		127.5	127.5
GT		943.6	
CC		465.0	
WEST DELTA ZONE (3 Plants)	TOTAL MW	1437.8	OVER 20 YR
FUEL: MAZOUT ONLY		470.0	30
NATURAL GAS		967.8	195
TYPE: STEAM		635.0	195
GT		802.8	30
ALEXANDRIA ZONE (4 Plants)	TOTAL MW	1286.0	OVER 20 YR
FUEL: MAZOUT ONLY		113.0	113
NATURAL GAS		1120.0	
DIESEL/NAPHTHA		53.0	53
STEAM		1013.0	113
GT		273.0	53
CANAL ZONE (6 Plants)	TOTAL MW	1865.9	OVER 20YR
FUEL: MAZOUT ONLY		185.0	88
NATURAL GAS		1663.9	
DIESEL		17.0	
TYPE: STEAM		1685.0	88
GT		180.9	
SOUTH UPPER EGYPT ZONE (HYDRO-3Pl.)	TOTAL MW	2715.0	
NORTH UPPER EGYPT ZONE (2 Plants)	TOTAL MW	390.0	OVER 20YR
FUEL: MAZOUT ONLY		390.0	90
TYPE: STEAM		390.0	90
SYSTEM TOTALS	TOTAL MW	11910.3	
FUEL: MAZOUT ONLY		1685.5	848.5
NATURAL GAS		7089.8	195
DIESEL/NAPHTHA		70.0	53
MAZOUT/DIESEL		350.0	175
HYDRO		2715.0	
TOTAL		11910.3	1271.5
TYPE: STEAM		5860.5	1188.5
GT		2869.8	83.0
CC		465.0	
HYDRO		2715.0	
TOTAL		11910.3	1271.5

Note: Installed capacity is not indicative of rated capacity or available capacity.

Annex 2 Generation, Sales and Losses

EEA's gross generation has grown from about 20 TWh in FY81 to about 47 TWh in FY93, an average of about 7.4 percent per annum. Whereas, electricity sales has grown from 15.6 TWh to 39 TWh during the same period. However, system losses which amounted to about 19 percent in FY81 has dropped to about 14 percent in FY93.

SUMMARY OF GENERATION AND SALES, 1981-1993

FY	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
GENERATION AND SALES (GWh)													
GROSS	19870	21895	24540	27691	30064	32244	35201	37845	39580	41649	43478	45482	47096
NET	19236	21148	23729	26708	28915	30894	33794	36219	37788	39949	41817	43705	45331
SALES	15582	17331	19579	22253	23761	26163	28470	30555	32303	34469	36293	37656	38942
GROWTH RATES (%)													
GROSS GENERATION		10.2%	12.1%	12.8%	8.6%	7.3%	9.2%	7.5%	4.6%	5.2%	4.4%	4.6%	3.5%
NET GENERATION		9.9%	12.2%	12.6%	8.3%	6.8%	9.4%	7.2%	4.3%	5.7%	4.7%	4.5%	3.7%
TOTAL SALES		11.2%	13.0%	13.7%	6.8%	10.1%	8.8%	7.3%	5.7%	6.7%	5.3%	3.8%	3.4%
NETWORK AND COMMERCIAL LOSSES													
LOSSES	3654	3817	4150	4455	5154	4731	5324	5664	5485	5480	5524	6049	6389
% OF NET	19.0%	18.0%	17.5%	16.7%	17.8%	15.3%	15.8%	15.6%	14.5%	13.7%	13.2%	13.8%	14.1%

Source: EEA Demand Study.

Electricity Sales by Sector

Sales of electricity include VHV and HV (132 kV and above) industrial consumers supplied directly by EEA and MV and LV consumers which are mostly supplied through the DCs. Evolution of sales broken down by sectors is shown below:

ELECTRICITY SALES BY SECTOR (GWh)

FY	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Industry:													
VHV	4256	4089	4152	4774	4624	4910	5371	5935	6270	6629	6667	6741	6849
HV	632	694	812	880	1019	167	1200	1326	1366	1563	1646	1589	1634
Other	4321	870	5421	5808	6148	7735	7115	7512	8055	8447	8841	9252	9615
Sub-total	9209	9653	10385	11462	11791	12812	13686	14773	15691	16639	17154	17582	18098
Agriculture	777	836	897	1007	1108	1197	1166	1221	1265	1299	1367	1239	1725
Public Utilities	1159	1324	1683	1739	1752	1964	2192	2207	2165	2403	2612	2785	3160
Commercial	423	564	701	885	1043	1194	1380	1441	1526	1679	1813	1704	1035
Residential	3355	4124	5055	6237	7121	8059	8864	9844	10440	11220	12063	12897	13280
Government	672	723	821	929	965	983	1041	1051	1218	1229	1285	1451	1642
Total sales	15595	17224	19542	22259	23780	26209	28329	30537	32305	34469	36294	37658	38942

Source: EEA Demand Study

Annex 3 Electricity Prices and Costs

Tariff-setting Procedure

1. The electricity sector in Egypt lacks clear and well-defined guidelines for setting prices. The procedure can be described as an ad-hoc process which is driven by financial requirements and political considerations: the 1976 "EEA law" only stipulates that its Board of Directors shall "suggest a tariff for distributing and selling power...[which] shall be effective only on being approved by the Minister's cabinet."

2. In practice, this results in a process whereby a consensus is sought between EEA, the DCs and the Government in which financial requirements are balanced by public acceptability.

Evolution of electricity prices

3. The table below shows the evolution of average electricity prices for different consumer categories.

EVOLUTION OF ELECTRICITY PRICES (US¢/kWh)

FY	91	92	93	94
Industrial	2.1	2.9	4.0	3.9
UHV (Kima)	0.6	1.4	1.4	1.4
UHV (Other)	1.7	2.0	2.0	2.0
HV	2.7	3.4	3.4	3.4
Agriculture	2.4	3.3	3.5	3.4
Distribution Cos.	1.6	1.9	2.5	2.8
Commerce	2.8	2.7	4.7	8.6
Residential	1.1	1.4	1.9	2.5
Housing Cos.	1.4	1.8	2.6	3.2
Government	4.1	5.2	5.5	6.7
Total	2.0	2.6	3.5	3.7

Source: EEA

There has been a considerable effort to adjust prices, with an average increase of around 20% during the FY91-FY94 period.

Marginal Costs

4. A LRMC model from a tariff study carried out in 1991/92 is used as a basis for determining the economic costs for EEA. 1994 marginal costs are presented below:

REFERENCE MARGINAL COST TARIFFS (US¢/kWh)

MV>500kWH	4.3
MV<500kWH	5.7
UHV	2.6
HV	3.4
Dist. Cos.	3.5
Commerce	6.5
Residential	6.1
Housing Cos.	3.3
Public Lighting	6.3

When compared to present tariff levels, the major distortions lie in the UHV rates enjoyed by large industries and in the residential rate. The commercial rate is between 20-50 percent above the reference economic cost.

Tariff structure

5. Present tariffs have the following structure:

- All high voltage consumers have a flat kWh rate
- Medium and low voltage consumers have a binomial rate with kW and kWh charges
- Residential and Commercial consumers have a blocked energy charge.

This structure does not reflect system costs and, in particular, high voltage users should have a demand charge as well as time of day (TOD) energy charges. EEA is planning to implement these reforms.

Taxes on Electricity

6. Two types of taxes are added to the electricity bills:

- A "broadcasting" tax of 0.2 Pt/kWh (Cairo) or 0.1Pt/kWh (other regions) on the first 45kWh/month. Given that these amounts only apply to a small block of consumption, they do not significantly alter consumers' choices;
- Fixed charge taxes per bill that amount to 44 pt (13¢) per month and a yearly supply tax of 300 pt (90¢) per consumer; these fixed charges do not influence consumer behavior either.

Annex 4 EGPC Responsibilities and Associated Companies

Function	*Role of EGPC*	*Executing Agency*	*Commercial Relationship with EGPC*
Oil and gas exploration	Issues licenses. Forms joint venture agreement with private companies	Private companies, mostly multinationals.	Commercial 50:50 share of production
Gas transportation	Controlled via a 100% subsidiary	Petroleum Pipeline Corporation	Client relationship
Oil refining	Controlled via 100% subsidiaries	7 refineries of various sizes	Client relationship
Gas distribution	Controlled via 100% owned subsidiary	Petrogas	Client relationship
Marketing of oil products	Controls 70% of the market via subsidiaries	MISR and COOP subsidiaries plus 5 private companies	Client relationship with subsidiaries.
Issuing of outlet licenses	Determines location	EGPC	N/A

Annex 5 Comparative Analysis: Hydrocracker vs FCC

Economics

1. The ESMAP working group carried out a preliminary evaluation of the relative economics of distillate hydrocracking vis-à-vis mild fluid catalytic cracking (FCC) for a 15 million ton refining capacity, in which the cracking catalyst is specially designed to minimize gasoline and maximize light cycle oil that is suitable for blending into diesel. This process has been commercially proven in several units during the past decade. The estimated product realization, based on may 1995 spot market prices, from the two cases are shown in the table below.

Product	*US$/ton*	*Mild FCC '000 tons/year*	*Mild FCC MMUS$/year*	*Hydrocracking tons/year*	*Hydro-cracking MMUS$/year*
LPG	170.0	975.0	167.8	350.0	59.50
Gasoline	207.0	3720.0	770.0	2445.0	506.12
Kerosene	165.5	1700.0	281.4	2874.0	475.65
Diesel	157.2	4555.0	716.3	6551.0	1030.1
Fuel oil	99.0	2668.0	264.1	1125.0	110.4
Fuel and loss	--	562.0	--	955.0	--
Bitm. and lubes		870.0	--	870.0	--
Total		15050.0	2197.5	15170.0	2181.8

Note: Natural gas required for hydrogen generation for hydrocracker is not included.

2. The total production from 15 million tons of crude oil with the two different types of crackers are compared with the 1993 product consumption in the country in the table below to illustrate that both the alternatives will satisfy the domestic requirement, so that the investment decision could be taken only on the basis of economic advantage and engineering reliability of the selected technology. In fact, the product demand could be met with lower crude production when the crackers are in operation, thereby increasing the quantity of crude oil available for export.

3. The investment cost for the hydrocracker complex with all its associated facilities would exceed that for the mild FCC complex by about US$400 million. The operating cost for the hydrocracker complex would be about US$100 million as against

US$64 million for the FCC complex due to the high pressure and the cost of generating hydrogen. As indicated in the table above, the sales realization from the hydrocracker complex is about US$16 million less than that for FCC. On this basis, the incremental investment cost of about US$400 million cannot be economically justified.

Product	*1993 Demand*	*With FCC ('000 tons)*	*With DHC ('000 tons)*
LPG	1063.0	975.0	350.0
Gasoline/naphtha	1877.0	3720.0	2445.0
Kerosene/turbine fuel	1629.0	1700.0	2874.0
Gas oil/diesel	4779.0	4555.0	6551.0
Fuel oil	6779.0	2668.0	1125.0
Bitumen	600.0	600.0	600.0
Lubes	258.0	270.0	270.0
Total	16985.0	14333.0	14025.0

4. The FCC has greater operating flexibility. The catalyst inventory can be quickly changed on stream to adjust the product mix to maximize profitability. Catalysts are available from a variety of vendors to achieve different product distributions. Hydrocracking catalysts are usually specified by the licenser and can only be replaced at the end of the operating cycle of several years.

5. The FCC produces economically viable quantities of propylene that could be converted into valuable polypropylene, and butylene that could be converted to valuable alkylate. Additional revenue from this has not been included in the above tables. Due to the high-octane gasoline production from the FCC, catalytic reformers, existing as well as new ones, could be designed to produce aromatics (benzene and xylene) or gasoline as required by the market.

Construction

6. The FCC could be manufactured in Egypt to vendor's specifications with the exception of the rotating equipment. This represents a significant foreign currency saving as well as a significant boost to the local economy. Against this, the hydrocracker would have to be imported at an expense of valuable foreign currency. The reactors are heavy, multi-cladded with special metals produced by specialty shops in Italy, France, and Japan. They require special cranes to install and are difficult to maneuver inside the refinery during the installation phase. The construction time for the hydrocracker will be at least six months longer than that required for the FCC.

Maintenance and Operability

7. Hydrocrackers are prone to hydrogen leaks during startup, shutdown, and emergencies. Because hydrogen diffuses into the metal during operation at the high temperatures and pressures employed, a special depressuring/cool-down program is required to allow hydrogen to diffuse out of the metal during shutdowns. A rapid drop in pressure will cause hydrogen to expand inside the metal and crack the equipment. This requires an advanced control system to manage such a program during normal shutdowns. A control system failure could lead to serious damage to the equipment. Hydrocrackers are prone to flange leaks and leaks through cracks in the equipment, which worsen as the unit ages. Equipment repairs require special metallurgical skills that are not likely to be available in Egypt and could be very expensive.

Safety

8. The high operating pressure and temperature in a hydrogen-rich atmosphere and the potential for leaks raise the risk of explosions that can destroy a significant portion of the refinery and cause the loss of human life.

Track record

9. Unsatisfactory operation of hydrocrackers in the past in Kuwait and Iran for several years should be carefully investigated. Compared with hydrocracking, FCC is relatively simpler to operate and maintain.

Stream Efficiency

10. The hydrocracker would probably start its operation at about 90 percent of the stream efficiency of the FCC. As the unit ages, the stream efficiency will probably drop to 80 percent that of the FCC. This reduces significantly the product revenue differential between the two units.

Annex 6 Crude Run in Upgraded Refineries, 1992

Product	*MMT/Year*	*US$/ton**	*MMUS$/Year*
LPG	227	144.7	32.8
Gasoline, domestic	1,982	131.3	260.2
Gasoline, export	4,801	146.0	701.0
Jet fuel	3,054	143.8	439.2
Diesel oil	7,648	137.1	1048.9
Mazout	4,997	70.0	349.8
Coke	135	57.0	7.7
Asphalt	581	103.4	60.1
Oils	206	115.2	23.7
Miscellaneous	334	100.0	33.4
Purchased butane	–501	144.7	–72.5
TOTAL	24,258		2,884.2

* Platt's Oilgram

Annex 7 Economic Costs and Current Tariffs

(Piaster/cubic meter, 1993/94 prices)

	Economic cost					
Customer category	*Up to city gate*	*Distribution*	*Conversion to gas*	*Total*	*Current prices (additional tax, not included)*	*Current prices as % of economic cost*
Residential	11-14	87	*	98-101	24.0 (4)	28%
Commercial/ small industrial	11-14	15	About 20.0	About 48	**34.0 (4)	83%
Medium industrial	11-14	2	Below 5.0	Below 21	Not yet connected	
Public sector & power plants	11-14	2	NA	13-16	**12.6 (0.3)	95%
Investment sector in free zones	11-14	2	NA	13-16	**28.5 (0.3)	47%

* Included in Distribution costs.

** Conversion cost borne by customers.

Source: "Gas Distribution Pricing Study," July 1993.

Annex 8 Long-Run Marginal Costs Estimations

British Gas has calculated the long-run marginal costs for EGPC in 1994 based on the base case and the most-likely case. The costs are summarized in the tables below.

Long-Run Marginal Costs of Exploration, Production, and Transmission (1993/94 Prices)

Base case	*LRMC*	
Gas Production	**Pt/m^3**	**US Cents/m^3**
Existing Fields	3.69	1.11
Existing Discoveries	12.72	3.83
Unproven Reserves	13.45	4.05
Gas Production in Total	9.93	2.99
Gas Transmission	1.23	0.37
Grand Total	11.18	3.36

Most likely case	*LRMC*	
Gas Production	**Pt/m^3**	**US Cents/m^3**
Existing Fields	3.69	1.11
Existing Discoveries	12.52	3.77
Unproven Reserves	13.38	4.03
Gas Production in Total	10.52	3.17
Gas Transmission	1.13	0.34
Grand Total	11.65	3.51

Source: EGPC /British Gas.

British Gas recommended to base the LRMC on existing discoveries in the most-likely case adding the estimated costs for gas transmission. The result is 13.65 piaster/m^3, which is a more conservative estimate than the Grand Total figure (11.65 piaster/m^3). Using an exchange rate of 3.38 pt/UScent this translates to 4.0 UScent/m^3

The following are ESMAP working group comments:

> ***Gas Production.*** For fields under concession agreement, the LRMC has been calculated taking full account of the contracted arrangements specific to each license concession, including profit sharing and cost recovery. Also, exploration

costs are included for development fields (discovered but not yet developed fields) with concession agreements, and such costs have been based on unproven reserves. In all other cases, exploration costs have not been included. The LRMC for unproven reserves is based on the LRMC for development fields. As an example, the LRMC for unproven reserves in the Western Desert is assumed to be the same as the LRMC for development fields in this area. ESMAP team's viewpoint is that exploration costs for new fields are likely to be higher than for existing fields, and unproven reserves should not be included in LRMC calculations unless the costs include all exploration risks in full.

Transmission. Transmission costs are estimated based on the costs (including additional investment costs) of transmitting gas from the producers delivery point into the national network to the city gate or to major end users such as power plants.

Depletion Fee. It is concluded that there is no need for a depletion premium either in the base case or in the most likely case. The depletion premium is avoided by manipulation of gas production (rephasing) during the forecast period. The ESMAP working group's viewpoint is that in light of the uncertainty in demand-supply balance, a depletion fee should be included as gas supply is constrained until at least 1996/97 and maybe even longer if the assumptions vary (i.e., if the actual supply situation or the actual demand pattern differ from the assumptions).

Annex 9 Current Legal and Regulatory Framework

Law No. 20 (1976): Establishes EGPC-Holding.

Law No. 74 (1968): Promulgates PPC as a Joint Stock Company.

Decree No. 118 (1978): Petrogas: Joint Stock Company.

Law No. 217 (1980) & Decree No. 28 (1981): Natural Gas Law: Monopoly of Petrogas for Natural and LPG sales and connections to the distribution system, installations, and maintenance.

Ministerial Decree No. 15 (1988): Gives Egypt Gas monopoly on connections to the distribution system, installations, and maintenance and extends Petrogas monopoly to all customers in Egypt.

The last two laws give Petrogas responsibility as the sole marketer of gas in Egypt, the responsibility of determining technical specifications for connections and installations within buildings, right to access to properties and to supervise installations by Egypt Gas. All gas is sold according to Petrogas standard contracts. Petrogas is responsible for emergency measures.

EGPC is responsible for coordinating the work of PPC and Petrogas to large customers.

Annex 10 Primary Energy Consumption per Unit of GDP

Year	*Total primary energy consumption/ktoe*	*GDP/million 1984/85 LE*	*Primary energy per unit of GDP/(MJ/LE)*
1983/84	23599	32511	30.4
1984/85	24978	34754	30.1
1985/86	25403	36318	29.3
1986/87	26858	37771	29.8
1987/88	27905	39697	29.4
1988/89	28217	41563	28.4
1989/90	29648	43558	28.5
1990/91	30520	45170	28.3
1991/92	30848	46028	28.1
1992/93	30604	47151	27.2

Source: OECP

Annex 11 Final Energy Consumption by Sector, 1992/93

Sector	*Percent of total*	*mtoe*
Industry: Petroleum	4.4	1.0
Construction Materials*	10.9	2.5
Other	35.0	**7.9
Transport	26.6	6.5
Residential	17.6	4.0
Commercial	0.4	0.1
Agricultural	1.3	0.3
Other	1.8	0.3
Total	100.0	22.6

Source: OECP

*Construction Materials (Cement, Bricks, Tiles etc.) are all produced in factories owned by the Ministry of Housing, which reports energy data separately.

**Transport fuel comprises 3.1 mtoe Diesel
2.3 mtoe Gasoline
1.0 mtoe Other (Mainly Aviation Turbine and Fuel Oil)

Annex 12 Industrial Sector: Consumption and Savings Potential

Energy Consumption in Industry Sectors

Sector	*1980/81*		*1990/91*	
	mtoe	*%*	*mtoe*	*%*
Metallurgical industries*	1787	29.5	2912	26.3
Chemical industries	1534	25.4	1863	16.8
Spinning and weaving	800	13.2	1017	9.2
Food	504	8.3	699	6.3
Metallurgical and thermal+	136	2.2	190	1.9
Cement and building materials	1012	6.9	2621	23.6
Engineering	51	0.8	72	0.6
Other	224	3.7	1715	15.3
Total	6048	100	11089	100

Source: Egyptian National Department for World Energy Committee (1994) Arab Energy 5th Conference, Cairo 7 to 10 May 1994

* Iron & Steel, Foundries, Aluminum

\+ Phosphates, Manganese, Glass & Crystal, Ceramics

Calculation of Potential Energy Savings

Sector	% of energy consumption	Potential saving/%
Metallurgical industries*	26.3	25
Chemical industries	16.8	50
Spinning and weaving	9.2	25
Food	6.3	25
Metallurgical and thermal+	1.9	25
Cement and building materials	23.6	40
Engineering	0.6	45
Other	15.3	45

*Iron & Steel, Foundries, Aluminum +Phosphates, Manganese, Glass & Crystal, Ceramics

Average Specific Energy Consumption for Selected Industries

Industry	Egyptian specific energy consumption, kg fuel oil/tonne of product	International practice
Iron and Steel	950	Electric Arc Furnace 100–110 On-site Steel Rolling 530
Cement	200	90–120
Plastic	350	Extrusion 180 Blow Moulding 360 Injection Moulding 600
Rubber	1000	610 in Europe, 305 in Japan Figures for Car & Truck tires
Ammonia Fertilizer	1654	740–850 Total gas input: Feedstock and energy
Paper	1000	460 (mostly paper mills, little pulping)
Glass	620	120–190 Flat glass or bottles
Sugar	152	*
Primary Aluminum	4640	3375. Hall-Hérault process for primary aluminum 14000 kWh/tonne
Bakeries	1100	*
Canned Vegetables & Food	192	*
Copper	**544	Smelting 610 Refining 1260
Textiles	2270	*

Source: END/WEC (1994)

* Indicates that the sector is so broad that it is impossible to give a single figure for developed countries.

** It is not clear what processes are included in the figure for copper. The Egyptian Copper Company carries out a range of processes on copper and other non-ferrous metals. It would be necessary to clarify the 544 kg/tonne before any meaningful comparison could be made with developed country performance.

Annex 13 Wind and Solar Power: Installed and Potential

Wind Energy Projects in Egypt

MW	Details	Location	Made by	Funding	Installed
1	4x250 kW	Sidi Barany			1982
0.012		East Oweinat	MAN	Germany	1987
0.055		Abu-Ghousoun	MICON	UNDP	1987
0.4	4x100 kW	Ras Ghareb	Wincon, USA	USAID	1988
0.4	4x100 kW	Hurghada	Wincon+Iron & Steel Co	UNIDO	1990
3	30x100 kW	Hurghada	10 from Ventis	Germany/NREA	1993
			20 from Iron & Steel Co	NREA	1994
1.8	6x300 kW	Hurghada	Norteck + AOI	DANIDA/NREA	1994
0.75	30x25 kW	Remote sites	Energosystemen	Malieve (NL)/NREA	1994
60		Zafarana	to be agreed	DANIDA/NREA	TBA
100		Zafarana		to be decided	Study

Projected Future Electricity Supplies from Wind Power Generation

Year	Rating (MW)	Output (GWh/yr)	Percent of 1992/3 electricity generation	Percent of 2005 electricity generation	Percent of 2005 primary energy consumption
1994	5.2	13.6	0.03 %	0.017 %	0.007 %
1997	66	173	0.4 %	0.2 %	0.09 %
2005	500	1314	2.9 %	1.6 %	0.68 %

Projected Future Electricity Supplies from Solar Thermal Power Generation

Year	Rating (MW)	Output (GWh/yr)	Percent of 1992/3 electricity generation	Percent of 2005 electricity generation	Percent of 2005 primary energy consumption
1996	5	11	0.07%	0.04%	0.006%
2005	100	220	0.49%	0.28%	0.11%

Annex 14 Renewable Energy Potential

Renewable Energy: Grid Electricity Generation Potential

Source (2005)	Electricity production/ savings (GWh/yr)	Fraction of 1992/3 electricity generation	Fraction of 2005 electricity generation	Fraction of 2005 primary energy consumption
Wind	1314	2.9 %	1.6 %	0.68 %
Solar thermal power	220	0.49 %	0.28 %	0.11 %
Solar water heating	1590	3.5 %	2.0 %	0.82 %
Sugar (2005)	900	2.0 %	1.1 %	0.46 %
Biomass combustion	450	1.0 %	0.56 %	0.23 %
Urban wastes	1000	2.2 %	1.25 %	0.52 %
Total	**5474**	**12.09 %**	**6.79 %**	**2.82 %**

Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89--	
	Francophone Household Energy Workshop (French)	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa	06/96	182/96
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Bulgaria	Natural Gas Policies & Issues	10/96	188/96
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95

Region/Country	*Activity/Report Title*	*Date*	*Number*
Egypt	Energy Assessment (English)	10/96	189/96
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
	Industrial Energy Efficiency Technical Assistance Phase II	08/96	185/96
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87

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Mauritius	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vol. I-IV (English)	12/93	--
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--

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Tanzania	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
Togo	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
Zambia	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Petroleum Management Assistance (English)	12/89	109/89
	Power Sector Management Institution Building (English)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--
	EAST ASIA AND PACIFIC (EAP)		
Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86

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Indonesia	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979/SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
Western Samoa	Energy Assessment (English)	06/85	5497-WSO
	SOUTH ASIA (SAS)		
Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88

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India	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84Nepal
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Fomulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	EUROPE AND CENTRAL ASIA (ECA)		
Eastern Europe	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
Portugal	Energy Assessment (English)	04/84	4824-PO
Turkey	Energy Assessment (English)	03/83	3877-TU
	MIDDLE EAST AND NORTH AFRICA (MNA)		
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
	Energy Sector Institutional Development Study (English and French)	05/95	173/95
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector(English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91

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	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	National Energy Plan (Spanish)	08/91	131/91
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91

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Mexico	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR

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Energy End Use Efficiency: Research and Strategy (English)	11/89	--
Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
Development of Regional Electric Power Networks (English)	10/94	--
Roundtable on Energy Efficiency (English)	02/95	171/95
Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96

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