ENTRO

EASTERN NILE POWER TRADE PROGRAM STUDY

AfDB

MARKET AND POWER TRADE ASSESSMENT

VOL 2 - EGYPT

FINAL MAIN REPORT

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EDF – Generation and Engineering Division
73 373
Le Bourget du Lac Cedex
France
Tel: +33-4-79 60 60 60
Fax: +33-4-56 65 20 13
eMail: 79 60 62 35
pierre.brun@edf.fr
http://www.edf.fr

Scott Wilson
Kanthack House, Station Road,
Ashford, Kent TN 23 1 PP
England
Tel: +44 (0) 1233 658200
Fax: +44 (0) 1233 658209
eMail: alan.bates@scottwilson.com
http://www.scottwilson.com

with participation of:

- EPS (Egypt)
- Tropics (Ethiopia)
- YAM (Sudan)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PHYSICAL UNITS AND CONVERSION FACTORS

bbl	barrel (1t = 7.3 bbl)
cal	calorie (1 cal = 4.1868 J)
Gcal	Giga calorie
GWh	Gigawatt-hour
h	hour
km	kilometer
km²	square kilometer
kW	kilo Watt
kWh	kilo Watt hour (1 kWh = 3.6 MJ)
MBtu	Million British Thermal Units (= 1 055 MJ = 252 kCal)
	One cubic foot of natural gas produces approximately 1,000 BTU
MJ	Million Joule (= 0,948.10^{-3} Mbtu = 238.8 kCal)
MW	Mega Watt
m	meter
m^3/d	cubic meter per day
mm	millimeter
mm^3 or hm^3	million cubic meter
Nm^3	Normal cubic meter, i.e. measured under normal conditions, i.e. 0°C and 1013 mbar
	(1 Nm^3 = 1.057 m^3 measured under standard conditions, i.e. 15°C and 1013 mbar)
t	ton
Toe	tons of oil equivalent
Tcf	ton cubic feet
°C	Degrees Celsius

General Conversion Factors for Energy

To:	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	4.1868×10^{4}	10^{7}	1	3.968×10^{7}	11630
MBtu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
ADF	African Development Fund
CC	Combined Cycle
CCGT	Combined Cycle Gas Turbine
CIDA	Canadian International Development Agency
CT	Combustion Turbine
DANIDA	Danish Development Assistance
DFID	Department for International Development (UK)
DIDC	Department for International Development Cooperation (GoF)
DSA	Daily Subsistence Allowance
EEHC	Egyptian Electricity Holding Company
EEPCO	Ethiopian Electric Power Corporation
EHV	Extra High Voltage
EHVAC	Extra High Voltage Alternating Current
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EN	Eastern Nile
ENCOM	Eastern Nile Council of Ministers
ENSAP	Eastern Nile Subsidiary Action Program
ENSAPT	Eastern Nile Subsidiary Action Program Team
ENTRO	Eastern Nile Technical Regional Office
ENTRO PCU	Eastern Nile Technical Regional Office Power Coordination Unit
FIRR	Financial Internal Rate of Return
GEP	Generation Expansion Plan
GTZ	German Technical Co-operation
HPP	Hydro Power Plant
HFO	Heavy fuel oil
HV	High Voltage
HVDC	High Voltage Direct Current
ICCON	International Consortium for Cooperation on the Nile
ICS	Interconnected System
IDEN	Integrated Development of the Eastern Nile
IDO	Industrial Diesel Oil
IMF	International Monetary Fund
JICA	Japanese International Co-operation Agency
JMP	Joint Multipurpose Project
LNG	Liquefied Natural Gas
LOLP	Loss of Load Probability
LPG	Liquefied Petroleum Gas

LRFO	Light Residuel Fuel Oil
MENA	Middle East, North Africa Countries
MIWR	Ministry of Irrigation & Water Resources (Sudan)
MWR	Ministry of Water Resources (Ethiopia)
MWRI	Ministry of Water Resources and Irrigation (Egypt)
MSD	Medium Speed Diesel (TPP)
NBI	Nile Basin Initiative
NEC	National Electricity Corporation (Sudan)
NECC	National Electricity Control Centre (Egypt)
NELCOM	Nile Equatorial Lake Council of Ministers
NELSAP	Nile Equatorial Lake Subsidiary Action Program
NG	Natural Gas
NGO	Non Governmental Organization
NORAD	Norwegian Aid Development
NPV	Net Present Value
O&M	Operations and Maintenance
OCGT	Open Cycle Gas Turbine
OPEC	Organization of the Petroleum Exporting Countries
PBP	Pay Back Period
PHRD	Policy & Human Resource Development Fund
PIU	Project Implementation Unit
PRSP	Poverty Reduction Strategy Paper
RCC	Regional Electricity Control Centre (Egypt)
RE	Rural Electrification
SAPP	Southern Africa Power Pool
SIDA	Swedish International Development Agency
SSD	Slow speed diesel (TPP)
STPP	Steam Turbine Power Plant
STS	Senior Technical Specialist
TAF	Technical Assistant Fund
TPP	Thermal Power Plant
UA	Unit of Account
UNDP	United Nations Development Program
WB	World Bank

1. OVERVIEW

Egypt occupies the north-eastern corner of the continent of Africa, including the Sinai Peninsula, with a population of about 69.997 millions (2005), 43% in urban areas and 57% in rural areas. The growth rate of population is currently 1.96% (2006).

The economy of the country has developed in the last years with an annual GDP rate of 5%, pushed up by a significant production of petroleum products, electricity developments, and industrialization.

Egypt has a per capita electric energy consumption of 1 350 kWh (2001/2002). Access to electricity is high, around 98%, with negligible isolated systems.

Environmental improvements can be notice by the rate of CO_2 production in Egypt. It has been reduced from about 2.8 tons of CO_2 per Toe in 1981/1982 to about 2.5 in the year 2001/2002. This is because of the increase of the use of natural gas in the electric energy production.

Egypt Utility

Egyptian electric company is currently comprised of nine regional electricity distribution companies, five regional electricity generation companies, one electricity transmission companies. All these companies are blended in a Holding company, the Egyptian Electricity Holding Company (EEHC). Different authorities, such as New & Renewable Energy and Hydro Power, are directly linked to the Ministry of Electricity & Energy.

Current demand and generation supply

In Egypt, peak demand increased from 5 400 MW (1985/1986) to 17 300 MW (2005/2006). In the same period, energy generated increased from 32 TWh to 108 TWh, with a growth rate of 7% in the last ten years.

The total installed capacity in 2006 is 20 508 MW, with 17 543 MW of thermal plants, 225 MW of wind farms, and 2 740 MW of hydropower (4 plants).

Installed Capacity (MW)	ST	CCGT	OCGT	WIND	HYDRO	Total
Cairo	2270	1485	600			4355
West Delta	3330	1224	837			5391
East Delta	3991	1409	453	225		6078
Upper Egypt	1944					1944
Hydro					2740	2740
Total	11535	4118	1890	225	2740	20508
Installed Capacity (%)	56%	20%	9%	1%	13%	

Table 3.1-1 - Total installed capacity in 2006

One hydro plant, two thermal plants, and two wind farms are committed:

- ✓ The New Naga-Hammadi 64 MW and 460 GWh/year is planned to operate in 2008/2009,
- ✓ Talkha 750 MW CC (NG/HFO) in East Delta is planned to operate in 2007/2008,
- ✓ Kurimat (2) 750 MW CC (NG/HFO) in Upper Egypt is planned to operate in 2007/2008,
- ✓ Zafarana / Gabal El-Zait 55 MW is planned to operate in 2006/2007,
- ✓ Zafarana / Gabal El-Zait 150 MW is planned to operate in 2007/2008.

In the Egyptian hydro system, irrigation is the priority, the power production is only a by-product. The Ministry of Water and Irrigation defines the daily discharges in power plants and send this information to NECC every week.

Existing transmission system and power trade

Egypt is interconnected with Libya and Jordan. These interconnections are used for emergency situations and for power trade between Egypt and Jordan. Exports and imports measured from 2003 to 2005 represented less than 1% of total Egyptian electrical generation, but 20% of Jordanian generation. An export balance of 20 GWh to Lybia and of 680 GWh to Jordan were measured in 2004/2005.

The existing transmission system is equipped with a double circuit 500 kV backbone along the Nile river, from High Dam (2 100 MW) to Cairo (main load centre), and a single circuit (500 KV) from Cairo to the interconnection with Jordan. A 132 kV and 220 kV circuit follows the 500 kV backbone along the Nile river. The delta zone is supplied with a meshed 220 kV network, and extends towards west to Libya with a double circuit interconnection. An extension of the 500 kV network is currently under construction from Cairo 500 to Sidi Krir in West Delta. It is also the first milestone to reinforcement of the interconnection with Libya in 500/400 kV.

2. ORGANISATION OF THE REPORT

Module 2 deals with the assessment of the existing market and power trade situation in the Egypt, Ethiopia and Sudan.

This Module is organized in four Volumes:

- Volume 1: Overview of Module M2.
- Volume 2: Market of Power Trade assessment for Egypt.
- Volume 3: Market of Power Trade assessment for Ethiopia.
- Volume 4: Market of Power Trade assessment for Sudan.

Each volume analyses the existing situation in each country along the following items:

- Review of the electricity sector.
- Assessment of existing generation mix (TPP, HPP, geothermal, etc).
- Assessment of existing power trade.
- Assessment of existing transmission system.

The present Volume 2 presents the Market and Power Trade assessment in Egypt.

3. REVIEW OF THE ELECTRICITY SECTOR

3.1 ENERGY SECTOR BACKGROUND INFORMATION

Egypt is the largest economy of North Africa and is, with around 70 million inhabitants, home to almost half the region's population. Gross domestic product is expected to grow at an average 3.6% per year over the next 30 years.

3.1.1 GEOGRAPHIC INFORMATION

Egypt occupies the north-eastern corner of the continent of Africa including the Sinai Peninsula. It is bordered in the north by the Mediterranean Sea with a length of 995 km. The eastern border starts from Rafah city on the Mediterranean Sea, goes southwards to the city of Taba, then along the western shore of the Gulf of Aqaba to Sharm El-Sheikh, then southwards along the Red Sea to the Sudanese border. The south border extends along Sudan Republic while the western border extends along the Republic of Libya.

The total area of Egypt is about 1.0 Mkm², while the inhabited area is only about 4.0%, the rest of the area is desert and mountainous. The river Nile flows from the Sudan borders to Cairo in a narrow valley with a width varying between 2 km and 10 km, about 25 km north Cairo the river is divided in two branches, running through fertile land which is the river delta, up to the Mediterranean.

Egypt has a moderate climate, the temperature in Cairo varies between 9.0°C in winter to 35°C in summer, however it reaches an average of 42°C in Aswan. As to the rain fall, Cairo has an average winter precipitation of 6.0 mm during the month of December, while Alexandria has a precipitation of around 53 mm in December Rain falls rarely in Upper Egypt.

3.1.2 DEMOGRAPHIC INFORMATION

The periodical census started in Egypt in the year 1882, in which the population number was about 6.7 million inhabitants. The application of the decennial census started from 1897 census and lasted till the year 1947 census which was delayed until the year 1960. In 1966 the first population census based on sampling was conducted, then it was followed by the population and housing census of 1976, then 1986 and finally in 1996.

At present, the Central Agency for Public Mobilization and Statistics (CAPMAS) has started the population and housing census for 2006. **Figure 3.1-1**, shows the development of the population number during the period 1981/1982 to 2001/2002.

The growth rate changed between 2.0% to 2.9% per year with an average during the whole period of 2.3%. The current rate is 1.96% (in 2006).

According to (CAPMAS) the population was 69.997 millions in the year 2005. The same source indicates that urban population represents about 43% while rural population represents about 57%. **Table 3.1-1** shows the development during the period 1990 to 2004.

An information which might be needed in the estimation of residential energy consumption is the number of households which was about 12.7 millions in the year 1996 with an average of about 4.7 persons per household[1].

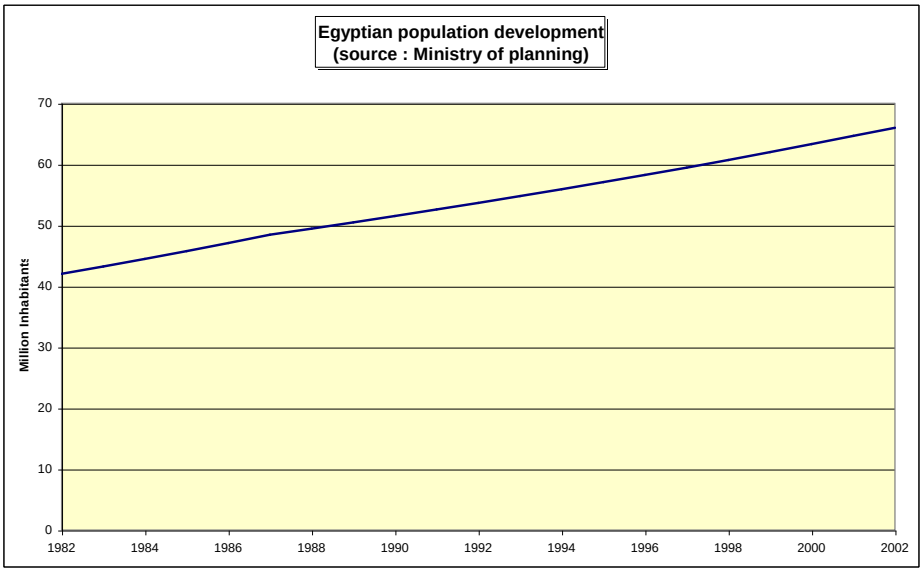


Figure 3.1-1 - Egyptian population evolution

Years	**Urban** (Mcapita)	**%**	**Rural** (Mcapita)	**%**	**Total** (Mcapita)
1990	22.519	43.4	29.392	56.6	51.911
1991	22.908	43.2	30.077	56.8	52.985
1992	23.366	43.2	30.716	56.8	54.082
1993	23.804	43.1	31.397	56.9	55.201
1994	24.276	43.1	32.068	56.9	56.344
1995	24.652	42.9	32.858	57.1	57.510
1996	25.019	42.6	33.736	57.4	58.755
1997	25.589	42.6	34.491	57.4	60.080
1998	26.123	42.6	35.218	57.4	61.341
1999	26.590	42.4	36.049	57.6	62.639
2000	27.181	42.5	36.795	57.5	63.976
2001	28.168	43.1	37.130	56.9	65.298
2002	28.554	42.9	38.074	57.1	66.628
2003	29.130	42.9	38.835	57.1	67.965
2004	29.474	42.5	39.856	57.5	69.330

Table 3.1-1 - Midyear population estimates (Urban & Rural). Excluding Egyptians Abroad. Source: CAPMAS.

[1] Excluding residents in public buildings. Source: CAPMAS

3.1.3 GENERAL OVERVIEWS ON ENERGY SECTOR

During the period 1981/1982 to 2001/2002, the total Petroleum energy consumption in Egypt increased from 15.577 M tons of oil equivalent (Toe) to 41.217 M Toe with an average annual increase of about 6.7%.

If we assume that this rate of development will continue for the next 30 years, the total Petroleum energy consumption will increase (7) seven folds to reach 287 million Toe in the year 2030. To be more realistic, this annual increase of 6.7% will saturate in the future and an average rate of only 5% may be considered. The total energy consumption of Egypt may only reach about 170 M Toe in 2030, considering also the increase in the energy efficiency.

As to the energy, resource and natural gas proven reserves are available in Egypt. Egypt estimated proven oil reserves as 3.7 B barrels or 0.3% of world reserves, while oil production averages 579 000 Bbl/day.

Natural gas production in Egypt averaged 3.4 Bcf/day in 2004, while according to the oil and gas Journal, Egypt's (**Table 3.1-2**) estimated proven gas reserves stand at 65.0 Tcf or roughly 1.5% of world reserves.

Year	Crude Oil (BBOE)	Natural Gas (BBOE)
1999/2000	3.711	8.980
2000/2001	3.682	10.64
2002/2003	3.582	10.600
2003/2004	3.602	11.580

Table 3.1-2 - Crude Oil (including condensates) and Natural Gas Reserves in Egypt.

3.1.4 POSITION OF EGYPT IN THE REGION

Appendix 1 shows that Egypt is the second highest producer of petroleum products among the neighbouring Arab Countries, members of OAPEC, with a 495 kbl/day of oil in 2004, which represents 15% of the area.

However, the petroleum revenues (2 588 MUSD in 2004) are not that high representing only 1% of the neighbouring countries (Appendix 1). Hydrocarbons currently make up 9% of Egyptian GDP, a low share in comparison with most other oil-and gas-exporting MENA countries.

3.2 ENERGY RESOURCE POTENTIAL AND BALANCES

3.2.1 ENERGY RESOURCE AND POTENTIAL

3.2.1.1 Oil

Resources and reserves:

Egypt's oil reserves have been fairly well explored and development uses relatively advanced oilfield technologies. Egypt's estimated that proven oil reserves stand at 3.7 Bbl, or 0.3% of world's reserves, mainly concentrated in the Gulf of Suez (about 50%), Western Desert, the Eastern Desert and the Sinai Peninsula areas. Although the government has indicated that oil reserves in place may be up to 13.2 billion barrels, there are some doubts about the remaining potential. The US Geological Survey sets undiscovered oil at 3.1 billion barrels.

Production:

Egypt's oil production has been in decline since it peaked at 980 kb/d in 1993. Future oil finds are likely to be small scale, insufficient to halt the overall decline in production. The crude oil production averaged 579 000 Bbl/day in 2005, less than 1% of world production.

Egypt's refineries have a combined crude oil processing capacity of 61 700 Bbl/day. The government has plans to increase production of lighter products, petrochemicals and higher octane gasoline.

The country is experiencing a squeeze on its oil exports: domestic demand has been rising whilst production has been declining. As a result, oil exports have fallen y over 50% in the past decade. World Energy Outlook (WEO) study assumes Egypt will become a net oil importer by around 2015.

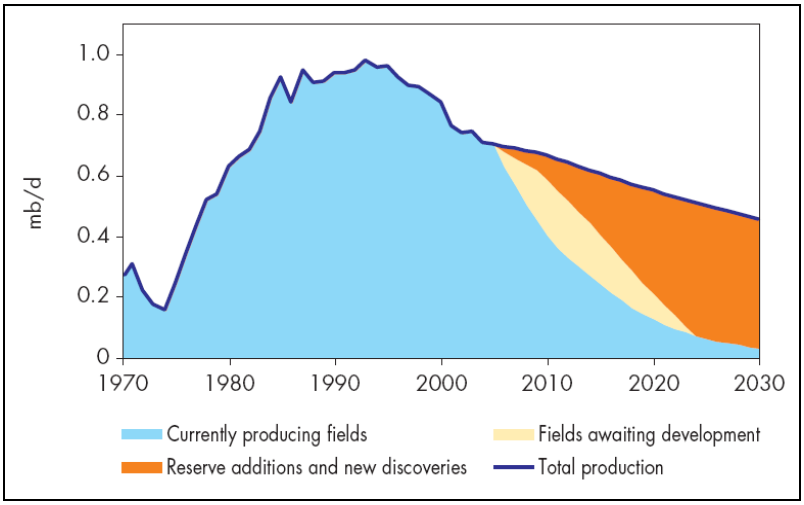


Figure 3.2-1 - Egypt's oil production by source (origin WEO 2005)

3.2.1.2 Natural Gas

Resources and reserves:

Egypt have an estimated proven gas reserves about at 65 (Tcf) or roughly 1.0% of world reserves. The success of gas exploration has increased dramatically since 1991, when foreign companies were first allowed to participate in the Egyptian natural gas sector (**Figure 3.2-2**). As a result proven gas reserves more than quadrupled since 1991.

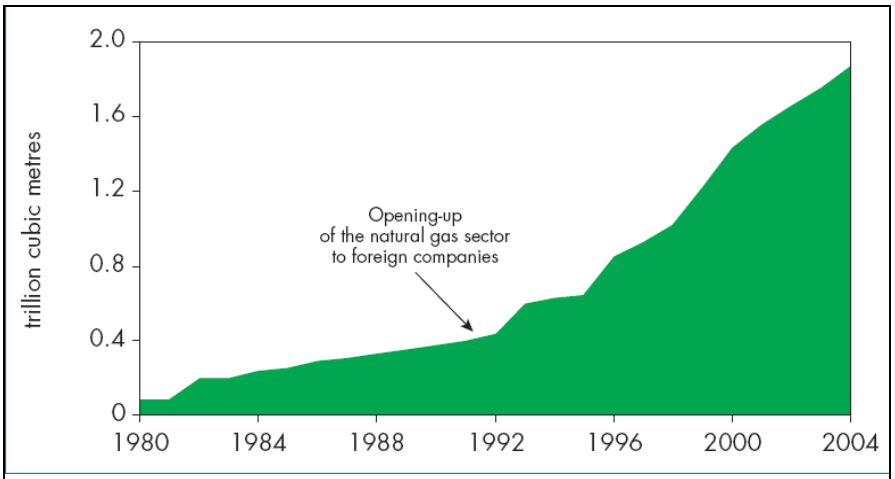


Figure 3.2-2 – Egyptian gas proven reserves.

The Egyptian government estimates probable or possible reserves to be as high as 2.8 to 3.4 tcm and appears to achieve "proven status" for these reserves.

Probable gas reserves are around 120 Tcf. Most of the increase has come as a result of new natural gas discoveries off shore the Nile Delta and Western Desert. In order to support its goals of doubling natural gas exports by 2010/2011, the government aims to add 30 Tcf from new natural gas discoveries offshore from the Nile's Delta.

Production:

In 2003, Egypt was the second largest natural producer in Africa (after Algeria).

Natural gas production in Egypt averages 3.0 Bcf/day in 2004, while production is expected to rise to roughly 5.0 Bcf/day by 2007 with much of the increased volume being exported as LNG (**Figure 3.2-3**).

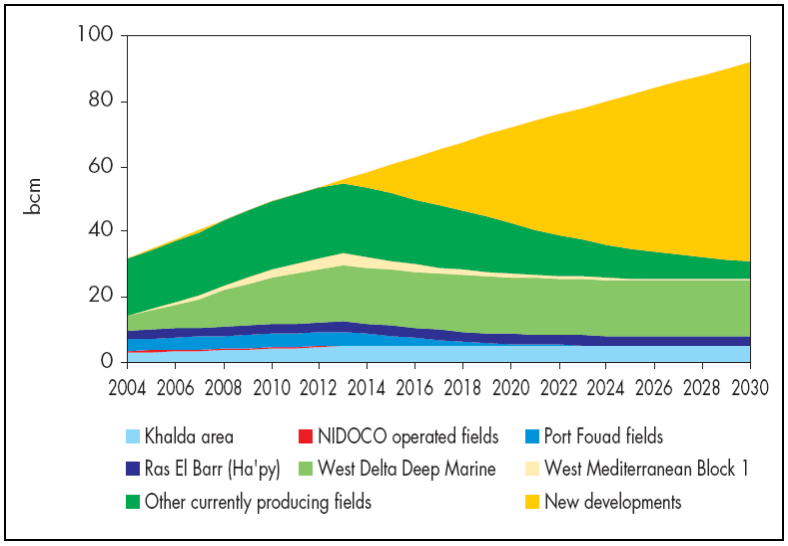


Figure 3.2-3 - Egypt-natural gas production forecast (WEO 2005)

Exports:

Egypt became an LNG exporter in 2005 with 1.55 Bcf/day. Three LNG trains are in operation.

The first phase of the Arab Gasline, which originates in Egypt and stretches over 264 km to reach Jordan, was completed in July 2003 and marked the starting point of natural gas exports from Egypt. There are plans to extend the pipeline to reach Syria and Lebanon, and possibly Turkey.

Israel and Egypt signed a Memorandum of Understanding on June 2005 for the construction of a sub-sea gas pipeline linking the two countries.

In WEO 2005 projections Egypt's net exports of gas are projected to increase all along 2030 despite increasing domestic demand (**Figure 3.2-4**).

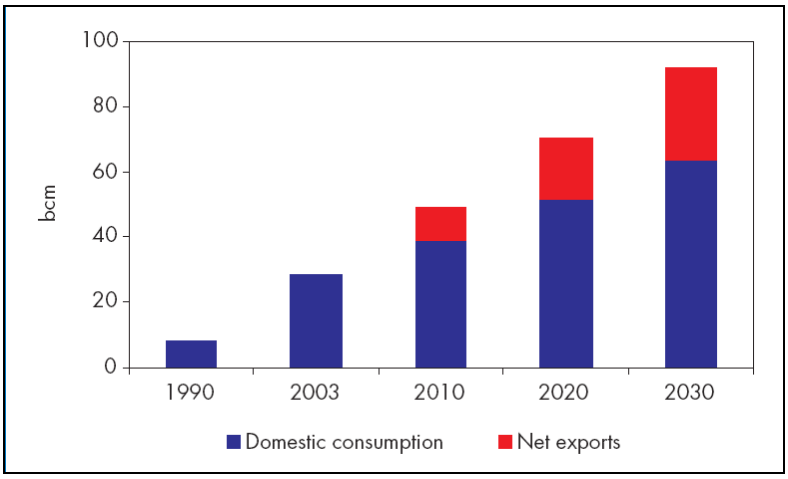


Figure 3.2-4 - Egypt's projected Natural Gas balance

3.2.1.3 Coal

There is no coal mine in Egypt.

3.2.1.4 Hydroelectric Energy

Hydroelectric energy in Egypt depends totally on the River Nile. Hydroelectric projects in Egypt are multipurpose, irrigation/water control, and electric energy generation. Three hydroelectric power plants are already built in Aswan.

The first plant has an installed capacity of 345 MW and the second with an installed capacity of 270 MW. The largest hydro electric plant was built at the Aswan High Dam with an installed capacity of 2 100 MW. At present (2005) the total installed capacity is 2 745 MW and the total energy generated in 2004/2005 was 12 644 MWh (this drop was due to the reduction of water flow).

The generated energy from the generating stations on the River Nile depends on the water inflow, which in turn depends on the irrigation water requirements, in addition to the changes in the amount of annual water inflow from the upper Nile resources. The hydro electric energy accordingly changes from day to day during the year, however, constant during the day. On the other hand, the electric energy requirements change from hour to hour during the day as well as the variations from month to month during the year.

3.2.1.5 New and Renewable Energy

Egypt lies between latitudes 22 and 32 North, with a daily 9-11 hours of sunshine. A hybrid generating station using solar parabola concentrators for steam generation in a combined cycle generating station of 150 MW is now under implementation at the Kurimat power station.

Egypt enjoys considerable wind energy resources with an average wind speed of 10 m/s in the Gulf of Suez western regions, 9.5 m/s in Zafarana region and 7 m/s in East Owainat area in the western desert. A pilot wind farm was built in Hurgada with a total capacity of 5.4 MW. Two successive stages of wind farms at Zafarana have been built with estimated energy production of 570 TWh/year.

3.2.1.6 Electric Energy Production

Five electricity generation companies are subordinated to the Egyptian Electricity Holding Company ; one of them is responsible for the hydro-electric generation, while the four others are responsible for the thermal generating stations. All the electric energy produced is fed into one national company, the Egyptian Electricity Transmission Company. The thermal generating stations are either of the conventional steam turbine units, combustion turbine units, or of the combined cycle system.

During the past decade the fuel used had been gradually changed from Gas oil to natural gas. The ratio of the natural gas had reached about 76% in 2004/2005.

Paragraph 4 presents the current installed capacity and generation.

Total energy generation to year 2004/2005 in around 108 TWh. The electric energy bought for industrial concerns was 69 GWh. Generating stations which are not connected to the unified power system, produced 202 GWh.

3.2.1.7 Total Energy Production

The attached **Table 3.2-1** shows the details of the total energy production in Egypt for the years 1999/2000, 2000/2001, 2002/2003 and 2003/2004. Total energy production shows a persistent growth rate, sustained by natural gas increasing production.

In contrast, Petroleum production shows a decline during the period 1999 to 2004 due to the increase of the dependence on natural gas.

Primary Energy (MTOE)	**1999 2000**	**2000 2001**	**2002 2003**	**2003 2004**
Crude Oil & Cond.	36.4	32.1	34.5	34.1
Natural Gases* including:	20.0	25.3	25.0	27.5
- Natural Gas	16.2	20.4	23.7	26.2
- Condensates	2.7	3.6		
- LPG	1.2	1.3	1.3	1.2
Hydropower	3.2	3.0	2.8	2.9
Coal	0.03	0.04	0.03	0.03
Total	**59.7**	**60.5**	**62.3**	**64.4**

Table 3.2-1 - Primary energy production. *Includes National Gas, Condensates and LPG.

3.2.1.8 Energy Consumption

3.2.1.8.1 Consumption of Petroleum Products

Appendix 2 give the sector and total consumption of petroleum products for the period from 1999/2000 to 2003/2004. It shows that the total consumption has increased from about 15.58 Mtoe in the year 1981/1982 to about 24.22 MToe in the year 2003/2004.

Figure 3.2-5 shows the consumption share by sector for year 2003/2004, with only 6% consumption to electricity production.

The share of the natural gas consumption rise from about 12% to about 46% in year 2001/2002. This increase was mainly in the electricity sector due to the replacement of gas instead of oil in the generating stations. In the year 2001/2002 the share of natural gas consumption was about 88% while it was only 15% in 1981/1982.

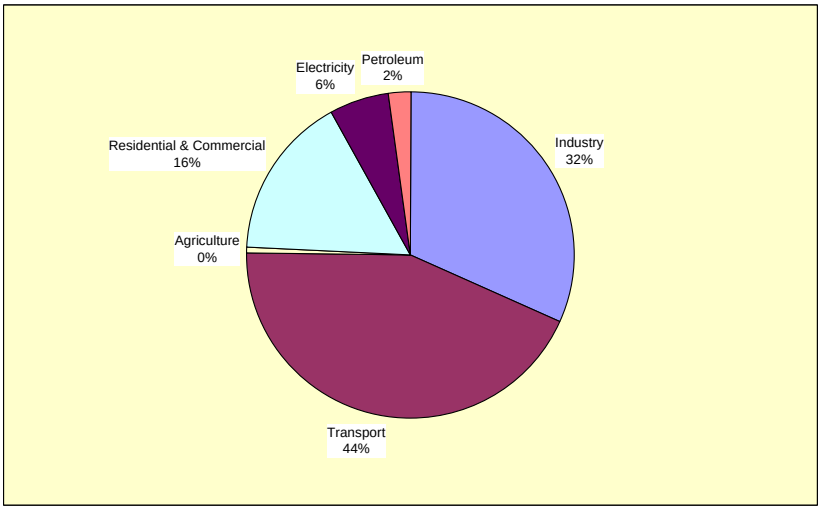


Figure 3.2-5 - Share of petroleum consumption by sector in 2003/2004.

The consumption of natural gas in the electricity sector increased from 0.7 MToe in year 1981/1982 to about 11.6 MToe in 2001/2002 while the petroleum consumption reduced from about 3.0 MToe to about 1.5 MToe.

It should be noticed that the total fuel consumption for electric energy generation has increased to cope with the increase in the electricity consumption.

3.2.2 ENERGY BALANCES

Studies of the structure of power pools and power trade between countries within the power pools are based basically on the energy balance in each of the members of the power pool. The balance will show whether this member has enough energy resources to satisfy its needs, whether it actually at present imports energy from its neighbors in the form of solid, liquid or gas and whether it has excess energy resources which can be exported. These studies should be done for the present conditions and also as foreseen in future.

In the other sections of this M2 Report and in M3 Report, the energy resources of Egypt has been reviewed as well as the energy consumption purposes.

In this section, the balance of energy environment in Egypt will be investigated. The main objective of the main study is to develop a demand forecast and hence investigate the responsibilities of the power pool and the interconnections within the pool to satisfy the power needs of the members and the economics of trade and exchanges.

Two photographic shots (Appendix 3) were taken for the energy supply in Egypt, one for the year 2000/2001 and the second for the year 2003/2004.

A tentative balance for 2003/2004 shows that from a total petroleum primary energy production of 62 Mtoe (**Table 3.2-1**) only 54 Mtoe of petroleum products is supplied (Appendix 3). In the same period, total consumption of petroleum products is around 24 Mtoe. In spite of the gap in these figures, it can be concluded that petroleum production and principally gas production are high enough to supply electricity market.

3.3 ECONOMIC, FINANCIAL

3.3.1 ECONOMIC AND FINANCIAL ENVIRONMENT

3.3.1.1 Past Development

The main indicator of the economic environment which affects the development of the energy demand is the Gross Domestic Production (GDP). The energy in any of its forms is a main item in the production of all commodities and services. Accordingly, energy demand and development are proportionately dependent on the development of the GDP.

Table 3.3-1 shows the actual annual rate of development of the GDP for the period 1981/1982 to 2001/2002 showing its subdivision on the production sectors namely: industry, agriculture, petroleum, electricity, transport and others.

Sectors	**Average of Annual Growth Rate** (%)	**Average of Annual Growth Rate** (%)	**Average of Annual Growth Rate** (%)
	1981/1982 – 1991/1992	**1991/1992 – 2001/2002**	**1981/1982 – 2001/2002**
Industry *	5.5	7.0	6.2
Agriculture	2.4	3.4	2.9
Petroleum	3.9	0.5	2.2
Electricity	10.2	5.9	8.0
Transport **	3.9	5.7	4.8
Commercial ***	5.5	5.6	5.6
Government and Public utility	6.8	4.8	5.8
Total	5.1	4.8	5.0

Table 3.3-1 - Development of the actual growth rate of the local aggregate and segmented output during 1981/1982 – 2001/2002.

It is clear from this Table that the average rate of the actual GDP was 5.0% annually.

The annual report of the Central Bank of Egypt for the year 2004/2005 gives the most up-to-date information on the economic environment.

According to the new policies and actions taken by the new government including the new taxation law, reduction of custom duties on some imports and correction of tariffs for some commodities, the gross domestic production at the fixed prices reached about 400.4 BEL at a development rate of 5.1% for the year 2004/2005 compared to 4.2% in the previous year. On the other hand the

GDP at market cost reached 427 BEL increasing at 4.5% for the year 2004/2005 corresponding to 4.1 for the previous years.

Table 3.3-2 shows that the share of electricity in the GDP was 6.7 BEL in 2003/2004 (5.5%) and 7.2 BEL in 2004/2005 (6.8%).

Production Sectors	2003/2004		2004/2005	
	B.E.L	%	B.E.L	%
Agriculture & Fishing	62.4	4.0	64.6	3.5
Extractions (Petroleum, Gas and Others)	30.9	2.4	31.2	0.8
Conversion industries (Oil refining, others)	72.9	1.6	76.5	5.0
Electricity	6.7	5.5	7.2	6.8
Water	1.7	4.9	1.7	4.0
Building and construction	16.4	4.2	17.1	4.0
Total	191.0	2.8	198.3	3.8

Table 3.3-2- Total production by economic sector and actual development rates.

Inflation rate, it has been reduced to 4.7% for the consumer commodities for the year 2004/2005 while it has been reduced to 5.1% for the whole sale prices for the year 2004/2005 compared to 15.9% for the previous year.

3.3.1.2 Recent Economic Policy Development

Since the new cabinet of Ministers was appointed in July 2004, a number of significant structural and institutional reforms have been implemented. Among these which may affect the energy sector are (i) the adoption of the floating currency exchange rates regime, (ii) tariffs and tax reforms which may have possible impact on trade and investment and (iii) increase in energy and water prices.

3.3.1.3 Privatization

Between July 2004 and April 2005, the Government privatized 22 national companies yielding approximately 3.3 BEL. The total amount received during the period 1995-2003 (according to the Central Bank Report) was 16.619 BEL.

3.3.1.4 Inflation Rate

According to the 2004/2005 Report of the Central Bank, the inflation rate of the consumer prices has been reduced to reach 4.7% in the year 2004/2005 while it was as high as 16% during 2003/2004. Similarly the bulk trade prices inflation has reduced from 15% in 2003/2004 to 5.9% in 2004/2005.

3.3.1.5 Foreign Trade

Egypt imports (48.9 BEL) have been higher than exports (18.5 BEL) for the last 10 years albeit foreign trade during this period (1995-2004) shows a continued increase of exports with the corresponding improvement of the balance.

3.3.1.6 Remittances of Egyptians Working Abroad

The improvement of economic conditions has insured the confidence of Egyptians working abroad in Arab and European countries as well as Australia and Canada to transfer their savings to Egyptian banks. The remittances will continue to be at the same level of about 3.0 BUS$.

3.3.1.7 Institutional Setting

The institutional setting of the energy sector is mainly subordinated to the cabinet of Ministers. The organizations concerned are:

- ✓ the Ministry of Petroleum and Mineral resources,
- ✓ the Ministry of Electricity and Energy,
- ✓ the Ministry of state for Environmental Affairs,
- ✓ the Ministry of Higher Education and Scientific Research,
- ✓ the Ministry of Economic Development.

3.3.1.7.1 Ministry of Petroleum and Mining

The organizational structure of this ministry includes four main organizations:

- ✓ the Egyptian General Authority for Petroleum,
- ✓ the Egyptian Holding Company for Natural Gases,
- ✓ the Egyptian Holding Company for Petrochemicals
- ✓ the South Valley Holding Company for Petroleum.

Each of these companies has subsidiaries of national and joint-venture companies in the fields of investigation, drilling, production, transport and distribution.

Organizational Structure of the Petroleum Sector

In the year 2000, the Ministry of Petroleum has set up a comprehensive strategy. Among its most important implementation mechanism is adjusting and developing the petroleum sector structure through separating the natural gas and petrochemicals activities from those of the Egyptian General Corporation, and to establish an independent entity for each of them in addition to paying special and concentrated attention to Upper Egypt through establishing an independent entity. After adding the mineral resources activity to the responsibilities of the Ministry of Petroleum, and establishing the General Authority for Mineral Resources on the 14th of October 2004, the oil sector in Egypt consisted of (5) five strong bodies which are:

- ✓ Egyptian General Petroleum Corporation (EGPC),
- ✓ Egyptian Natural Gas Holding Company (EGAS),

- ✓ Egyptian Petrochemicals Holding Company (ECHEM),
- ✓ Ganoub El-Wadi Petroleum Holding Company (GANOPE),
- ✓ Egyptian General Authority for Mineral Resources.

Several Public Sector companies operate in the field of petroleum:

1. General Petroleum Co. (G.P.C.)
2. Petroleum Pipeline Co. (PPC)
3. Misr Petroleum Co.
4. Petroleum Cooperatives Co. (COOP)
5. Petroleum Gases Co. (PETROGAS)
6. Suez Oil Processing Co. (S.O.P.C)
7. El Nasr Petroleum Co. (N.P.C)
8. Alexandria Petroleum Co. (APC)
9. Ameryia Petroleum Refining Co. (A.R.R.C)
10. The Egyptian Petrochemical Co. (E.P.C.)
11. Assiut Oil Refining Co.

3.3.1.7.2 Ministry of Electricity and Energy

The Ministry of Electricity and Energy includes mainly the Egyptian Electricity Holding Company which is responsible for the strategic planning of the sectors of electricity and energy as well as the studies and research required for its development and design. Subsidiaries to the Holding Company are six companies for power generation, one electricity transmission company and eight electricity distribution companies in the geographic subdivisions of Egypt. In addition the Ministry of Electricity and Energy subordinates several general authorities which are:

- ✓ the Rural Electrification Authority,
- ✓ the Hydro-electric Power Plants Authority,
- ✓ the Nuclear Power Plants Authority,
- ✓ the New and Renewable Energy, Development Authority,
- ✓ the Nuclear Materials Authority.

In addition, a Regulator Agency was recently established namely: Egyptian Electric Utility and Consumer Protection Regulatory Agency. The complete Organization Chart of the Ministry of Electricity & Energy, and others counterparts, are given in Appendix 4.

3.4 DYNAMICS OF INTERACTIONS BETWEEN THE ENERGY SECTOR, THE ECONOMY, AND THE ENVIRONMENT

3.4.1 CONTRIBUTION OF THE ENERGY SECTOR IN THE GROSS DOMESTIC PRODUCTION

The contribution of the energy sector in the GDP at constant price level in the year 2003/2004 was about 30.9 BEL for petroleum sector, representing 8.12% of the total. The contribution of electricity was about 6.75 BEL, representing only 1.77%. On the other hand the rate of increase of the electricity share was higher than that of the petroleum.

However, the total share of energy has increased from about 7.5% to about 10% of the total GDP.

3.4.1.1 Correlation between energy consumption and GDP

The factor of correlation between the rates of development of energy consumption to the rate of development of the GDP gives an indication on the economic conditions.

Table 3.4-1 shows that during the period 1981/1982 to 2001/2002, the GDP has developed at an average rate of about 5% annually, while the rate of development of the electricity consumption was around 7% annually with a ratio of about 1.4.

Period	Average Annual Growth Rate			Correlation	
	Total Local Product	Petroleum Energy Consumption	Electric Energy Consumption	Demand for Petroleum Energy	Demand for Electric Energy
81/1982-91/1992	5.1%	5.6%	8%	1.1	1.6
91/1992-01/2002	4.8%	4.4%	6%	0.9	1.3
81/1982-01/2002	5%	5%	7%	1.0	1.4

Table 3.4-1 - Correlation between rates of development of consumption and GDP during 81/1982-2001/2002. Petroleum Energy Include Petroleum Product and Natural gas.

On the other hand the correlation factor between the rate of development of the total consumption of petroleum products is about the same as the rate of development of the GDP.

3.4.2 ENERGY AND ECONOMY INDICES

The main indices correlating energy and economy are:

- ✓ Energy intensity: The total primary energy intensity varied during the period 1981/1982 to the year 2001/2002 between 158-167 koe/kLE of GDP on the basis of constant prices of the year 1996/1997.
- ✓ Electrical energy intensity: The intensity of the electric energy consumption increased from 185 kWh/kLE of GDP in the year 1981/1988 to about 277 kWh/kLE in the 2001/2002 at the constant prices of 1996/1997.

- ✓ Per capita primary energy: The per capita primary energy consumption increased from 469 koe in the year 1981/1982 to about 731 koe in the year 2001/2002.
- ✓ Per capita electric energy: The per capita electric energy consumption increased from about 521 kWh in the year 1981/1982 to about 1350 kWh per capita in the year 2001/2002.

3.4.2.1 Contribution of Energy Sector in the Investment

The contribution of the investments in the energy sector in the total investments. The share has increased from 13.9% in the year 1999/2000 to 20.5% in the year 2003/2004 reaching 14.4 BEL.

3.4.3 ENERGY AND THE ENVIRONMENT

The Egyptian law No. 48 for the year 1982 and the law No. 4 for the year 1994 both are regulating the gas emission from the power stations and pollutants in the water effluent discharged to the River Nile and sea water. The laws define the maximum allowable pollutants in the air and water to not exceed the limits and the criteria as indicated below aiming to protect the human health and avoiding environment hazards.

- The power sector is committed to minimize the pollutants to the lowest possible limits in order to comply with environmental requirements of the Egyptian laws and the international standards. Therefore one of the pre-requisites before selecting power stations sites is to study and measure the background air pollution, and water quality of the cooling water discharge, the noise level and other environmental parameters such as the access roads availability, demographic impacts, the effect on the surroundings and cultivated lands.

- A Computerized mathematical model has to be carried out before selecting the sites and the high of the chimneys. One of the front end activities is to install metrological and Gaseous wastes, air quality measurement stations one year before starting the power stations operation, to measure the background and the exact pollutants from the source after running the plant in order to ascertain and evaluate the results of the model and the actual pollutions.

- The law is also regulating the thermal pollution in the river and sea water in order to safeguard the biological marine life.

- For the wind farms locations special consideration is given to avoid interference with the Bird migration-flying routes, Noise level is also restricted.

It is well known that burning of hydro-carbon fuels, whether oil, gas, coal or wood produces gases including CO_2 and other gases which will affect the environment. A factor has been defined to indicate the severity of the effect of energy production on the environment.

The rate of CO_2 production in Egypt has been reduced from about 2.8 tons of CO_2 per Toe in 1981/1982 to about 2.5 in the year 2001/2002. This is because of the increase of the use of natural gas in the electric energy production.

Similarly, the CO_2 production rate per kWh has been reduced from 1.0 kg/kWh in the year 1981 to about 0.514 kg/kWh in 2003.

Electricity participation in total emission of CO_2 due to sector consumption of petroleum products and natural gas is about 35%.

To decrease emissions, protect environment and social gains, an important strategy for development of renewable energy generation and rural electrification carried out in Egypt. In fact, Egypt has already started the Rural Electrification Project in the year 1971. Through the Egyptian Government financing and support the electrification of rural areas, including small towns, village and farms, has spread steadily. At present about 98% of the population in Egypt has access to electricity supply. The project had a high social impact as it made the electricity available to hospitals, schools as well as homes. Electricity is now used for irrigation water pumping and other forms of industries and workshops. It is even used for cooking, replacing wood and bottled gas.

3.5 ENERGY SECTOR SUSTAINABILITY

Sustainability is the ability of a system to face decay and its ability of perpetual survival.

Energy sector sustainability, whether for the whole world or for a country is influenced by two main factors, firstly the presence of energy sources and the ability for future development. The second main factor is the rate of the consumption of the energy to ensure that it will not overcome the rate of development of the energy resources. Sub-factors are the development of the technologies of energy transformation and the improvement of the technologies for increasing the efficiency of energy utilization.

Watching with care the oil and gas exports and also watching with care electric energy exchanges on the electricity interconnection systems are also important factors in the energy sustainability.

The first step is to study the present situation of the energy balance in the country.

3.5.1 ENERGY DEMAND FORECAST

In Egypt, peak demand increased from 5.4 GW (1985/1986) to 17.3 GW (2005/2006). In the same period, energy generated changed from 32.3 TWh to 108 TWh.

Demand forecast of the total energy including all sources of energy depends mainly on certain parameters including the gross domestic product, population, and energy prices. The future development of these parameters can be forecasted based on the historic series of their development as well as the vision of planning engineers and economists. In general, the adopted base for forecasting is the econometric method to forecast the energy demand as a function of the economic and demographic variables. Regression analysis (based on historical data) is used to correlate the total energy consumption as a dependent variable to a set of independent variables (electricity sales per sector, total gross domestic product (GDP), GDP per sector, population, tariff).

The Egyptian Electricity Holding Company has developed a demand forecast for the electric energy for Egypt ; it was recently updated until 2030 (see M3 V2 report). The annual increase of demand varied with an average of 5.6%. The expected forecast to medium scenario is summarized as follows:

2007/2008	19 646 MW
2010/2011	23 658 MW
2020/2021	40 963 MW
2029/2030	61 825 MW

3.5.2 LONG TERM GENERATION EXPANSION PLAN

Usually, The Egyptian Electricity Holding Company prepares five-years plans for the generation expansion using computer program (EGEAS). The present plan is the 6th plan (2007~2012), the 7th plan (2012~2017) and 8th plan (2017~2022). It is worth to invention that the least cost generation plan (technico economical) has been prepared for the 6th plans i.e. up to the year 2011/2012 for the later plans ; no economical analysis has been done yet (see M3 V2 report for more detail).

3.5.2.1 Mini Hydropower Projects

The present and future situation of energy challenges necessitates extending the implementation and development of the use of renewable energy resources. Intensive efforts have been executed in Egypt to achieve this goal. Around 13 mini-hydropower projects can add 30 MW for generation in the future.

3.5.2.2 New and Renewable Energy

Renewable Energy strategy was developed and incorporated as an integral element of the national energy planning. In the course of implementing the said Renewable Energy strategy, the Ministry of Electricity and Energy (M.O.E.E.) has been periodically reviewing and updating it to reflect projections for possible contribution of renewable energy technology / application options to the strategic goals.

New and Renewable Energy Authority (NREA) was established in 1986 to act as the national focal point to introduce and promote energy technologies in Egypt. NREA is entrusted to plan and implement renewable energy programs in coordination with other national and international institutions within the framework of its mandate which includes:

1. Resource Assessment.
2. Research, development, demonstration, testing and evaluation of different renewable energy technologies.
3. Proposing Egyptian standards for R.E. equipments and systems, and conducting tests to evaluate their performance.
4. Rendering consultancy services in the field.
5. Technology transfer and development of local manufacturing capabilities.
6. Education and training.
7. Information dissemination among the concerned entities and communities.
8. Promotion of R.E. projects among potential inter national financing institutions.

Studies and measurements have proved that the area of Suez Gulf is characterized with high wind speed, which can be utilized for producing electricity. Advanced and accurate measurements were conducted. The outcomes have revealed that the Suez Gulf is one of the best sites for wind energy in the world. The area can host about 20 000 MW installed capacity of wind farms.

An area of 80 Km^2 was remarked at Zafarana to implement large-scale grid connected wind farms. An area of about 64 Km^2 to the west of that area was remarked as an extension. Currently procedures are being taken to remark another area of 700 Km^2 at Gabal El-Zait. 145 MW wind farms has been implemented and operated into stages in cooperation with Danida and KFW.

The Strategy aims at increasing the capacities of the wind farms to reach 3 000 MW by the year 2020. The M3 Vol 2 report presents detailed information concerning the Egyptian Expansion Generation Plan.

3.5.2.3 Solar Energy

Egypt as one of the sun-belt countries is endowed with high intensity of direct solar radiation ranging between 2000-3200 kWh/m^2 /year from north to south.

A conceptual design for the first Solar Thermal Combined –Cycle Power plant of 150 MW Capacity to be installed at El-Kuraymat, 90 Km south Cairo, was concluded. Short lists for pre-qualified contractors of both Solar, and Combined cycle Islands are under preparations. The project is expected to be operated by mid 2009.

Based on the results of performance of the first plant and technology achievements in the field, a program for a series of similar plants will be prepared, targeting 750 MW generating capacity by the year 2020.

Implementation of the project will be financed as follows:

1. The combined cycle island by JBIC and NREA.
2. The solar island by the World Bank (GEF), and NREA.
3. Consulting services for project construction management, by JBIC and NREA.

With regard to the Photo-Voltaic applications, it is considered the most appropriate one for rural and remote areas of small scattered loads. The total capacity of Photo-Voltaic systems in Egypt ranges between 4-and 4.5 MW, for lighting, water pumping wireless communications and commercial advertising at high ways.

3.5.2.4 Biomass Energy

Biomass energy is a promising source that helps in enhancing the economic return and improving the environmental, social and health conditions on both individuals and local societies levels in the rural areas in addition to maximizing the benefits from all organic wastes by producing different types of biofuels. NREA contributes in developing and localizing some equipment of the biomass systems to be coped with the Egyptian conditions by participating in some pilot projects aiming at encouraging the local manufacturing of some biomass equipments. Two ongoing pilot projects are under implementations as follows:

1- Developing a Complementary Mobile Briqueting System for Plant Residues in the Field project, in cooperation with the Academy of Scientific Research & Technology

2- Developing a Clean Small Carbonization System, in cooperation with US-Egypt Joint Science & Technology Board affiliated to Academy of Scientific Research & Technology.

3.6 STATUS OF PRIVATE SECTOR PARTICIPATION IN THE ENERGY SECTOR

3.6.1 ELECTRICITY PRIVATE SECTOR

Egypt's electric power sector is currently comprised of nine regional electricity distribution companies, five regional electricity generation companies, one electricity transmission companies and a Holding company.

Until July 2000, these companies were state owned companies, when they were legally transferred to public sector companies.

At present, Egypt has three privately owned power stations which are financed under Build, Own, Operate and Transfer (BOOT) financing scheme. The first BOOT project is in Sidi Krir and is a gas-fired steam power station with two 325 MW generating units and began commercial operation in 2001. It was originally owned by Inter Gen which is an joint venture of Bechtel Enterprise and Shell Generating Ltd along with local partners with a 20 year contract.

The second and the third generating stations are also of 2×325 MW each as fired steam and the BOOT contract was a warded to EDF. They are located near the cities of Suez and Port-Said. The two plants which have been in service since 2003 now belong to Tanjong's Powertek through a contract in 2006.

3.6.1.1 Natural Gas

Due to major recent discoveries, natural gas is likely to be the primary growth engine of Egypt's energy sector for the foreseeable future. Beginning in the early 1990s, foreign oil companies began more active exploration for natural gas in Egypt. Major foreign companies involved in natural gas exploration and production in Egypt are shown in the following section.

- ✓ (IEOC) International Egyptian Oil Company, a subsidiary of Eni, operating in the gulf of Suez, the Nile Delta, and the Western Desert regions.
- ✓ (IECO), BP in Nile Delta region.
- ✓ The Obeiyed and Khalda have shown great potential for increasing natural gas production ; the output is transported to Alexandria by a 180-mile pipeline.

3.6.1.2 Private Sector in Oil & Gas Business

- ✓ Gulf of Suez Petroleum Company (Gupco) under a production Sharing Agreement (PSA) between BP and The Egyptian General Petroleum Corporation (EGPC). Production in the Gupco fields, with most wells in operation since the 1960s and 1970s, has fallen in recent years. Gupco is attempting to slow the natural decline in its fields through significant investments in enhanced oil recovery (EOR) as well as in increased exploration.

- ✓ Petrobel is a joint venture between EGPC and Eni (Italy). Petrobel operates the Belayim fields near the Gulf of Suez and also is undertaking an EOR program to stem declining production.
- ✓ Badr El-Din Petroleum Company (EGPC and Shell).
- ✓ Suez Oil Company (EGPC and Deminex).
- ✓ El-Zafarana Oil Company (EGPC and British Gas –BG).
- ✓ Khalda Petroleum joint venture between Apache and EGPC.
- ✓ BP (El Morgan field 40,000 to 50,000 bbl/d).
- ✓ Wadi El-Sahl field is producing about 20,000 bbl/d.
- ✓ EGPC and Eni is producing about 40,000 bbl/d.
- ✓ Khalda Petroleum joint venture between Apache and EGPC is producing about 50,000 bbl/d.

Refining

Nine refiners have a combined crude oil processing capacity of 761,700 bbl/d, the largest is El-Nasr refinery at Suez, which is owned by the Egyptian government through the EGPC.

3.7 ENERGY EFFICIENCY

3.7.1 ENERGY EFFICIENCY IN ELECTRIC POWER SYSTEMS

As early as the beginning of 1990's especially with the increase of the cost of oil, the Ministry of Electricity and Energy realized the importance of improving the energy efficiency in the electric power system. The Public Sector Authority of Electricity Distribution has entrusted the Electric Power Systems Engineering Company to carry out a study of investigating the electric energy losses in the distribution network and give recommendations for the design and rehabilitation of the distribution networks for the optimization of the electric energy losses.

At that time, the investigation have shown that the electric losses in some districts of the electricity distribution companies were as high as 15%. The main causes were the high percentage losses in lightly loaded distribution transformers, in long and heavily loaded feeders and in poor contacts. Recommendations were given for the optimization of initial loading and the optimization of the life loading of distribution transformers. Also the optimization of the length and cross-sectional area of the conductors and the optimum timing for rehabilitation. Recommendations for reducing the non-technical losses were also given. Implementing these recommendations by the electricity distribution companies improved the efficiency and reduced the losses by a factor of 85%.

Early in the millennium 2000, the Egyptian Electricity Transmission Company realized the highest electric energy losses of the whole transmission and distribution systems of about 16%. It took the necessary measures to optimize the power and energy losses. The total system losses reached about 14.5% in the year 2004/2005.

3.7.2 ENERGY EFFICIENCY IN INDUSTRIAL CONCERNS

With the increase of the energy prices and the corresponding energy tariffs, many of the industrial concerns have carried out studies and implemented recommendations in the following fields:

Load Management

The purpose is to coordinate the electric peak load demand of the different sections of the factory for the purpose of reducing the total loading of the internal power distribution network and hence reducing the losses.

Installing Capacitors

Both within the factory distribution network to reduce the internal losses and also at the Intel power source to reduce the currents on the national network and hence the losses.

Combined Heat and Power

For those industries which use steam for some of their processes, steam is generated at higher temperature and pressure and used to drive steam turbines. Either the exhaust steam or the bled steam is used for the industrial processes of the factory.

Feeding the National Grid

In large industrial concerns where the generating station is large enough to be connected to the national grid, excess electric energy is exported to the national grid and hence improving the efficiency of the industrial concern.

3.7.3 ENERGY SAVING ILLUMINATION LAMPS

The development of fluorescent lamps and the sodium lamp and the halogen lamps has introduced technologies for providing the same light intensity with lower electric energy consumption than incandescent lamps. These new lamps are gradually introduced for lighting in shops, factories, offices, and streets. Some of the electricity distribution companies in Egypt are providing these lamps for their residential and commercial customers with their costs paid in instalments.

Building Codes

Egypt has set building codes standards to be implemented in new buildings for the reduction of electricity consumption both for winter heating and summer cooling.

3.7.4 ENERGY EFFICIENCY IN TRANSPORTATION

(a) Railways

During the past half century, the Railway Authority has been changing the driving power of locomotives from steam engines to combustion turbines. The efficiency of combustion turbines is known to be better than that of the steam engine.

(b) City Public Transport

City tramways and city trolley busses has been replaced gradually by underground metro. Energy losses in the frequent starts and stops to cope with the city traffic has been stopped, as the underground metro has a free way between the stations.

(c) Bottled Natural Gas

Egypt started the use of bottled natural gas to replace liquid gasoline for busses, taxies and private automobiles. The purpose is to improve the efficiency and at the same time reduce the emission of pollutants. Filling stations are now available in Cairo, Alexandria and Other large cities.

3.7.5 ENERGY EFFICIENCY IMPROVEMENT AND GREENHOUSE GAS REDUCTION PROJECT (EEIGGR)

Project Objectives

The Energy Efficiency Improvement and Greenhouse Gas Reduction Project (EEIGGR) started in February 1999 as a joint effort between GEF (Global Environment Facility), UNDP (United Nations Development Program), EEHC and OEP.

The overall objective of this project is to meet suppressed and still growing power and energy demands through reliable, efficient and rational consumption patterns, thereby reducing greenhouse gas emissions, protecting the local environment while at the same time providing a sustainable alternative to capacity expansion as the sole method of meeting demand.

The project is expected to contribute to this objective by removing barriers to energy efficiency and conservation measures through the initiation of energy audit activities, promoting energy services, encouraging sound energy policy, encouraging maximum private sector participation and lastly by making key information readily available to all players in the Egyptian energy sector.

The duration of the project is four and a half years and the budget is US$ 5.9 million, plus in-kind contributions. The funds come from the Global Environment Facility (GEF), the Government of Egypt and the United Nations Development Program (UNDP). UNDP is the implementing agency for the project, the Egyptian Electricity Holding company and the Ministry of Electricity and Energy are the implementing agencies and the United Nations Department for Economic and Social Affairs is the cooperating agency.

Project Components

There are three components to the project: (1) Loss Reduction, Load Shifting and Load management ; (2) Energy Efficiency Market Support and (3) Cogeneration. The immediate objectives of each component are given below. The responsible party for each objective is indicated.

Component 1: Loss Reduction, Load Shifting and Load Management

Component 2: Energy Efficiency Market Support

Component 3: Co generated Power Group in EEHC

3.8 CROSSCUTTING ISSUES (POPULATION, GENDER, POVERTY, GOVERNANCE, ETC)

Table 3.8-1 presents the contribution of the energy sector in the total employment in Egypt for the years 1999/2000 up to 2003/2004. The Table shows that the total share of employment in the energy sector had raised from 1.2% in 1999/2000 to 1.4% in 2003/2004. The share of the electricity sector in almost constant during that period (0.8%). However, the actual increase was in

the petroleum sector (from 0.5% to 0.6%). This growing share in the petroleum sector depicts the growing activities of this sector.

Table 3.3-1, presented before, shows the development of the actual growth rate of the local aggregate and segmented output during 1981/1982 – 2001/2002. The table shows that the actual average of annual growth rate is around the range of 5%.

Year	Total employees	Contribution of energy sector			Share		
		Petroleum	Electricity	Total	Petroleum (%)	Electricity (%)	Total (%)
1999/2000	17 419	82	130	212	0.47	0.75	1.22
2000/2001	17 984	86	134	220	0.48	0.75	1.22
2002/2003	18 179	112	139	251	0.62	0.74	1.38
2003/2004	18 659	116	140	256	0.62	0.75	1.37

Table 3.8-1 - Contribution of Energy Sector in Total Employment.

The balance of trade is shown in **Table 3.8-2** for the years 1990, 1995, 2000 and 2003 respectively. The imports had increased by about 53%, while the exports had increased by about 42%.

Year	Imports (Cif) BUS$	Exports (Fob) BUS$
1990	12.182	5.417
1995	15.813	6.076
2002	16.809	6.763
2003	18.627	7.696

Table 3.8-2 - Balance of Trade.

The Appendix 5 presents some additional information which may be of interest, namely: durable goods, dwelling units investments, population and finally the distribution of labor force.

4. ASSESSMENT OF THE EXISTING GENERATION MIX

The purpose of this task is to establish the power generation capacity of the existing power generation facilities.

4.1 OVERVIEW OF THE EXISTING GENERATION MIX

Egyptian electric system is well connected. Only 0,2% of the total generation comes from power stations which are not connected to the unified system. In this context, isolated systems can be neglected.

The generation mix is composed of thermal, hydraulic, and wind power stations. Each station is described in the next paragraph with data collected from EEHC, NREA, NECC, and Ministry of Irrigation, with collaboration of EPS.

The total installed capacity in 2006 is presented in **Table 4.1-1** for each Generation Company. This capacity of 20 508 MW will change to 22 213 MW in 2007 (see next paragraph). The main characteristic of the Egyptian generation mix is the strong participation of thermal power plants that represent 85% of the total installed capacity.

Installed Capacity (MW)	ST	CCGT	OCGT	WIND	HYDRO	Total
Cairo	2270	1485	600			4355
West Delta	3330	1224	837			5391
East Delta	3991	1409	453	225		6078
Upper Egypt	1944					1944
Hydro					2740	2740
Total	11535	4118	1890	225	2740	20508
Installed Capacity (%)	56%	20%	9%	1%	13%	

Table 4.1-1- Installed capacity (2006) by type for each Generation Company in Egypt. Source: EEHC.

Thermal plants are often dual fuel (NG/HFO or NG/DO) but most of the time they burns NG, switching to other fuel in the case of NG supply problems. **Figure 4.1-1** shows an evolution of the annual generation from 1996/1997 to 2004/2005 with a progressive participation of Wind power (523 GWh in 2004), IPP (69 GWh in 2004) and BOOT (13 200 GWh in 2004). Total generation has risen from 58 TWh (1996/1997) to 108 TWh (2005/2006), with a growth rate of 7% in the last ten years.

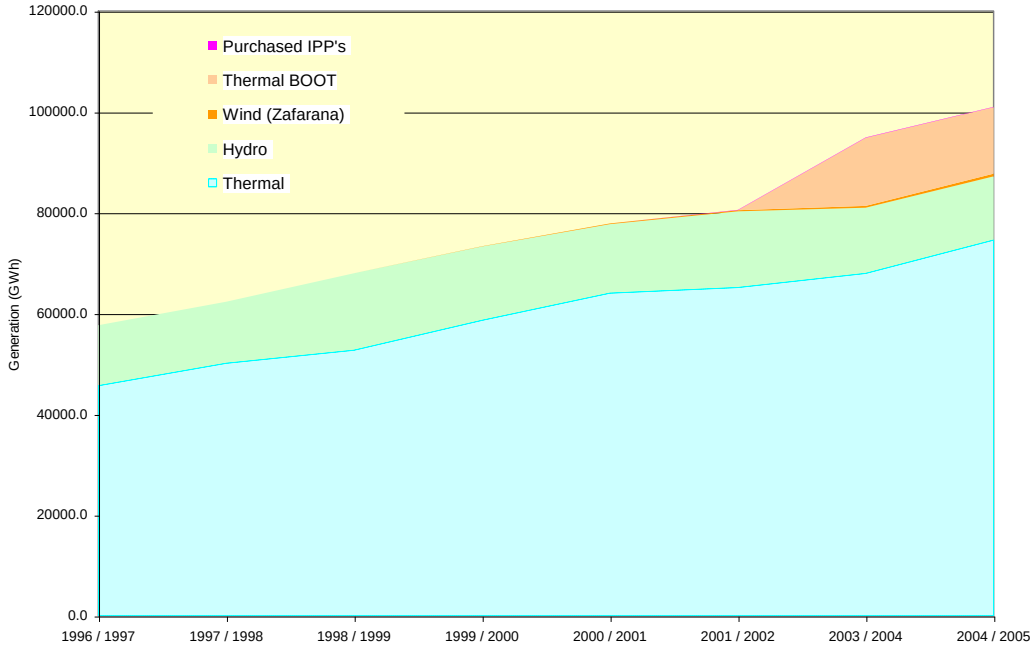


Figure 4.1-1 - Annual energy generation in Egypt power system.

4.2 EXISTING AND COMMITED THERMAL PLANTS

In Egyptian electrical system, there are 4 thermal generation companies geographically distributed. TPP capacities are in majority Steam Turbine, following by CCGT, and OCGT. Technical characteristics of these 33 power stations (including wind Zafarana) are described in the next paragraph.

The installed capacity will reach at the end of the fiscal year 2007/2008 a total of 22 213 MW (**Table 4.2-1**) with the commissioning of new power plants.

Two thermal plants are committed to 2007/2008 :

- ✓ Talkha CCGT (NG/HFO) in East Delta: 750 MW
- ✓ Kurimat (2) CCGT (NG/HFO) in Upper Egypt: 750 MW

Two wind farms (Zafarana / Gabal El-Zait) are committed:

- ✓ to 2006/2007: 55 MW
- ✓ to 2007/2008: 150 MW

The participation of thermal plants in total power capacity keeps on increasing (86%). Installed capacity is composed essentially of Steam Turbines but investments in CCGT plants have risen continually, going from 20% of the total installed capacity in 2006 to 25% in 2007/2008. With the increase in the Egyptian identified reserves of Natural Gas, a special policy has been adopted for the replacement of liquid fuel (HFO & LFO) with NG due to its distinguished advantages in economical and environmental aspects. Accordingly, most of TPP are equipped with dual burner. Usage of NG in power plants connected to the gas grid reached 81.2% in 2004/2005 representing 76.4% of total fuel consumption in the power system.

Installed Capacity (MW)	ST	CCGT	OCGT	WIND	HYDRO	Total
Cairo	2270	1485	600			4355
West Delta	3330	1224	837			5391
East Delta	3991	2159	453	430		7033
Upper Egypt	1944	750				2694
Hydro					2740	2740
Total	11535	5618	1890	430	2740	22213
Installed Capacity (%)	52%	25%	9%	2%	12%	

Table 4.2-1- Installed capacity (2007/2008) by type for each Generation Company in Egypt. Source: EEHC

4.2.1 TECHNICAL CHARACTERISTICS

Appendix 6 synthesizes the technical characteristics of the existing thermal plants and committed thermal plants (EEHC, 2006). These characteristics will be used to model the generation power system in Module 6.

4.3 EXISTING AND COMMITED HYDRO GENERATION PLANTS

In the Egyptian hydro system, irrigation is the priority, the power production is only a by-product. The Water Resources and Irrigation Ministry defines the daily discharges in power plants and send this information to NECC every week. High Dam generation is used as peak shaving station and Aswan Dam, and the others run of the river plants, as base. Inflow, outflow, and irrigation flows data are presented in Appendix M2 Vol 2, item 8.

4.3.1 HYDRO SCHEMES

Hydro plants in Egypt are distributed along the Nile (**Figure 4.3-1**), with High Dam upstream using Nasser lake reservoir water, followed by Aswan I and Aswan II, both with a small intermediate reservoir. Then, downstream, two run of the river power stations complete the whole hydro system: Esna and Naga Hammadi (with a small power station that will be replaced by a new one committed to 2007/2008).

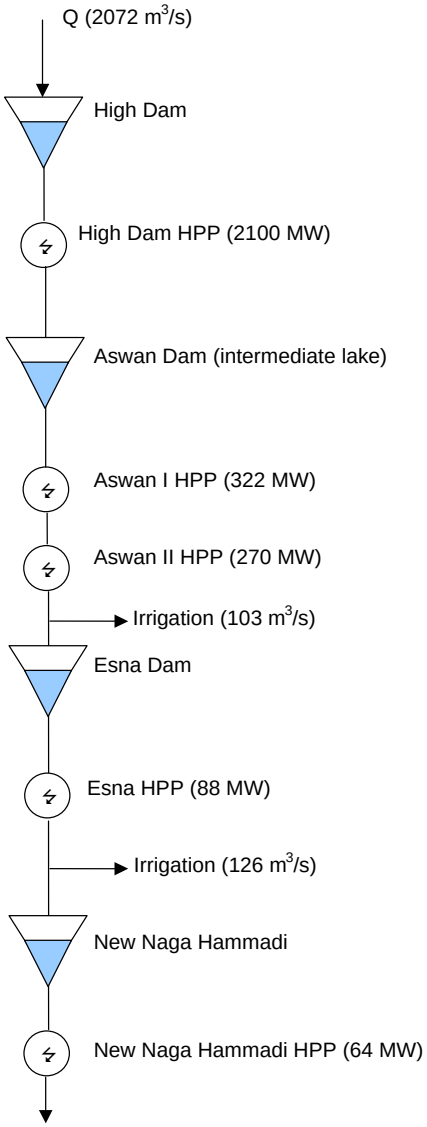


Figure 4.3-1 - Hydro scheme for the existing HPP in Egypt

4.3.2 PRESENTATION OF EACH MAJOR HPP

The High Dam power plant consists of 12 Francis turbines, each with a capacity of 175 MW, produces a total annual energy of about 11 500 GWh. The plant began operation in 1967 and is linked to the Unified Power System by two 500 KV transmission lines.

Execution Period	: 1960 – 1967
Head	: 67 m
Discharge	: 280 m^3/s/Unit
Installed Capacity	: 12 X 175 = 2 100 MW (10 units in operation, while 2 in maintenance)
Annual Energy	: 11 500 GWh
Cost	: about 400 ML.E at that time
Rehabilitation	: 2 units in turn from 09/2004 to 09/2011
Lake Nasser	: dead storage 31.10^3 hm^3 (147 m) ; active storage 90.10^3 hm^3 (175 m) ; flood storage 41.10^3 hm^3 (182 m)

The Aswan I hydro electric power station was completed in 1960. The hydropower consists of nine units (Kaplan turbines) and is linked to the Unified Power System by two 132 KV transmission lines.

Execution Period	: 1955 – 1960
Head	: 22 m
Discharge	: 174 m^3/s/Unit
Installed Capacity	: 7X46 = 322 MW
Annual Energy	: 1 537 GWh
Cost	: about 30 ML.E at that time.

The Aswan II hydroelectric power plant was constructed in 1980-1985 and situated directly downstream of Aswan Dam. The power plant consists of four turbines of Kaplan type, each with an output of 67.5 MW produced an annual average energy of 1 800 GWh.

Execution Period	: 1980 – 1985
Head	: 20 m
Discharge	: 360 m^3/s/Unit
Installed Capacity	: 4 X 67.5 = 270 MW
Annual Energy	: 1 800 GWh
Cost	: about 450 ML.E at that time.

The Esna hydroelectric power plant is equipped with six Kaplan Bulb turbines with rated capacity of 14.8 MW each. This power plant is linked to the Unified Power System through 132 KV double - circuit overhead lines.

Execution Period	: 1989 – 1995
Head	: 5.7 m
Discharge	: 275 m^3/s/Unit
Installed Capacity	: 6 X 14.8 = 88 MW
Annual Energy	: 634 GWh
Cost	: about 650 ML.E at that time.

The Naga-Hammadi is a small hydro electric power plant of 2.7 MW ; it was built (1926) on a diversion of Naga-Hammadi barrage in Upper Egypt. It'll be replaced by New Naga-Hammadi, planned to operate in 2008.

Head : 5.6 m
Discharge : 320 m^3/s/Unit
Installed Capacity : 4 X 16 = 64 MW
Annual Energy : 460 GWh
Cost : about 400 ML.E at that time.

4.3.3 OTHER SMALL HYDRO GENERATION

Two small hydro plants are settled near Cairo.

The El-Azab mini-hydro power plant in EL-Fayom, south-west of Cairo, was the first utilization of hydropower in Egypt. This first hydropower plant was started in operation in 1926.

Re habitation Period : 1988 – 1991
Head : 5.8 m
Discharge : 7.5 m^3/s/Unit
Installed Capacity : 2 X 340 = 680 kW
Annual Energy : 4.75 G.W.h
Cost : about 6 ML.E at that time.

The El-Lahoun mini-hydro power plant near El-Azab plant.

Execution Period : 1997 – 2003
Head : 2 m
Discharge : 27.5 m^3/s/Unit
Installed Capacity : 2 X 400 = 800 kW
Annual Energy : 6 G.W.h
Cost : about 30 ML.E at that time.

4.3.4 TECHNICAL CHARACTERISTICS

These technical characteristics (Appendix 7) will be used to model the generation power system and also the water balance along the three countries. Missing technical data will be estimated from literature values or according consultant expertise.

4.3.5 DESCRIPTION OF INFLOWS AND REFERENCE HYDROLOGICAL PERIOD

Data concerning this topic was collected from Water Resources and Irrigation Ministry and EPS.

The hydrological cycle of High Dam is quite marked with lower inflow values from December to June (mean Qin around 700 m^3/s) and higher inflow values from July to November (mean Qin around 4 000 m^3/s). The dispersion of inflow data is stronger during the flood period, varying from around 3 000 to 9 000 m^3/s (**Figure 4.3-2**).

From the period between 1998 and 2002 the natural flow of the river was higher than the average. Since the life storage of the dam was fully completed, outflows from the spillway were observed in order to secure the dam safety.

The distance between High Dam and Aswan Dam is short, only 7 km, and there is no output from the intermediate lake between these two HPP. Thus, it is considered that inflow data to Aswan I and Aswan II HPP is the same of the outflow from High Dam.

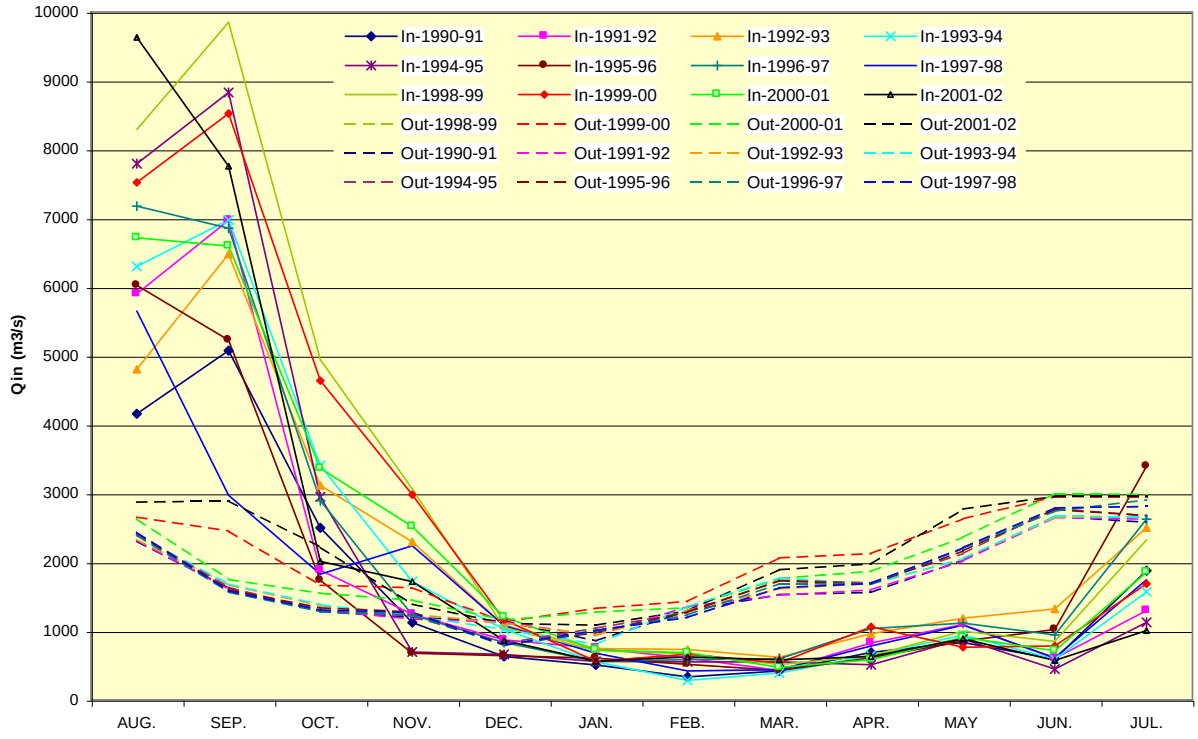


Figure 4.3-2 – Natural inflow and outflow series to High Dam from 1990 to 2002. Source: Water Resources and Irrigation Ministry, 2006.

Inflow data to Esna and Naga Hammadi HPP[2] is showed in **Figure 4.3-3**. It seems coherent with outflow from the cascade High Dam/Aswan HPP ; irrigation outflow is already taken into account. Losses, such as evaporation and infiltration, are also considered.

[2] Multipurpose Development of the Eastern Nile, One–System inventory report on water resource related Data and information – EGYPT. Fahmy, A. 2006.

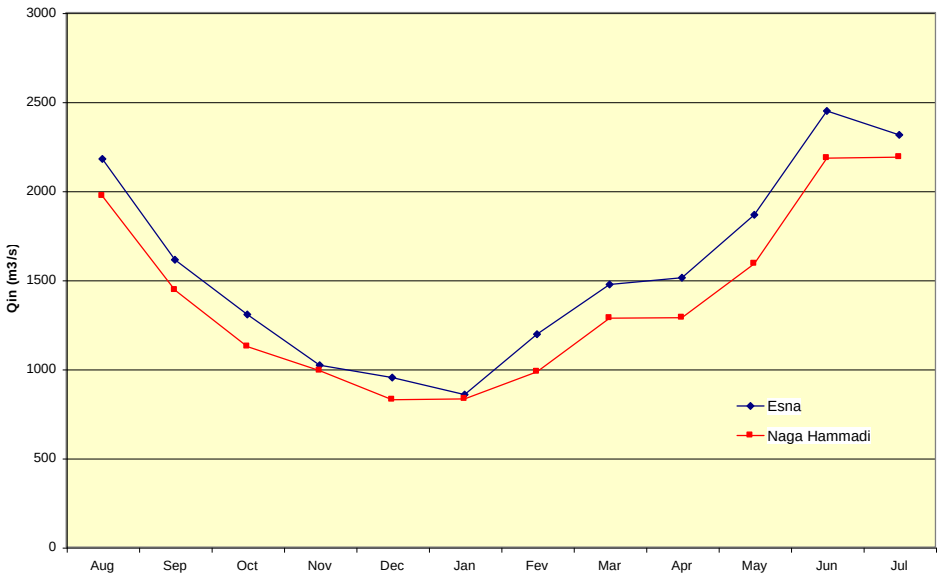


Figure 4.3-3 – Mean inflow to Esna and Naga Hammadi HPP from 1980 to 2000. Source[2]: Fahmy, A. 2006.

4.4 RENEWAL ENERGY

Two successive stages of wind farms at Zafarana (**Figure 4.4-1**) have been built with estimated energy production of 570 TWh/year (load factor 42.6%, NREA). A small farm at Hurghada (Red Sea Cost) is in operation with 9 GWh generation in 2003/2004 and around 10 GWh in 2004/2005 (load factor 20.4%, NREA). Technical characteristics of Zafarana wind farm is presented in Appendix 6.

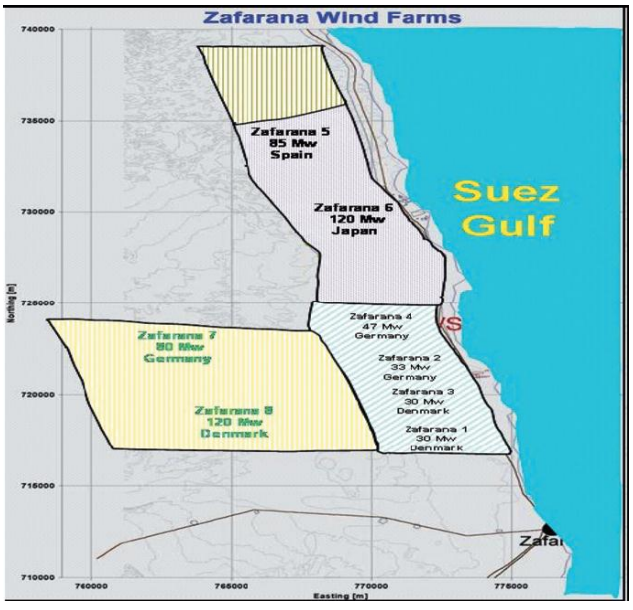


Figure 4.4-1 - Zafarana site location. Source NREA, 2004/2005.

In spite of a high dispersion in monthly wind patterns, two seasons of high (March-October) and low (November-February) wind speed can be identified. The former season has an mean generation of 52.9 GWh and the last season has an mean generation of 22.3 GWh. **Figure 4.4-2** shows generation for typical months of each period.

In a daily basis, Zafarana generation shows also two different patterns: high wind and low wind hours (**Figure 4.4-3**).

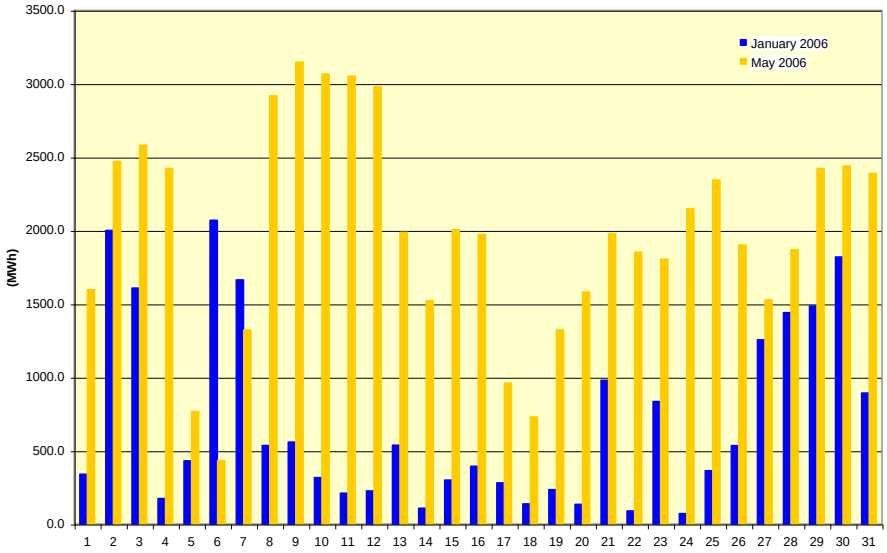


Figure 4.4-2 – Zafarana daily generation for typical months of high wind season and low wind season. Source: NREA, 2004/2.

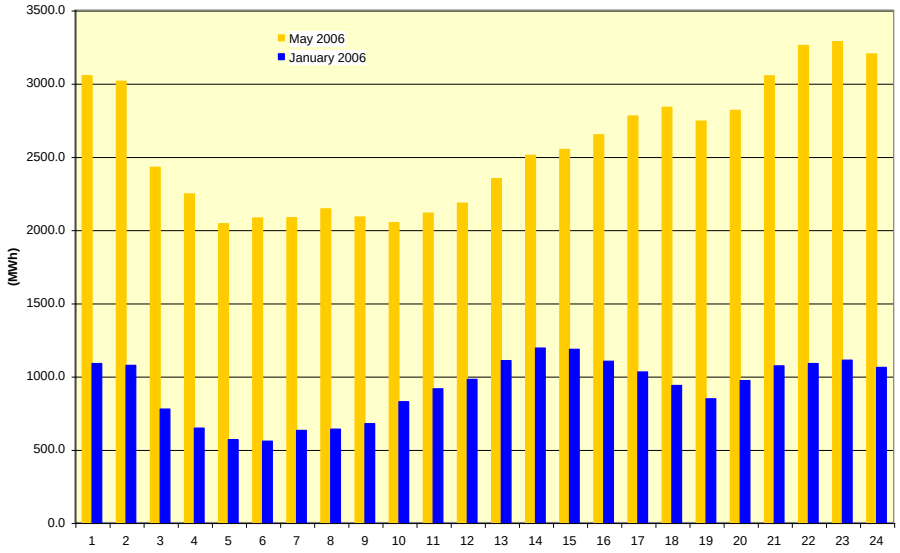


Figure 4.4-3 - Zafarana hourly generation for typical months of high wind season and low wind season. Source: NREA, 2004/2.

5. ASSESSMENT OF THE EXISTING TRANSMISSION NETWORK

See PSS/E file PSSE_2006-2007.txt

See the Appendix 8 – Egyptian grid

This task reviews the existing transmission network in the three countries, focussing on the possible constraints created by the integration of the three power systems.

Existing Transmission System (see Appendix M2_V2_B3 – Market and power trade assessment, Egyptian grid)

The existing transmission system consists of 18 682 km of UHV transmission lines (excluding the 33 and 66 kV networks):

Voltage (kV)	Length (km)
500	2 262
400	33
220	13 920
132	2467
66	16 248
33	2 725

Table 4.4-1 - Existing transmission system

The 500 kV double circuit backbone extends from Aswan (High Dam – 2 100 MW, 800 km south of Cairo) to Cairo along the Nile river, and after a single ring around Cairo, extends east to Taba, north of the Aqaba Gulf, to the 400 kV interconnection with Jordan, and via Jordan, to Syria and Lebanon. The main units (Kureimat steam units - 630 MW) are connected on the 500 kV backbone, 100 km south of Cairo.

There are a total of 146 UHV and VHV substations in the system, of which 13 are at 500 kV level, 128 include 220 kV level and 25 include 132 kV level.

Egypt is interconnected with Libya (double 220 kV circuit) and Jordan (single 400 kV circuit with a submarine cable) since 1998, and via Jordan, to Syria since 2000 and Lebanon in single 400 kV circuit. There is power trade between Egypt and Jordan, Egypt exports about 100 MW to Jordan and Syria all along the year.

The National Control Centre (NECC) operates the 500 and 220 kV system, and several regional control centres are in charge of the 132 and 66 kV networks.

Cairo and delta region are facing low voltage at peak time, and are therefore equipped with 8 switchable 100 Mvar capacitors in 220 kV:

- 6 around Cairo: 4 in Cairo East, and 2 in Cairo 220 substations
- 2 in Mansura substation

The 220 kV antenna toward the interconnection with Libya is equipped with two 25 Mvar switchable reactors in Marsa Matruh and 2 in Saloum (on the border side), and 2 in Tobrouk (Lybian side).

The 500 kV network along the Nile river, is compensated by self:

- 1 self on each line High Dam – Naga Hammadi, on High Dam side
- 1 switchable self on Naga Hammadi bus bar
- 3 switchable selves on Samalut bus bar

The network is ruled by a national control centre (for the 500 and 220 kV network) and regional ones (for the 132 and 66 kV networks).

Committed Transmission Installations

An extension of the 500 kV network is currently under construction from Cairo 500 to Sidi Krir in West Delta. It is also the first milestone to the reinforcement of the interconnection with Libya in 500/400 kV.

The extension to the Libyan border is expected by 2015, with substations in Dabba and Saloum.

6. ASSESSMENT OF EXISTING POWER TRADE

Electric interconnection has proved its technical and economic effectiveness, as it permits exchange of electric power among their networks, and strengthen the stability of the connected networks. The following interconnections concerning Egypt have been fulfilled:

- ✓ Egypt – Libya Implemented on 28/5/1998, on 220 kV
- ✓ Egypt – Jordan Implemented on 21/10/1998, 400 kV
- ✓ Syria – Jordan Implemented on 8/3/2000, 400 kV

These interconnections are used for emergency situations as well as power trade. For the Egypt-Jordan interconnection, the power trade balance reveals a net export to Jordan in the range of 800 GWh/year, which represents less than 1% of total Egyptian electrical generation, but 20% of Jordanian generation.

Exports and imports measured from 2003 to 2005 are presented in **Table 4.4-1**. Annually, they are quite balanced from/to Lybia.

	Interconnection	Egypt – Libya 220 kV	Egypt – Jordan 400 kV
2002/2003	**Exports (GWh)**	94.812	864.3
	Imports (GWh)	140.272	39.136
	Balance (GWh)	-45.46	825.164
2003/2004	**Exports (GWh)**	212.761	826.312
	Imports (GWh)	68.51	52.703
	Balance (GWh)	144.251	773.609
2004/2005	**Exports (GWh)**	122.693	749.928
	Imports (GWh)	103.746	70.402
	Balance (GWh)	18.947	679.526

Table 4.4-1 – Energy exported and imported on Egyptian interconnections during 3 years. Source EEHC.

A General Interconnection Agreement was signed between the five Electrical Power Utilities of Egypt, Iraq, Jordan, Syria and Turkey in order to regulate electrical exchanges in interconnections.

Moreover, a specific agreement was signed between the Electrical Power Systems of Egypt and Jordan. An Operating Committee implements these agreements.

In these agreements, a bill for any service is provided during the month and has to be paid 15 days after issuance of the bill. Services concerning energy and power exchanges, reserves, reactive power flows, daily capacity, hourly capacity, conservation energy, diversity capacity and energy, etc. are specified in the agreements. Price of services are determined according to each system cost, incremental/decremental costs, or some specified prices such as:

- ✓ US$ 160/MW/day for daily capacity ;
- ✓ US$ 960/MW/week for short term capacity ;
- ✓ US$ 7/MW/hour for hourly capacity ;
- ✓ US$ 3/MWh for transmission wheeling (in addition to losses compensation).

The possible future evolution of power trades between Egypt and the neighbouring countries is discussed in Module 3 Vol2.

ENTRO

EDF – Generation and Engineering Division
73 373
Le Bourget du Lac Cedex
France
Tel: +33-4-79 60 60 28
Fax: +33-4-79 60 62 35
eMail: pierre.brun@edf.fr
http://www.edf.fr

Scott Wilson
Kanthack House, Station Road,
Ashford, Kent TN 23 1 PP
England
Tel: +44 (0) 1233 658200
Fax: +44 (0) 1233 658209
eMail: alan.bates@scottwilson.com
http://www.scottwilson.com

with participation of:

EPS (Egypt)
Tropics (Ethiopia)
YAM (Sudan)

EASTERN NILE POWER TRADE PROGRAM STUDY

AfDB

MARKET AND POWER TRADE ASSESSMENT

VOL 2 - EGYPT

FINAL APPENDIX

30 APRIL 2007

LIST OF APPENDICES

1. PETROLEUM PRODUCTION AND REVENUES IN OAPEC

1.1. Petroleum Production (kOil bl/day) in the Members Countries in OAPEC

Countries	**2000**	**2001***	**2002***	**2003***	**2004***
Emirates	315	295	302	298	295
Bahrain	30	28	25	23	22
Tunisia	90	89	88	87	85
Algeria	235	224	223	220	215
Saudi Arabia **	1 290	1 212	1 194	1 175	1 164
Syria	236	231	231	226	220
Iraq ***	472	450	397	392	388
Qatar	42	41	41	23	23
Kuwait **	215	199	185	175	188
Libya	180	170	166	163	160
Egypt	495	481	469	480	496
Total	**3 600**	**3 420**	**3 321**	**3 262**	**3 256**

* Estimated Data
** The Saudi Arabia and Kuwait data includes the oil sector consumption and the crude oil consumption used in generating electricity
*** The Iraq data includes the crude oil consumption used in generating electricity
Source: Organization of Arab Petrol Exported Countries – OAPEC.

1.2. Petroleum Revenues (MUS$) in the Members Countries in OAPEC

Countries	**2000**	**2001**	**2002**	**2003**	**2004***
Emirates	25 264	18 607	17 300	22 414	26 148
Bahrain	3112	2 677	1 806	2 054	2 589
Tunisia	**	**	**	**	**
Algeria	13 862	12 300	12 370	11 736	14 204
Saudi Arabia	97 654	74 835	63 814	59 788	70 866
Syria	2 987	2 704	2 484	2 163	2 743
Iraq	19 598	8 627	10 400	15 685	19 771
Qatar	9 726	7 500	6 885	6 964	7 834
Kuwait	24 741	19 002	14 057	14 976	18 183
Libya	18 262	12 780	10 482	10 875	12 230
Egypt	2 844	2 373	2 015	1 917	2588
Total	**218 050**	**161 405**	**141 613**	**148 572**	**177 156**

* Estimated Data
** The data points out that the consumption volume exceeds the production volume of the crude oil
Source: Organization of Arab Petrol Exported Countries – OAPEC.

2. SECTOR CONSUMPTION OF PETROLEUM ENERGY

Sector consumption of petroleum products during 1999 to 2004

Sector (MTOE)		1999/2000	2000/2001	Growth Rate (%)	Share of Total Consumption (2000/2001) (%)	Share of Total Energy Use (2000/2001) (%)	2002/2003	2003/2004	Growth Rate (%)	Share of Total Consumption (2003/2004) (%)	Share of Total Energy use (2003/2004) (%)
Industry	Energy	5.800	5.884	1.43	24.78	26.47	6.660	6.397	(3.95)	26.40	28.31
	Non Energy	1.243	1.197	(3.75)	5.04		1.136	1.322	16.34	5.46	
	Total	7.044	7.080	0.52	29.81		7.796	7.719	(0.99)	31.86	
Transport	Energy	9.391	9.634	2.59	40.75	43.35	9.667	10.323	6.80	42.61	45.69
	Non Energy	0.262	0.264	0.74	1.11		0.290	0.234	(19.13)	0.97	
	Total	9.654	9.899	2.54	41.68		9.956	10.558	6.04	43.58	
Agriculture	Energy	0.082	0.085	2.59	0.36	0.38	0.074	0.061	(17.79)	0.25	0.27
	Non Energy	0.0428	0.0428	0.00	0.18		0.0476	0.0505	6.12	0.21	
	Total	0.125	0.127	1.70	0.54		0.121	0.111	(8.40)	0.46	
Residential &Commercial	Energy	3.464	3.672	6.02	15.46	16.52	3.851	3.873	0.57	15.99	17.14

Sector consumption of petroleum products (cont.)

Sector (MTOE)		1999/2000	2000/2001	Growth Rate (%)	Share of Total Consumption (2000/2001) (%)	Share of Total Energy Use (2000/2001) (%)	2002/2003	2003/2004	Growth Rate (%)	Share of Total Consumption (2003/2004) (%)	Share of Total Energy use (2003/2004) (%)
Electricity	Energy	3.272	1.971	(39.75)	8.30	8.87	1.768	1.413	(20.04)	5.83	6.25
	Non Energy	0.0126	0.0126	0.00	0.05		0.0146	0.0156	6.67	0.06	
	Total	3.285	1.984	(39.60)	8.35		1.782	1.429	(19.82)	5.90	
Petroleum	Energy	0.796	0.978	22.87	4.12	4.40	0.494	0.529	7.03	2.18	2.34
	Non Energy	0.0068	0.0068	0.00	0.03		0.0078	0.0078	--	0.03	
	Total	0.803	0.985	22.67	4.15		0.502	0.537	6.92	2.22	
Total	**Energy**	**22.806**	**22.224**	**(2.55)**	**93.59**	**100**	**22.513**	**22.596**	**0.37**	**93.27**	**100**
	Non Energy	**1.568**	**1.523**	**(2.85)**	**6.41**		**1.496**	**1.630**	**8.97**	**6.73**	
	Total	**24.374**	**23.748**	**(2.57)**	**100**		**24.008**	**24.226**	**0.91**	**100**	

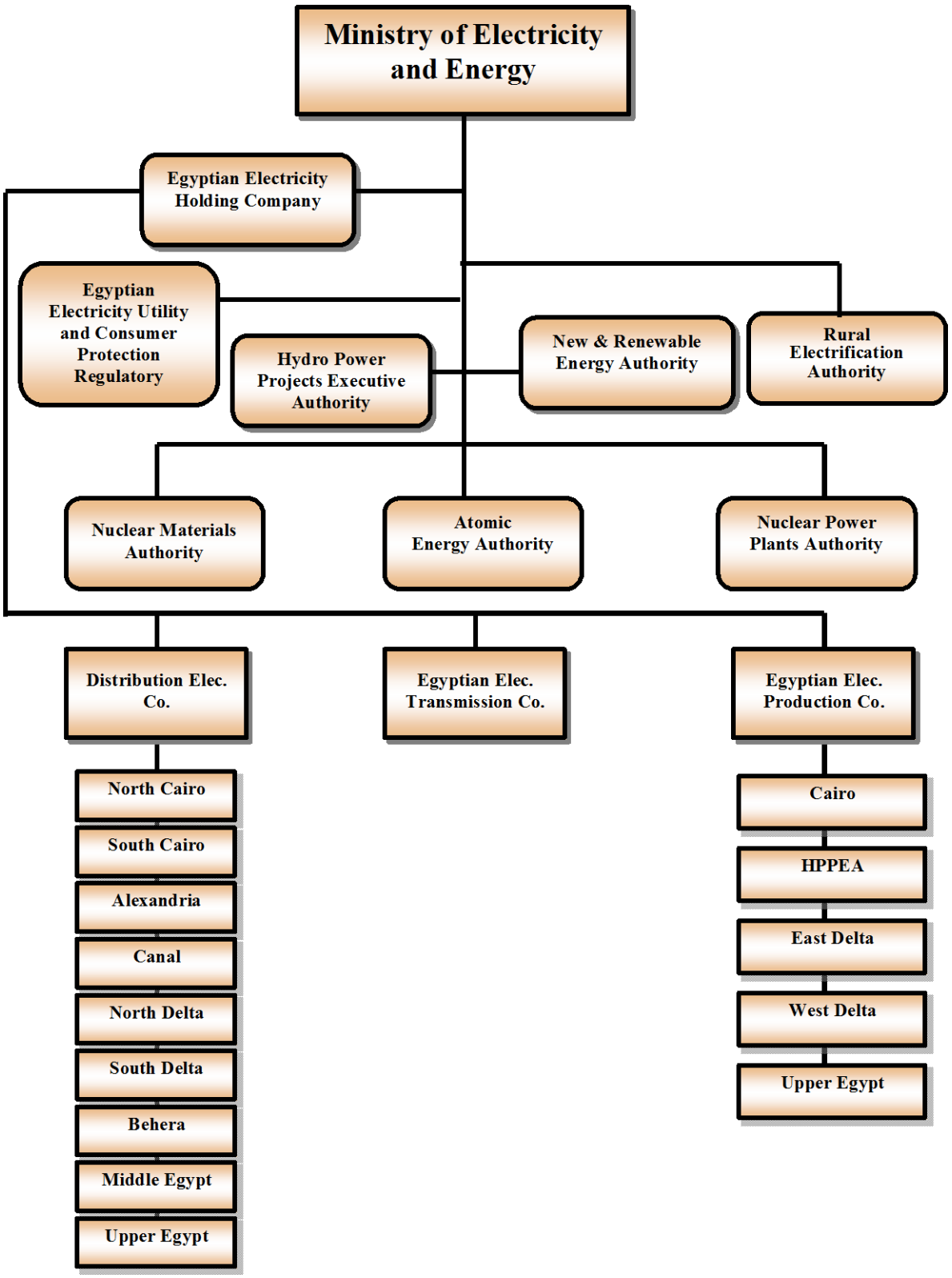
3. PRIMARY ENERGY PRODUCTION AND SUPPLY

Primary Energy Production (Commercial) 2000/2001 (MTOE)	
Crude Oil	32.115
Natural Gas	20.390
Condensate	3.599
LPG	1.355
Total Petroleum Energy	57.459
Hydropower	2.997
Coal	0.039
Total Energy Production	**60.495**
Exports (crude oil)	(7.388)
Exports (coal)	(0.038)
Partner Share [1]	(4.170)
Net Expenses *[2]	(6.081)
Bought from Partner Share [3]	6.286
Imports (coal)	1.219
Partner Share (gases)	(8.750)
Bought from Partner Share (gases)	8.750
Statistical Differences	0.863
Stock Change	0.296
TOTAL ENERGY Supply (Commercial)	**49.226**

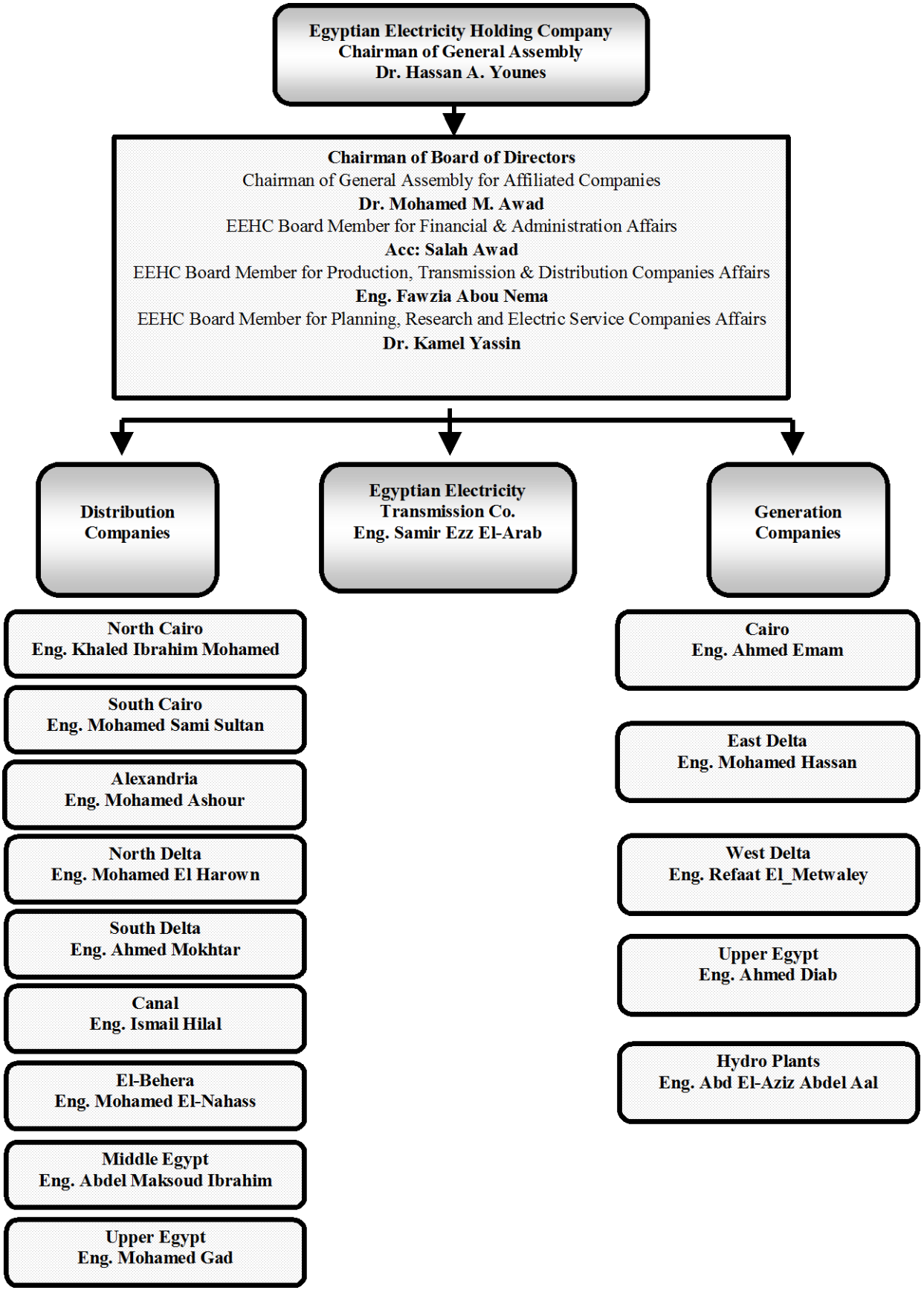
Primary Energy Production (Commercial) 2003/2004 (MTOE)	
Crude Oil & Condensates	34.075
Natural Gas	26.236
LPG	1.234
Total Petroleum Energy	**61.545**
Hydropower	2.863
Coal	0.025
Total Energy Production	**64.433**
Exports (crude oil)	(7.954)
Partner share$ & Net expenses ** (crude oil)	(9.828)
Bought from Partner ± Stock Change & Statistical Differences (crude oil)	9.391
Imports (coal)	1.213
Exports (coal)	(0.025)
Total Energy Supply (Commercial)	**57.23**

4. ORGANIZATION CHARTS

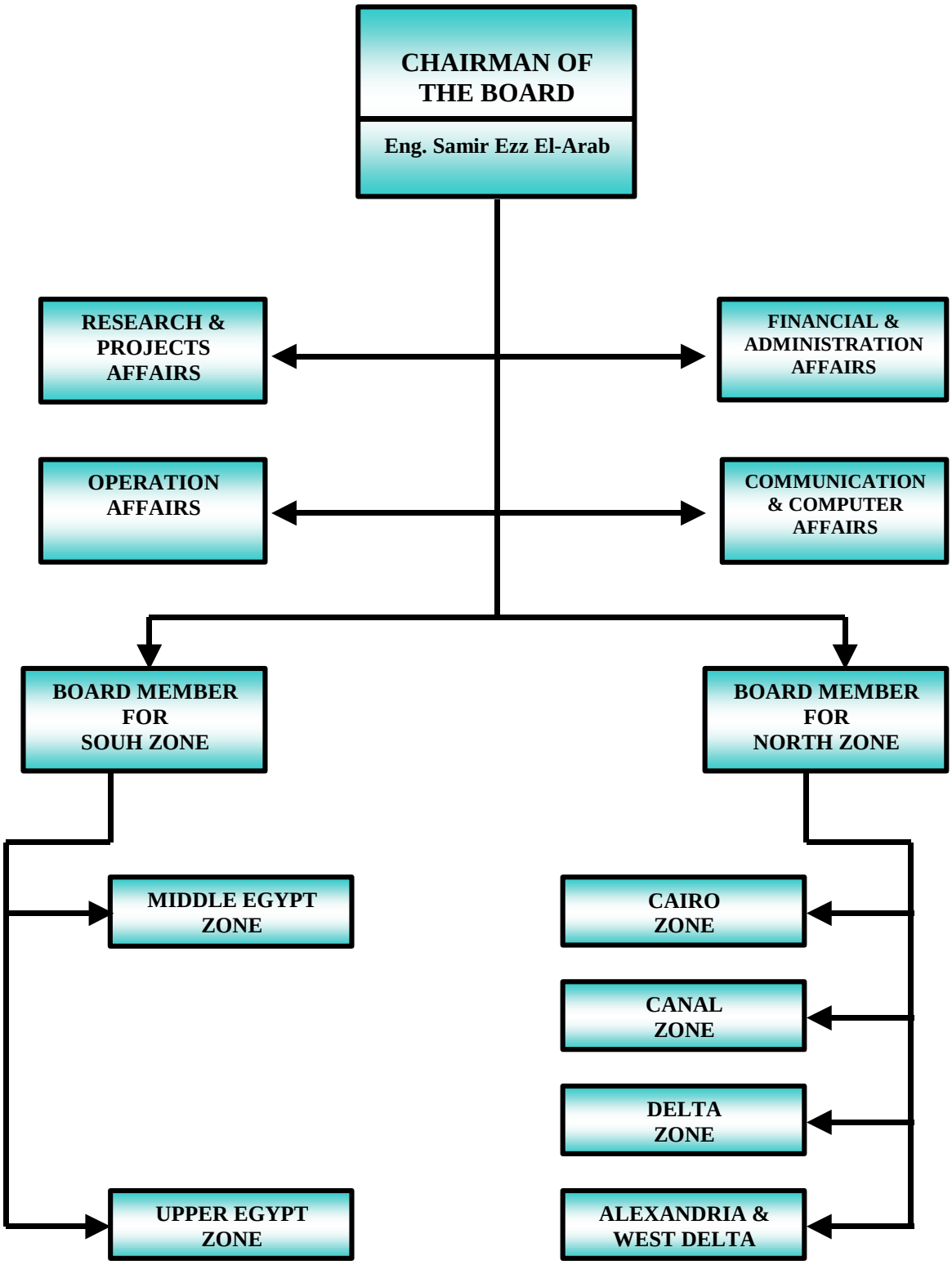
Ministry of Electricity and Energy



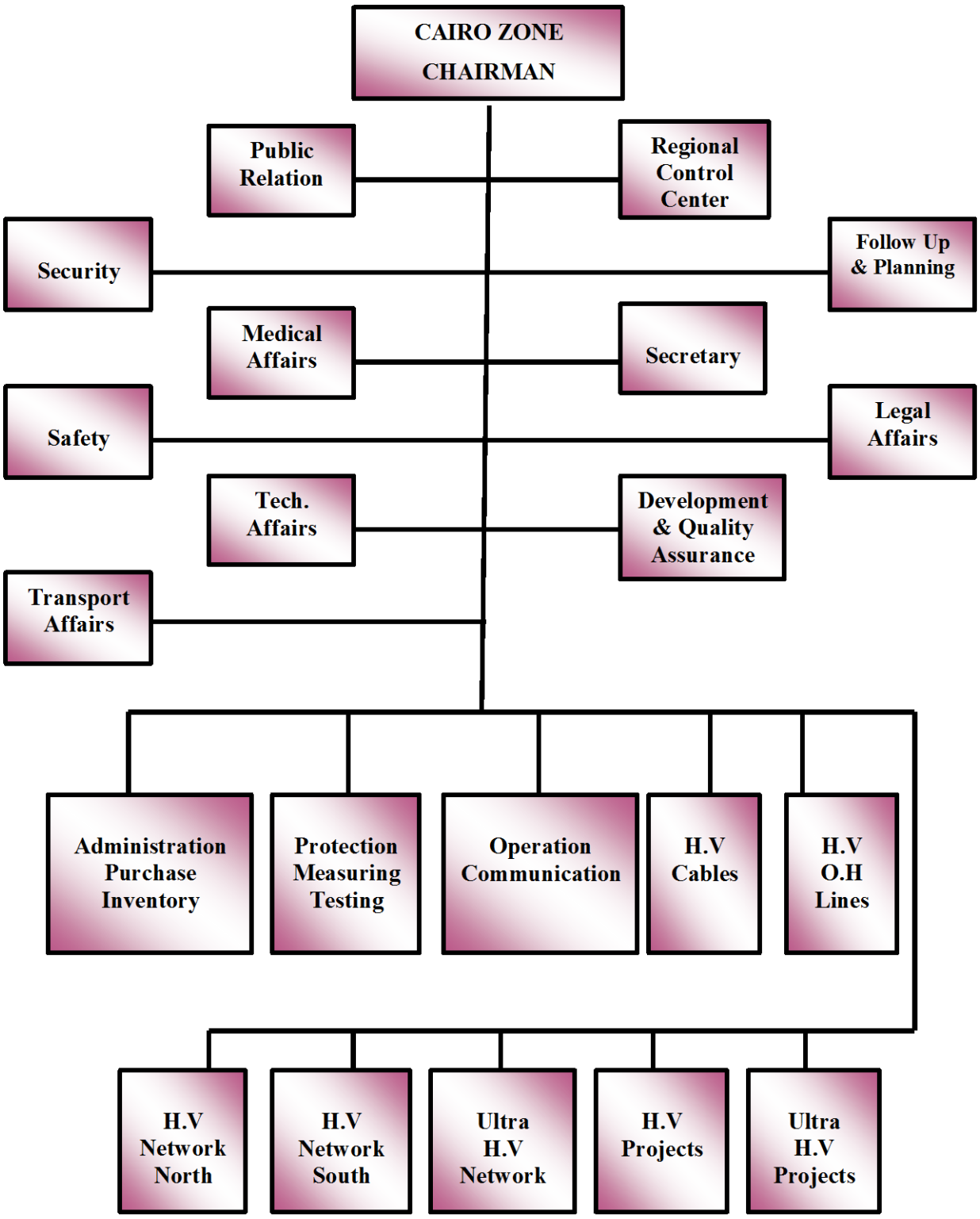
EEHC Organization Chart



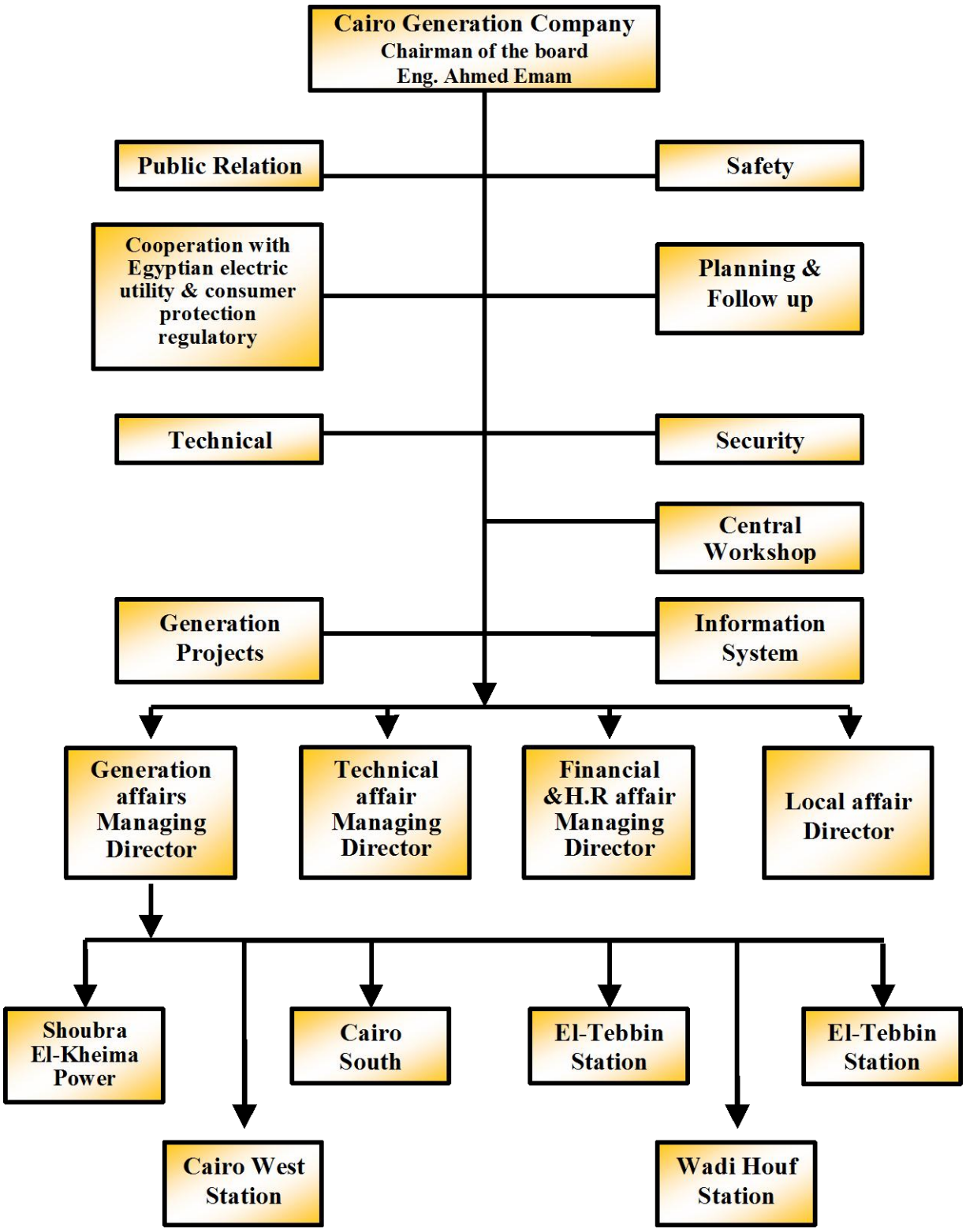
EETC - Egyptian Electricity Transmission Company



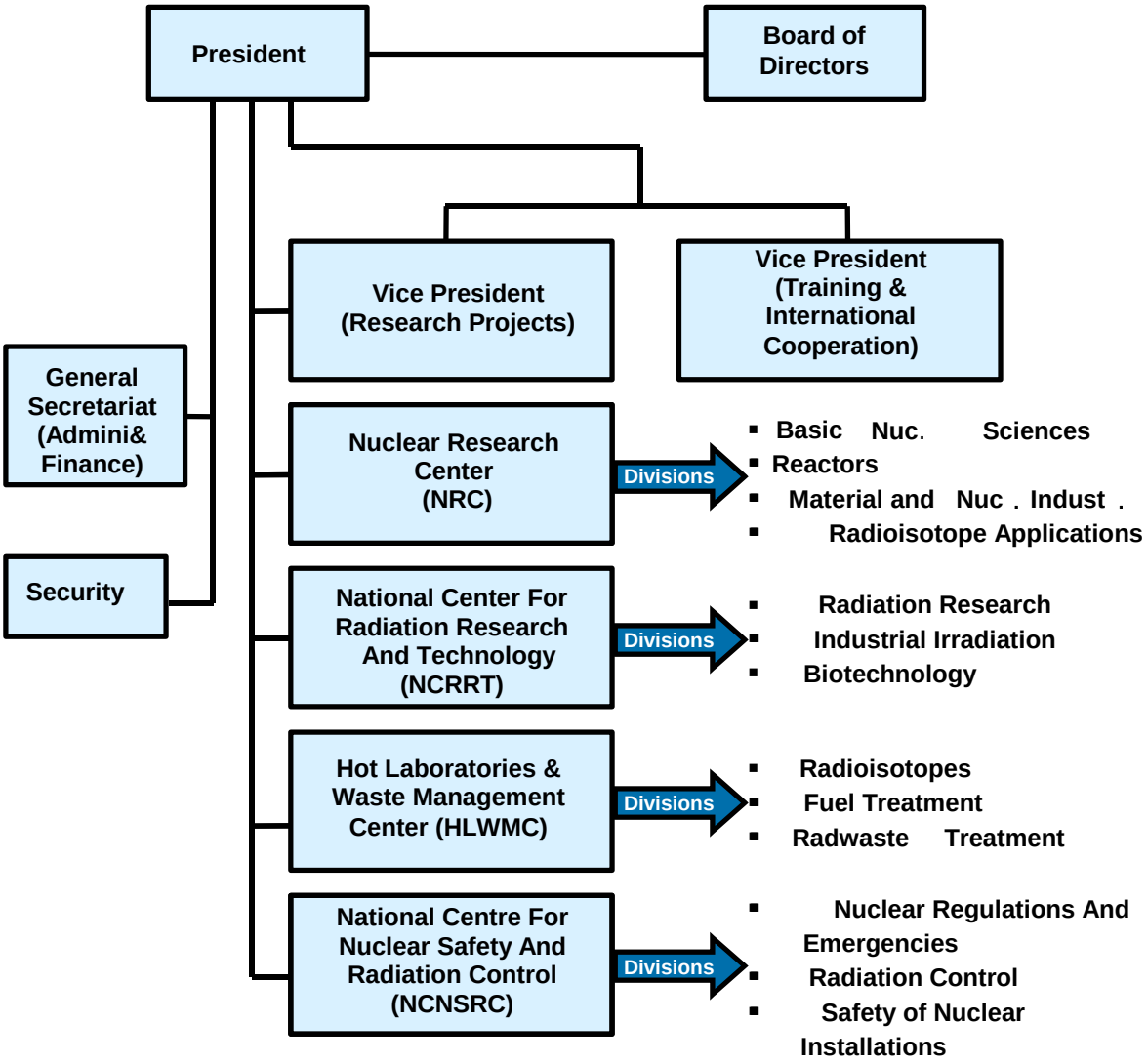
Cairo Zone Company



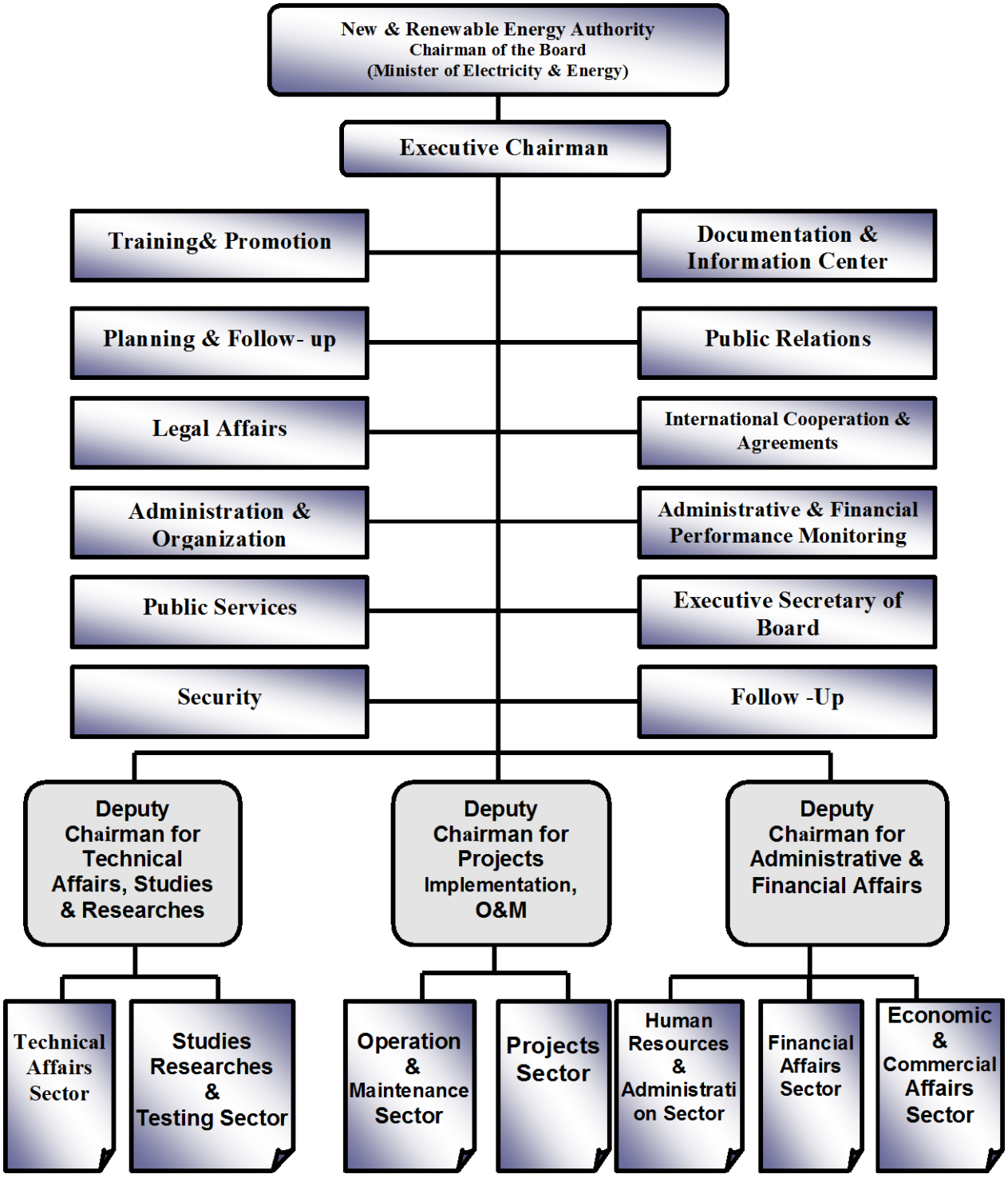
Cairo Generation Company



Egyptian Atomic Energy Authority



New & Renewable Energy Authority



5. CROSSCUTTING ISSUES

Cropping Area, by Season

(kFEDDAN)	*2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Winter Crops *From November to May*	6 482	6 571	6 479	6 286	6 454	6 366	6 324	6 206	5 960	6 379
Summer Crops *From March/April to September & includes Cans and Cotton*	6 193	6 074	6 102	6 016	5 757	5 868	5 799	5 952	6 009	5 722
Nile Crops *From May to October*	637	631	606	590	623	598	675	618	693	699
Total *Excluding Orchards*	**13 312**	**13 276**	**13 187**	**12 892**	**12 834**	**12 832**	**12 798**	**12 776**	**12 662**	**12 800**

Dwelling Units Investment in Urban Areas, By Sector

(kL.E)	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
Public Sector	942 779	1 516 979	1 827 406	2 233 098	2 108 514	1 087 283	797 967	1 284 501	971 932	7 442 828
Private Sector	424 821	371 067	333 460	420 718	596 269	596 269	350 000	3 349 000	3 905 000	637 000 (1)
Total	**1 367 600**	**1 888 046**	**2 160 866**	**2 653 816**	**2 704 783**	**1 683 552**	**4 297 967**	**4 633 501**	**4 876 932**	**742 828**

(1)Private sector is calculated basically on issued licenses since 2 years before date of the report private sector includes what have been executed in new cities. Source: Ministry of Housing, Utilities & Urban societies.

Total area, inhibited area and population by Province in January 2005

Total Area	Inhabited Area	Inhabited Area/Total Area %	Population in January 2005	Pop./Total Area Km^2	Pop./Inhabit. Area Km^2
3 085.00	190.42	6.17	7 764 758	2 516.94	40 777.0
2 300.00	1 675.50	72.85	3 821 208	1 661.39	2 280.6
1 351.14	1 320.68	97.75	537 799	398.03	407.2
9 002.21	9 002.21	100.00	488 507	54.27	54.3
910.00	668.87	73.50	1 077 958	1 184.57	1 611.6
3 716.00	3 471.00	93.41	4 932 188	1 327.28	1 421.0
4 911.00	4 764.28	97.01	5 115 416	1 041.62	1 073.7
1 124.00	1 072.72	95.44	3 875 096	3 447.59	3 612.4
3 748.00	3 748.25	100.01	2 589 604	690.93	690.9
1 947.53	1 942.41	99.74	3 929 011	2 017.43	2 022.7
2 499.00	2 435.93	97.48	3 230 475	1 292.71	1 326.2
9 826.00	6 943.62	70.67	4 693 214	477.63	675.9
5 067.00	5 066.96	100.00	863 293	170.38	170.4
13 184.00	1 191.00	9.03	5 644 228	428.11	4 739.1
10 954.00	1 369.41	12.50	2 255 152	205.87	1 646.8
6 068.00	1 856.00	30.59	2 422 319	399.20	1 305.1
32 279.00	2 411.65	7.47	4 048 887	125.43	1 678.9
25 926.00	1 574.00	6.07	3 422 255	132.00	21 742.0
11 022.00	1 593.92	14.46	3 807 893	345.48	2 389.0
10 798.00	1 740.72	16.12	2 935 214	271.83	1 6862
62 726.00	1 004.77	1.60	1 120 272	17.86	1 115.0
2 410.00	226.73	9.41	421 774	175.01	1 860.2
119 099.00	71.13	0.06	186 363	1.56	2 620.0
440 098.00	1 082.24	0.25	169 675	0.39	156.8
166 563.00	1 716.41	1.03	270 085	1.62	157.4
27 564.00	4 058.65	14.72	309 529	11.23	76.3
31 272.00	16 791.00	53.69	65 145	2.08	3.9
1 009 449.88	**78 990.48**	**7.83**	**69 997 318**	**69.34**	**886.1**

Distribution of Labor Force By Sex & Place of Residence in 1990 & 2003

Residence	1990		2003		Average Annual Growth Rate 1990-2003 (%)	
	Females	Males	Females	Males	Females	Males
Urban	1 482 500	5 202 200	2 196 400	6 761 600	3.02	2.02
Rural	2 454 100	6 403 800	2 324 600	907 100	-0.42	2.68
Total	3 936 600	11 606 000	4 521 000	15 838 700	1.06	2.39

Source: CAPMAS, Labor force sample survey.

6. TECHNICAL CHARACTERISTICS OF THERMAL POWER PLANTS

The following three tables below show all technical characteristics of thermal power plants operating in Egypt. This information was transmitted by EEHC in December 2006. This data base was validated by the Consultant and EPS in a tight collaboration with EEHC.

The installed capacity of a thermal plant is the nominal output of the plant given by the constructor under standard conditions (usually 15°C temperature and sea level pressure conditions).

The net capacity (or sent out capacity) is obtained from the nominal capacity by subtraction of auxiliaries consumption and possible derating resulting from actual temperature and pressure conditions.

The following typical values were considered:

Auxiliary consumption:

- 4% for STPP,
- 3% for CCGT,
- 2% for OCGT.

Derating for the Egyptian conditions (temperature):

- 5% for CCGT and OCGT,
- 0% for STPP.

Accordingly:
Net available capacity = Installed capacity – auxiliary consumption – derating

Name of the plant	Unit number	Plant site location	Type of generation unit	Comm. date	Planned decomm. date	Fuel(s) types	Installed capacity (MW)	Net available capacity EEHC(MW)	Net available capacity EPS(MW)	Capacity derating	Auxiliary consump.	Net available capacity calculated (MW)	Net available capacity considered (MW)	Forced outage rate (%)	Planned outage rate (weeks)	Efficiency EEHC (%)	Efficiency EPS (%)	Efficiency considered (%)	Fixed O&M costs ($/kW-year)	Variable O&M costs ($/MWh)	Fixed O&M costs considered ($/kW-year)	Variable O&M costs considered ($/MWh)
Cairo North 1	1	Cairo	CCGT	2005	2030	NG	750	750	750	37.5	21.4	691.1	691.1	6	3		52	52.0	16.3	0.2	16.3	0.2
Talkha	1	East Delta	CCGT	2007/2008	2033	NG/HFO	750			37.5	21.4	691.1	691.1	6	3		52	52.0	16.3	0.2	16.3	0.2
Kurimat (2)	1	Upper Egypt	CCGT	2007/2008	2033	NG/HFO	750			37.5	21.4	691.1	691.1	6	3		52	52.0	2.1	3.7	16.3	0.2
Nobaria 1	1	West Delta	CCGT	2006	2031	NG	750	750		37.5	21.4	691.1	691.1	6	3		52	52.0	16.3	0.2	16.3	0.2
Cairo South 1	1	Cairo	CCGT	1995	2020	NG/DO/HFO	570	55	473	28.5	16.2	525.3	473.0	7	5	39.1		39.1	7.3	0.1	7.3	0.1
Damieta 1	1	East Delta	CCGT	1993	2033	NG/DO	375	382.3		18.8	10.7	345.6	345.6	6	3	45.6		45.6	8.6	0.1	8.6	0.1
Damieta 2	2	East Delta	CCGT	1993	2033	NG/DO	375	382.3		18.8	10.7	345.6	345.6	6	3	45.6		45.6	8.6	0.1	8.6	0.1
Damieta 3	3	East Delta	CCGT	1993	2033	NG/DO	375	382.3		18.8	10.7	345.6	345.6	6	3	45.6		45.6	8.6	0.1	8.6	0.1
Cairo South 2	2	Cairo	CCGT	1995	2020	NG/DO	165	54	165	8.3	4.7	152.0	152.0	7	5	36.1		36.1	7.3	0.1	7.3	0.1
Damanhour		West Delta	CCGT	1995	2035	NG/DO	158	151.9		7.9	4.5	145.6	151.9	6	3	42		42.0	7.7	0.0	7.7	0.0
Mahmodia 1	1	West Delta	CCGT	1995	2035	NG/DO	158	150.4		7.9	4.5	145.6	150.4	6	3	41.7		41.7	7.0	0.1	7.0	0.1
Mahmodia 2	2	West Delta	CCGT	1995	2035	NG/DO	158	151.9		7.9	4.5	145.6	151.9	6	3	41.7		41.7	7.0	0.1	7.0	0.1
Talkha 1		East Delta	CCGT	1989	2029	NG/DO	141.8	139.2		7.1	4.0	130.7	139.2	7	3	37.5		37.5	6.1	0.0	6.1	0.0
Talkha 2		East Delta	CCGT	1989	2029	NG/DO	141.8	139.2		7.1	4.0	130.7	139.2	7	3	37.5		37.5	6.1	0.0	6.1	0.0
Cairo North 2	2	Cairo	OCGT	2006	2031	NG	500		500	25.0	9.5	465.5	465.5	6	3	35		35.0	16.3	0.2	16.3	0.2
Nobaria 2	2	West Delta	OCGT	2006	2031	NG	500	250		25.0	9.5	465.5	465.5	6	3	38		38.0	16.3	0.2	16.3	0.2
Sharm El Sheiek	Emergency Units	East Delta	OCGT			DO	146			7.3	2.8	135.9	135.9	8	6	22.9		22.9	5.0	5.8	5.0	5.8
Herghada	Emergency Units	East Delta	OCGT			DO	143.2			7.2	2.7	133.3	133.3	8	6	21.8		21.8	4.3	11.4	4.3	11.4
Mahmodia 1	1	West Delta	OCGT	1981	2011	NG/DO	50	29.9		2.5	1.0	46.6	46.6	9	3	22.8		22.8	7.0	0.1	7.0	0.1
Mahmodia 2	2	West Delta	OCGT	1981	2011	NG/DO	50	26.9		2.5	1.0	46.6	46.6	9	3	22.8		22.8	7.0	0.1	7.0	0.1
Wadi Houf 1	1	Cairo	OCGT	1985	2015	NG/DO	33.3	25	25	1.7	0.6	31.0	25.0	8	3	22.7		22.7	5.0	3.7	5.0	3.7
Wadi Houf 2	2	Cairo	OCGT	1985	2015	NG/DO	33.3	25	25	1.7	0.6	31.0	25.0	8	3	22.7		22.7	5.0	3.7	5.0	3.7
Wadi Houf 3	3	Cairo	OCGT	1985	2015	NG/DO	33.3	30	30	1.7	0.6	31.0	30.0	8	3	22.7		22.7	5.0	3.7	5.0	3.7
Shabab1	1	East Delta	OCGT	1982	2012	NG/DO	33.3	30		1.7	0.6	31.0	30.0	8	3	25.3		25.3	6.5	0.8	6.5	0.8
Shabab2	2	East Delta	OCGT	1982	2012	NG/DO	33.3	29		1.7	0.6	31.0	29.0	8	3	25.3		25.3	6.5	0.8	6.5	0.8
Shabab3	3	East Delta	OCGT	1982	2012	NG/DO	33.3	30.5		1.7	0.6	31.0	30.5	8	3	25.3		25.3	6.5	0.8	6.5	0.8
Siuf 1	1	West Delta	OCGT	1981	2012	NG/DO	32.3	21		1.6	0.6	30.1	21.0	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Siuf 2	2	West Delta	OCGT	1981	2012	NG/DO	32.3	22.5		1.6	0.6	30.1	22.5	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Siuf 3	3	West Delta	OCGT	1982	2012	NG/DO	32.3	23.5		1.6	0.6	30.1	23.5	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Siuf 4	4	West Delta	OCGT	1983	2013	NG/DO	32.3	19.2		1.6	0.6	30.1	19.2	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Siuf 5	5	West Delta	OCGT	1984	2014	NG/DO	32.3	19.5		1.6	0.6	30.1	19.5	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Siuf 6	6	West Delta	OCGT	1984	2014	NG/DO	32.3	19.8		1.6	0.6	30.1	19.8	8	3	20.7		20.7	3.5	0.2	3.5	0.2
Mahmodia 3	3	West Delta	OCGT	1981	2011	NG/DO	25	13		1.3	0.5	23.3	13.0	9	3	22.8		22.8	7.0	0.1	7.0	0.1
Port Said 2	2	East Delta	OCGT	1984	2014	NG/DO	23	18.9		1.2	0.4	21.4	18.9	2	3	24		24.0	8.4	0.9	8.4	0.9
Port Said 1	1	East Delta	OCGT	1977	2007	NG/DO	21	19.9		1.1	0.4	19.6	19.9	2	3	24		24.0	8.4	0.9	8.4	0.9
Port Said 3	3	East Delta	OCGT	1984	2014	NG/DO	20	13		1.0	0.4	18.6	13.0	2	3	24		24.0	8.4	0.9	8.4	0.9
Karmouz 1	1	West Delta	OCGT	1980	2010	NG/DO	9	9		0.5	0.2	8.4	8.4	8	3	23		23.0	15.4	61.1	15.4	61.1
Karmouz 2	2	West Delta	OCGT	1980	2010	NG/DO	9	9		0.5	0.2	8.4	8.4	8	3	23		23.0	15.4	61.1	15.4	61.1

Name of the plant	Unit number	Plant site location	Type of generation unit	Comm. date	Planned decomm. date	Fuel(s) types	Installed capacity (MW)	Net available capacity EEHC(MW)	Net available capacity EPS(MW)	Capacity derating	Auxiliary consump.	Net available capacity calculated (MW)	Net available capacity considered (MW)	Forced outage rate (%)	Planned outage rate (weeks)	Efficiency EEHC (%)	Efficiency EPS (%)	Efficiency considered (%)	Fixed O&M costs ($/kW-year)	Variable O&M costs ($/MWh)	Fixed O&M costs considered ($/kW-year)	Variable O&M costs considered ($/MWh)
Kurimat 1	1	Upper Egypt	ST	1999	2039	NG/HFO	627	627			25.1	601.9	601.9	7	6	41.9		41.9	3.4	0.5	3.4	0.5
Kurimat 2	2	Upper Egypt	ST	2000	2040	NG/HFO	627	627			25.1	601.9	601.9	7	6	41.9		41.9	3.4	0.5	3.4	0.5
Suez Gulf 1 (BOOT)	1	East Delta	ST	2003		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	41.5		41.5	80.2	0.1	80.2	0.1
Suez Gulf 2 (BOOT)	2	East Delta	ST	2003		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	41.5		41.5	80.2	0.1	80.2	0.1
Port Said East 1 (BOOT)	1	East Delta	ST	2003		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	41.8		41.8	80.2	0.1	80.2	0.1
Port Said East 2 (BOOT)	2	East Delta	ST	2003		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	41.8		41.8	80.2	0.1	80.2	0.1
Sidi Krir 3	3	West Delta	ST	2002		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	44.8		44.8	89.2	0.5	89.2	0.5
Sidi Krir 4	4	West Delta	ST	2002		NG/HFO	341.25	341.25			13.7	327.6	327.6	4	6	44.8		44.8	89.2	0.5	89.2	0.5
Cairo West Ext.1	1	Cairo	ST	1995	2035	NG/HFO	330	337	337		13.2	316.8	316.8	4	4	39.6		39.6	6.5	0.1	6.5	0.1
Cairo West Ext.2	2	Cairo	ST	1995	2035	NG/HFO	330	342	330		13.2	316.8	316.8	4	4	39.6		39.6	6.5	0.1	6.5	0.1
Oyon Mousa 1	1	East Delta	ST	2001	2041	NG/HFO	320	309			12.8	307.2	309.0	7	4	41.5		41.5	5.3	0.0	5.3	0.0
Oyon Mousa 2	2	East Delta	ST	2001	2041	NG/HFO	320	310			12.8	307.2	310.0	7	4	41.5		41.5	5.3	0.0	5.3	0.0
Sidi Krir 1	1	West Delta	ST	1999	2039	NG/HFO	320	320			12.8	307.2	307.2	7	6	41.9		41.9	4.8	0.1	4.8	0.1
Sidi Krir 2	2	West Delta	ST	2000	2040	NG/HFO	320	319			12.8	307.2	307.2	7	6	41.9		41.9	4.8	0.1	4.8	0.1
Shoubra 1	1	Cairo	ST	1984	2024	NG/HFO	315	305	305		12.6	302.4	305.0	4	4	38.6		38.6	5.0	0.1	5.0	0.1
Shoubra 2	2	Cairo	ST	1985	2025	NG/HFO	315	314	314		12.6	302.4	302.4	4	4	38.6		38.6	5.0	0.1	5.0	0.1
Shoubra 3	3	Cairo	ST	1985	2025	NG/HFO	315	314	314		12.6	302.4	302.4	4	4	38.6		38.6	5.0	0.1	5.0	0.1
Shoubra 4	4	Cairo	ST	1988	2028	NG/HFO	315	314	314		12.6	302.4	302.4	4	4	38.6		38.6	5.0	0.1	5.0	0.1
Ataka 3	3	East Delta	ST	1987	2027	NG/HFO	300	286			12.0	288.0	286.0	4	7	37.1		37.1	7.6	0.1	7.6	0.1
Ataka 4	4	East Delta	ST	1989	2029	NG/HFO	300	285			12.0	288.0	285.0	4	7	37.1		37.1	7.6	0.1	7.6	0.1
Assiut Ext.1	1	Upper Egypt	ST	1992	2032	HFO	300	240.6			12.0	288.0	240.6	4	6	36.9		36.9	5.0	0.2	5.0	0.2
Assiut Ext.2	2	Upper Egypt	ST	1996	2036	HFO	300	208			12.0	288.0	207.5	4	6	36.9		36.9	5.0	0.2	5.0	0.2
Abu Kir 5	5	West Delta	ST	1991	2031	NG/HFO	300	283.2			12.0	288.0	283.2	6	6	40.7		40.7	7.6	0.3	7.6	0.3
Damanhour (GIS)		West Delta	ST	1991	2031	NG/HFO	300	294.4			12.0	288.0	294.4	4	4	38.4		38.4	8.3	0.2	8.3	0.2
Talkha Ext.1	1	East Delta	ST	1993	2033	NG/DO	210	199			8.4	201.6	199.0	4	4	37.1		37.1	9.2	0.1	9.2	0.1
Talkha Ext.2	2	East Delta	ST	1995	2033	NG/DO	210	203			8.4	201.6	203.0	4	4	37.1		37.1	9.2	0.1	9.2	0.1
Abu Soltan 1	1	East Delta	ST	1983	2023	NG/HFO	150	137			6.0	144.0	137.0	4	5	33.4		33.4	7.4	0.1	7.4	0.1
Abu Soltan 2	2	East Delta	ST	1983	2023	NG/HFO	150	139			6.0	144.0	139.0	4	5	33.4		33.4	7.4	0.1	7.4	0.1
Abu Soltan 3	3	East Delta	ST	1984	2024	NG/HFO	150	139			6.0	144.0	139.0	4	5	33.4		33.4	7.4	0.1	7.4	0.1
Ataka 1	1	East Delta	ST	1985	2025	NG/HFO	150	139.3			6.0	144.0	139.3	4	7	37.1		37.1	7.6	0.1	7.6	0.1
Ataka 2	2	East Delta	ST	1985	2025	NG/HFO	150	140.4			6.0	144.0	140.4	4	7	37.1		37.1	7.6	0.1	7.6	0.1
Abu Soltan 4	4	East Delta	ST	1986	2026	NG/HFO	150	140			6.0	144.0	140.0	4	5	33.4		33.4	7.4	0.1	7.4	0.1

Name of the plant	Unit number	Plant site location	Type of generation unit	Comm. date	Planned decomm. date	Fuel(s) types	Installed capacity (MW)	Net available capacity EEHC(MW)	Net available capacity EPS(MW)	Capacity derating	Auxiliary consump.	Net available capacity calculated (MW)	Net available capacity considered (MW)	Forced outage rate (%)	Planned outage rate (weeks)	Efficiency EEHC (%)	Efficiency EPS (%)	Efficiency considered (%)	Fixed O&M costs ($/kW-year)	Variable O&M costs ($/MWh)	Fixed O&M costs considered ($/kW-year)	Variable O&M costs considered ($/MWh)
Abu Kir 1	1	West Delta	ST	1983	2023	NG/HFO	150	140			6.0	144.0	140.0	6	6	37.3		37.3	7.6	0.3	7.6	0.3
Abu Kir 2	2	West Delta	ST	1983	2023	NG/HFO	150	141			6.0	144.0	141.0	6	6	37.3		37.3	7.6	0.3	7.6	0.3
Abu Kir 3	3	West Delta	ST	1984	2024	NG/HFO	150	141			6.0	144.0	141.0	6	6	37.3		37.3	7.6	0.3	7.6	0.3
Abu Kir 4	4	West Delta	ST	1984	2024	NG/HFO	150	140.7			6.0	144.0	140.7	6	6	37.3		37.3	7.6	0.3	7.6	0.3
Kafr Dawar 1	1	West Delta	ST	1980	2020	NG/HFO	110	105			4.4	105.6	105.0	7	8	30.9		30.9	9.7	0.2	9.7	0.2
Kafr Dawar 2	2	West Delta	ST	1980	2020	NG/HFO	110	94.5			4.4	105.6	94.5	7	8	30.9		30.9	9.7	0.2	9.7	0.2
Kafr Dawar 3	3	West Delta	ST	1984	2024	NG/HFO	110	93			4.4	105.6	93.0	7	8	30.9		30.9	9.7	0.2	9.7	0.2
Kafr Dawar 4	4	West Delta	ST	1986	2026	NG/HFO	110	93.5			4.4	105.6	93.5	7	8	30.9		30.9	9.7	0.2	9.7	0.2
Cairo West 1	1	Cairo	ST	1966	2024	NG/HFO	87.5	83	83		3.5	84.0	83.0	4	4	33.8		33.8	6.5	0.1	6.5	0.1
Cairo West 2	2	Cairo	ST	1966	2024	NG/HFO	87.5	83	83		3.5	84.0	83.0	4	4	33.8		33.8	6.5	0.1	6.5	0.1
Cairo West 3	3	Cairo	ST	1966	2024	NG/HFO	87.5	83	83		3.5	84.0	83.0	4	4	33.8		33.8	6.5	0.1	6.5	0.1
Cairo West 4	4	Cairo	ST	1979	2037	NG/HFO	87.5	83	83		3.5	84.0	83.0	4	4	33.8		33.8	6.5	0.1	6.5	0.1
Damanhour 3	3	West Delta	ST	1968	2018	NG/HFO	65	57.3			2.6	62.4	57.3	9	4	31.5		31.5	8.0	0.1	8.0	0.1
Damanhour 4	4	West Delta	ST	1968	2018	NG/HFO	65	56.5			2.6	62.4	56.5	9	4	31.5		31.5	8.0	0.1	8.0	0.1
Damanhour 5	5	West Delta	ST	1969	2019	NG/HFO	65	57.3			2.6	62.4	57.3	9	4	31.5		31.5	8.0	0.1	8.0	0.1
Arish 1	1	East Delta	ST	2000	2040	NG/HFO	33	31.7			1.3	31.7	31.7	9	10	35.7		35.7	26.3	0.5	26.3	0.5
Arish 2	2	East Delta	ST	2001	2040	NG/HFO	33	31.7			1.3	31.7	31.7	9	10	35.7		35.7	26.3	0.5	26.3	0.5
Assiut1	1	Upper Egypt	ST	1966	2016	HFO	30	25.3			1.2	28.8	25.3	7	4	29.6		29.6	22.7	0.1	22.7	0.1
Assiut2	2	Upper Egypt	ST	1967	2017	HFO	30	26.1			1.2	28.8	26.1	7	4	29.6		29.6	22.7	0.1	22.7	0.1
Assiut3	3	Upper Egypt	ST	1967	2017	HFO	30	25.5			1.2	28.8	25.5	7	4	29.6		29.6	22.7	0.1	22.7	0.1
Siuf 3	3	West Delta	ST	1969	2014	HFO	30	12			1.2	28.8	12.0	4	4	20.8		20.8	9.4	0.3	9.4	0.3
Siuf 4	4	West Delta	ST	1969	2014	HFO	30	15			1.2	28.8	15.0	4	4	20.8		20.8	9.4	0.3	9.4	0.3
Matrouh 1	1	West Delta	ST	1990	2030	NG	30	30			1.2	28.8	28.8	9	8	29		29.0	15.1	0.5	15.1	0.5
Matrouh 2	2	West Delta	ST	1990	2030	NG	30	30			1.2	28.8	28.8	9	8	29		29.0	15.1	0.5	15.1	0.5
Siuf 1	1	West Delta	ST	1961	2011	HFO	26	17			1.0	25.0	17.0	4	4	20.8		20.8	9.4	0.3	9.4	0.3
Siuf 2	2	West Delta	ST	1961	2011	HFO	26	18			1.0	25.0	18.0	4	4	20.8		20.8	9.4	0.3	9.4	0.3
Zafarana		East Delta	WIND	2000/2006			225							8	6					5.4		5.4
Zafarana / Gabal El-Zait		East Delta	WIND	2007/2008			150							8	6					5.4		5.4
Zafarana / Gabal El-Zait		East Delta	WIND	2006/2007			55							8	6					5.4		5.4

Technical characteristics of thermal power plants operating in Egypt. Source: EEHC, Consultant, EPS, 2006.

7. TECHNICAL CHARACTERISTICS OF EXISTING HYDROPOWER PLANTS

	Existing					Construction
Data for each Hydro Plant	High Dam	Aswan Dam I	Aswan Dam II	Esna	Small Naga Hammadi	New Naga Hammadi
Energy coefficient in kWh/m3	0.1633	0.051	0.055	0.012	0.01	
Number of turbines	12	7	4	6	3	4
Maximum capacity of each turbine in MW	175	46	67.5	14.8	1.7	16
Maximum physical discharge of each turbine in m3/s	280	174	360	275	50	320
Total installed capacity (MW)	2100	322	270	88	5.4	64
Total maximum capacity (MW)						
Total maximum discharge (m3/s)	3360	1218	1440	1650	150	
Forced outage rate of the plant (%)	1	1	6	3	10	
Planned maintenance program for turbines (week)	2	2	2	2		
Aditional data for seasonal reservoirs :						
active storage capacity in hm3	90000					
average evaporation gradient in mm/month						
minimum imposed releases in m3/s						
Environmental constraints (biological life, fish recovery) or multipurpose constraints (irrigation, drinking water)	Irrigation			Irrigation	Irrigation	Irrigation
Fixed annual operating expenses ($/kW-year)	3.8	11.27	4.29	8.3		
Historical monthly generation for the longest period available	annual average 11500	annual average 1537	annual average 1800	annual average 634	annual average 38	annual average 460
Commissioning date	1967	1960	1985-86	1995	1926	2008
Planned decommissioning date						
Possible existing rehabilitation projects	from 2004 to 2011					

Source: data from Water Resources and Irrigation Ministry, EECH and EPS, 2006.

8. HYDROLOGICAL DATA

Aswan inflow (m3/s)												
	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.
In-1990-91	4159.2	5077.2	2501.5	1126.5	631.0	507.8	334.8	421.9	690.6	836.3	594.1	1878.0
In-1991-92	5902.8	6971.5	1885.5	1246.1	873.7	750.4	607.6	429.4	829.5	1093.9	605.7	1299.3
In-1992-93	4805.1	6481.5	3117.5	2299.4	1082.7	746.7	731.6	619.8	964.5	1187.3	1323.3	2505.2
In-1993-94	6302.3	6979.2	3408.8	1720.7	1026.7	552.6	285.2	392.0	648.1	944.6	590.3	1571.8
In-1994-95	7795.7	8831.0	2949.5	698.3	660.8	560.0	553.9	552.6	513.1	884.9	447.5	1127.5
In-1995-96	6026.0	5231.5	1739.8	679.0	642.2	608.6	516.7	429.4	613.4	855.0	1022.4	3397.6
In-1996-97	7179.7	6859.6	2897.3	1234.6	836.3	563.8	587.0	597.4	1037.8	1116.3	945.2	2628.4
In-1997-98	5652.6	2974.5	1829.5	2241.5	1079.0	679.5	421.6	440.6	783.2	1086.5	613.4	1747.3
In-1998-99	8292.3	9849.5	4947.0	3067.1	1052.9	716.8	669.6	515.2	644.3	1000.6	848.8	2326.0
In-1999-00	7523.1	8526.2	4640.8	2982.3	1164.9	563.8	665.5	537.6	1061.0	765.4	783.2	1687.6
In-2000-01	6716.7	6597.2	3367.7	2519.3	1205.9	728.0	686.2	474.2	586.4	911.0	713.7	1859.3
In-2001-02	9632.6	7758.5	2012.4	1720.7	866.2	563.8	624.2	582.4	632.7	888.6	574.8	1008.1

Aswan outflow (m3/s)												
	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Out-1990-91	2307.3	1624.1	1284.3	1198.5	1146.2	858.7	1295.5	1530.8	1560.6	2034.8	2669.5	2583.6
Out-1991-92	2326.0	1605.4	1303.0	1176.1	1131.3	937.1	1359.0	1523.3	1601.7	2019.9	2650.8	2628.4
Out-1992-93	2333.5	1672.6	1370.2	1247.0	1116.3	940.9	1303.0	1616.6	1691.3	2049.7	2654.6	2665.8
Out-1993-94	2400.7	1683.8	1385.2	1220.9	1026.7	806.5	1355.3	1773.4	1680.1	2053.5	2669.5	2665.8
Out-1994-95	2408.2	1639.0	1299.3	1220.9	821.4	1045.4	1269.4	1739.8	1702.5	2128.1	2781.5	2677.0
Out-1995-96	2438.0	1601.7	1336.6	1280.6	799.0	978.2	1280.6	1732.4	1680.1	2165.5	2766.6	2677.0
Out-1996-97	2397.0	1568.1	1284.3	1239.5	791.5	996.9	1235.8	1687.6	1683.8	2202.8	2744.2	2908.5
Out-1997-98	2434.3	1583.0	1306.8	1269.4	795.3	1011.8	1198.5	1631.6	1695.0	2210.3	2792.7	2811.4
Out-1998-99	2408.2	2587.4	2550.0	2113.2	1448.6	1366.5	1616.6	1975.1	2139.3	2609.8	2889.8	2975.7
Out-1999-00	2658.3	2456.7	1665.2	1631.6	1135.0	1332.9	1433.7	2064.7	2128.1	2632.2	2957.0	2949.5
Out-2000-01	2632.2	1751.0	1549.4	1452.4	1161.1	1276.9	1340.4	1766.0	1870.5	2363.4	2998.1	2986.9
Out-2001-02	2874.9	2893.5	2221.5	1392.6	1112.6	1086.5	1295.5	1892.9	1978.8	2774.0	2960.7	2960.7

Source: Water Resources and Irrigation Ministry, 2006.

	Mean Monthly Flow characteristics at selected points (Mm3)													
		Aug	Sep	Oct	Nov	Dec	Jan	Fev	Mar	Apr	May	Jun	Jul	TOTAL
High	Aswan Dam	6380	4698	3919	3604	3036	2874	3594	4398	4394	5505	6928	7148	56478*
Kalbia	Canal	154	132	115	114	86	39	100	97	103	268	1261	155	2624
Asfon	Canal	66	58	50	53	32	19	38	42	43	111	57	63	631
Esna	Barrages	5834	4319	3496	2734	2549	2292	3200	3947	4048	4994	6557	6196	50166
West Nagaa Hamady canal	Canal	315	357	205	232	176	89	210	218	226	238	284	329	2878
East Nagaa Hamady canal	Canal	117	100	87	103	72	32	88	88	89	95	105	121	1098
Nagaa Hamady barrage		5277	3862	3014	2652	2216	2227	2636	3440	3449	4260	5846	5861	44741
Ebrahimya	Canal	1097	852	745	709	592	216	679	735	799	831	1004	1160	9420
Assiut	Barrages	4330	3019	2353	2066	1798	2068	1789	2346	2601	3155	4719	4713	34958
Delta	Barrages	4347	3517	2754	2596	2458	2822	2259	2805	3405	3235	4706	5095	40000
Esmaillya	Canal	413	369	309	284	255	214	222	307	426	339	422	444	4003
Tawfeky	Rayah	485	390	282	270	257	184	203	313	322	341	529	583	4159
Dammeitta	Branch	1221	919	553	584	546	406	446	659	740	841	1408	1561	9884
Menofy	Rayah	665	463	374	362	319	256	254	405	449	433	670	756	5406
Rosetta	Branch	378	366	364	328	492	1212	656	320	277	350	555	457	5755
Behery	Rayah	722	659	546	487	450	359	317	538	570	588	720	753	6710
Nasri	Rayah	234	206	177	147	118	83	86	153	150	156	216	243	1968
El-Mansoriya	Canal	342	257	122	141	107	98	104	159	166	193	373	414	2477
eet Ghamir Feeder to	Mansoriya	2	16	51	49	53	29	27	45	36	41	33	74	458
Abasi	Rayah	576	437	270	277	229	185	171	302	352	375	649	739	4563
Zefta	Barrages	241	219	159	150	124	130	124	171	205	229	306	302	2360
Farskor	Dam	6	44	325	173	409	400	207	222	127	57	29	82	2080
Edfina	Barrages	6	119	215	207	433	996	579	199	81	64	41	12	2952

Source: Multipurpose Development of the Eastern Nile, One–System inventory report on water resource related Data and information – EGYPT. Fahmy, A. 2006.

Monthly Mean Discharges of Main Irrigation Canals In Egypt (Mm3)														
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Aswan	High Dam	2874	3594	4398	4394	5505	6928	7148	6380	4698	3919	3604	3036	56478
Kalbiya	Canal	39	100	97	103	268	1261	155	154	132	115	114	86	2624
Asfun	Canal	19	38	42	43	111	57	63	66	58	50	53	32	631
Isna	Barrages	2292	3200	3947	4048	4994	6557	6196	5834	4319	3496	2734	2549	50166
West	Naga Hamadi	89	210	218	226	238	284	329	315	357	205	232	176	2878
East	Naga Hamadi	32	88	88	89	95	105	121	117	100	87	103	72	1098
NagaHamadiBarrages	Naga Hamadi	2227	2636	3440	3449	4260	5846	5861	5277	3862	3014	2652	2216	44741
Ibrahimiya	Canal	216	679	735	799	831	1004	1160	1097	852	745	709	592	9420
Asyut	Barrages	2068	1789	2346	2601	3155	4719	4713	4330	3019	2353	2066	1798	34958
Delta	Barrages	2822	2259	2805	3405	3235	4706	5095	4347	3517	2754	2596	2458	40000
Ismailiya	Canal	214	222	307	426	339	422	444	413	369	309	284	255	4003
Tawfiki	Rayah	184	203	313	322	341	529	583	485	390	282	270	257	4159
Damietta	Branch	406	446	659	740	841	1408	1561	1221	919	553	584	546	9884
Minufy	Rayah	256	254	405	449	433	670	756	665	463	374	362	319	5406
Rosetta	Branch	1212	656	320	277	350	555	457	378	366	364	328	492	5755
Behery	Rayah	359	317	538	570	588	720	753	722	659	546	487	450	6710
Nasri	Rayah	83	86	153	150	156	216	243	234	206	177	147	118	1968
El-Mansoriya	Canal	98	104	159	166	193	373	414	342	257	122	141	107	2477
Mit	Ghamr	29	27	45	36	41	33	74	2	16	51	49	53	458
Abbasi	Rayah	185	171	302	352	375	649	739	576	437	270	277	229	4563
Zefta	Barrages	130	124	171	205	229	306	302	241	219	159	150	124	2360
Fariskur	Dam	400	207	222	127	57	29	82	6	44	325	173	409	2080
Idfina	Barrages	996	579	199	81	64	41	12	6	119	215	207	433	2952

Source: Multipurpose Development of the Eastern Nile, One–System inventory report on water resource related Data and information – EGYPT. Fahmy, A. 2006.

9. EGYPTIAN GRID

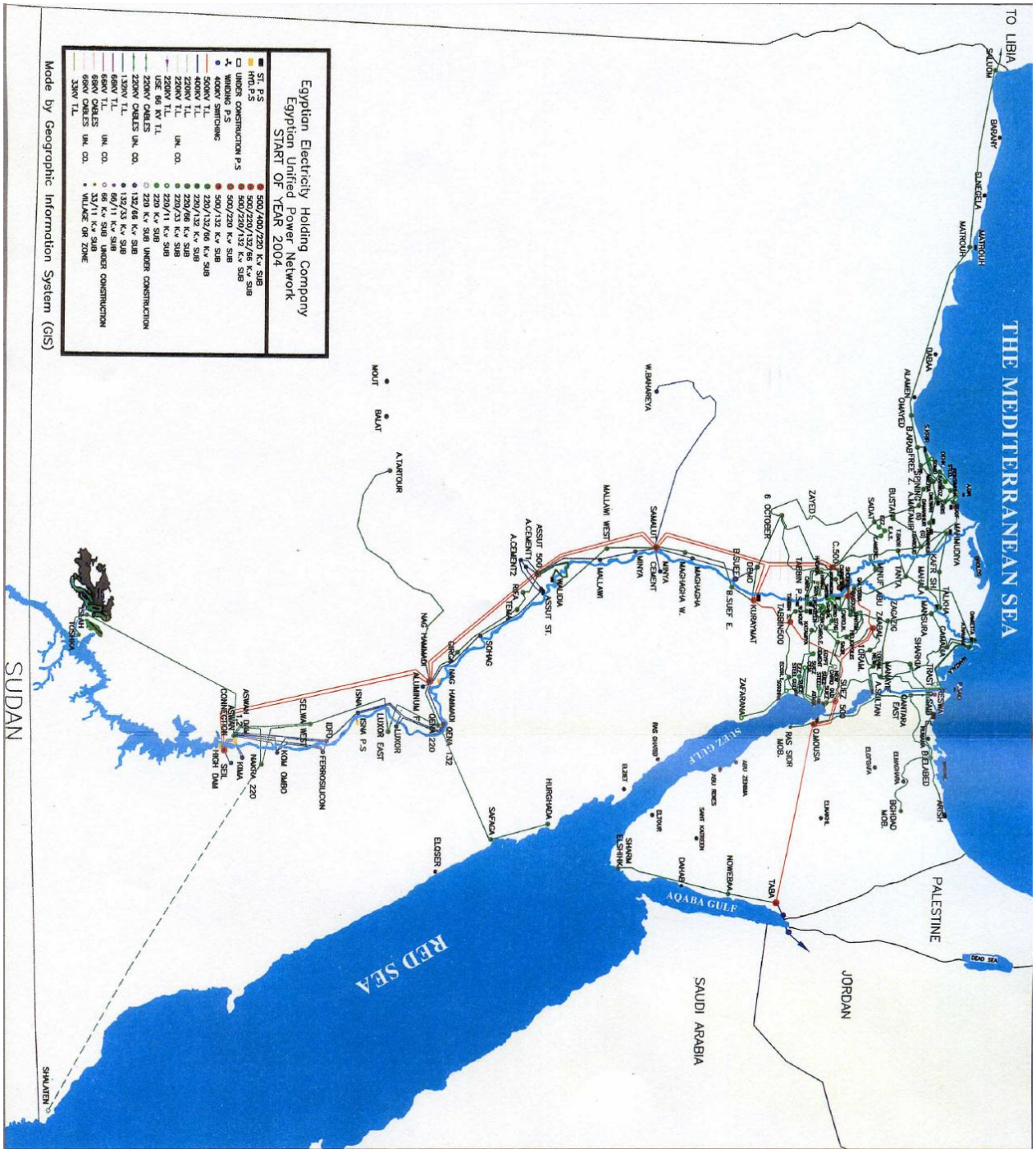


Figure 9-1 - Egyptian Grid

Source: EEHC Annual report 2002/2003.