ENTRO

EASTERN NILE POWER TRADE PROGRAM STUDY

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

AfDB

ENERGY SECTOR PROFILE & PROJECTIONS

VOL 2 - EGYPT

FINAL REPORT

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)

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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	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

1.1 HISTORICAL EVOLUTION OF POWER DEMAND

In Egypt, peak demand increased from 5.4 GW in 1986 to 17.3 GW in 2006. In the same period, energy generated increased from 32 TWh to 108 TWh, with an average annual growth rate of 7% in the last ten years.

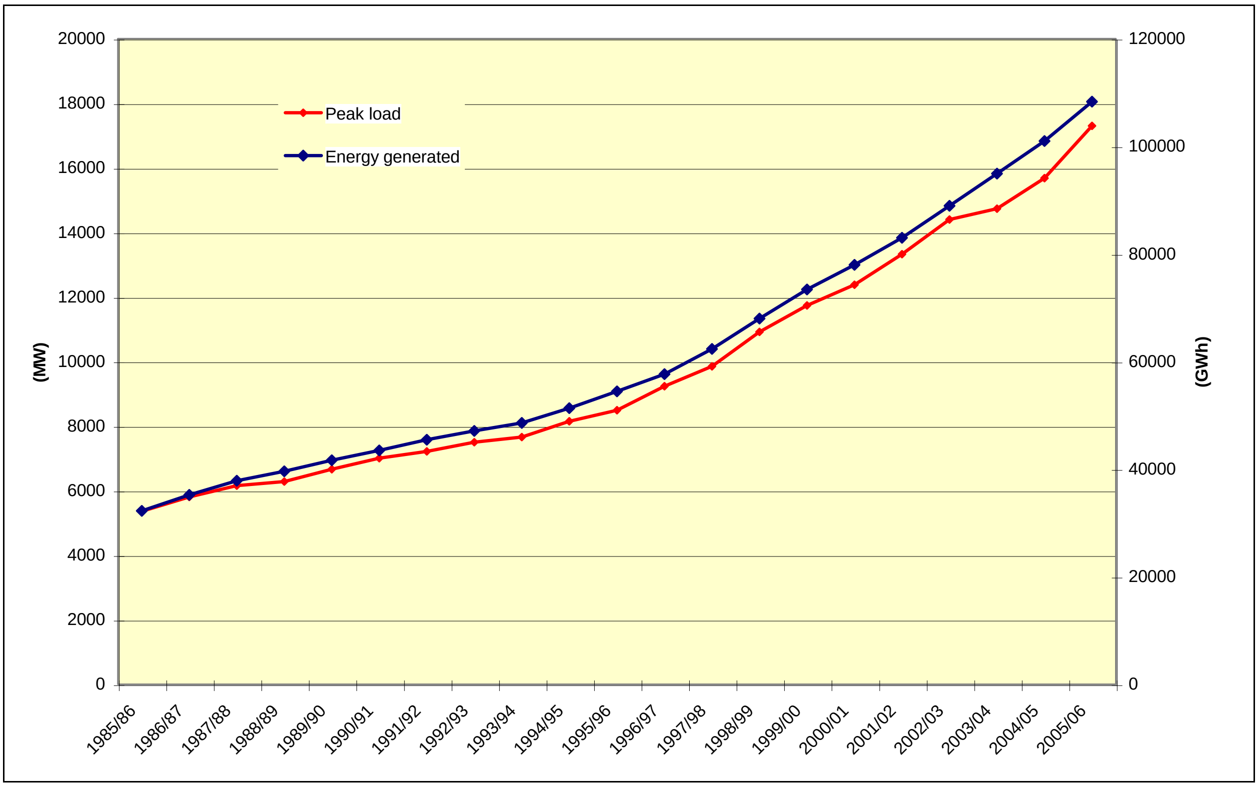

Figure 1.1-1 - Historical evolution of Egyptian demand (MW and GWh)

The share of consumption by consumer sector has changed in the last 20 years, with the industry sector decreasing from 55% to 35% and residential sector rising from 23% to 37%.

The load factor during this period remained constant, with an average value around 72%.

Losses have been decreased in the recent years to achieve a value of 14.7% in the year 2005/2006.

The peak load is observed during the summer, at 21h00 in working day. Last data concerning peak load are:

	2003	2004	2005	2006
Peak load (MW)	14 723	15 491	16 650	18 160

Table 1.1-1 - Historical evolution of Egyptian Peak load

1.2 DEMAND FORECAST

In 2006, EEHC prepared demand projections for the period from 2006/2007 to 2029/2030 for three scenarios (high, medium, and low).

Demand Forecast		07/2008	10/2011	15/2016	20/2021	25/2026	29/2030
TOTAL GENERATED ENERGY (GWh)	High	125653	155512	213438	279753	358909	437696
	Medium	123065	148538	198960	259708	334639	407272
	Low	120470	141901	186111	242846	317964	392195
PEAK LOAD (MW)	High	20059	24769	33860	44125	55610	66443
	Medium	19646	23658	31564	40963	51850	61825
	Low	19232	22601	29525	38304	49266	59536

Table 1.2-1 - Demand forecast for Egypt 2008-2030

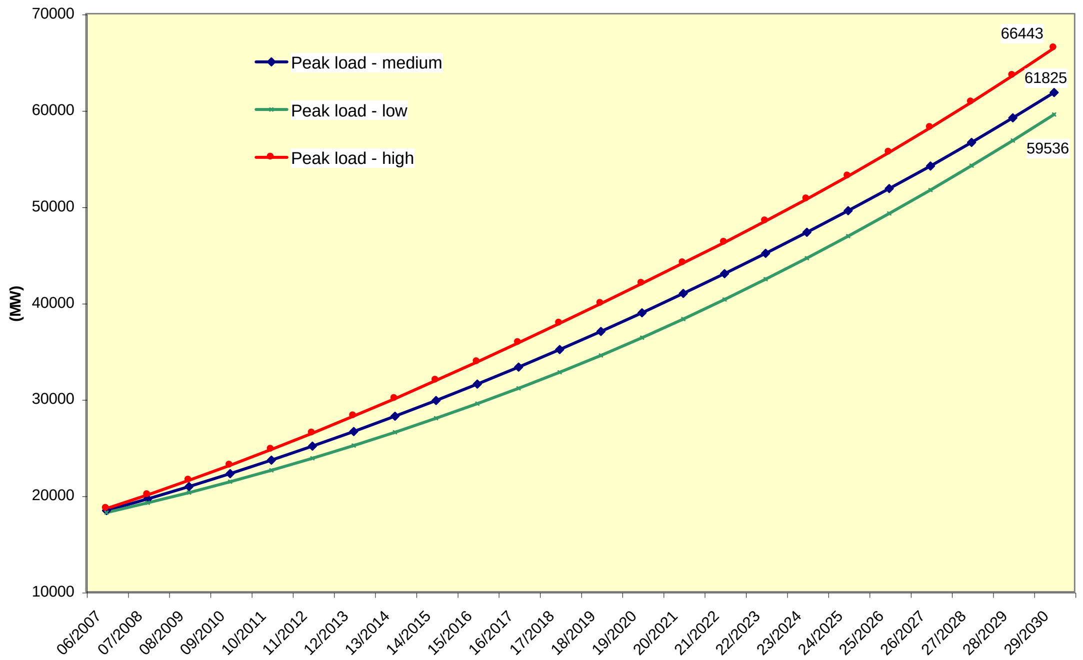

Figure 1.2-1 - Peak load projections for Egypt (2006/2007 to 2029/2030)

The respective annual growth rates for the high, medium and low scenarios for generation during the period from 2006/2007 to 2029/2030 are 5.9%, 5.6% and 5.5%. Annual growth rates for peak load are respectively 5.7%, 5.4% and 5.3%.

1.3 POTENTIAL POWER TRADES

In spite of available information and the local consultants expertise, the establishment of trade opportunities figures remains an speculative exercise. It is widely known that opportunities of trade depend on future plans of neighbouring countries as well as the other interconnections in the considered country (e.g. Sudan and Ethiopia and its transmission to Egypt and its neighbours).

Nevertheless, a tentative long term exchange hypothesis can be based on the following assumptions:

- ✓ Egypt will continue to present a positive export balance;
- ✓ Exports will be quite similar in both directions;
- ✓ Energy power exports will remain stable over the planning period according to the future long term contracts.

A conservative power export hypothesis is considered in the present Study:

Annual balance	2007		2008		2009		2010		2015		2020		2030	
	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)
Egypt -> Libya	800	200	800	200	800	200	800	200	800	200	800	200	800	200
Egypt -> Jordan	800	200	800	200	800	200	800	200	800	200	800	200	800	200

Table 1.3-1 - Power export hypothesis for Egypt

1.4 GENERATION SUPPLY OPTIONS

Considering the large availability of natural gas in Egypt, the thermal candidates identified for new generation investment are:

- 750 MW dual-fired (NG / HFO) CCGT for base load,
- 250 MW dual-fired (NG / HFO) OCGT for peak-load,
- 350 MW /450 MW / 650 MW dual-fired (NG / HFO) steam turbine.

Few significant hydro plants projects are considered in the Egyptian Nile basin. Only run of the river HPP are projected, with a clear priority of the water resources given to irrigation. Three plants are planned until 2012/2013: Damietta (13 MW), Zefta Barrage (5.5 MW), Assiut (40 MW).

The development of wind energy will be significant reaching a total installed capacity of 3 000 MW by 2030.

EEHC generation expansion plan includes the commissioning of five 1 000 MW units for Dabaa nuclear plant from 2016 until 2027.

The target considered for the development of Solar energy is 750 MW by the year 2020.

1.5 REVIEW OF THE GENERATION EXPANSION PLAN

EEHC develops five-year plans for the generation expansion and network expansion including substations and transmission. A least cost generation plan was prepared up to the year 2011/2012. For further horizons, no economical analysis has been done yet. The following table presents the most recent generation expansion data prepared by EEHC.

Name of the plant	Plant site location	Type of generation unit	Fuel(s) types	Installed capacity (MW)	Net available capacity (MW)	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Sidi Krir	East Delta	CCGT	NG/HFO	750	691.1	500	250																	
Kurimat (3)	Upper Egypt	CCGT	NG/HFO	750	691.1	500	250																	
Nobaria (3)	West Delta	CCGT	NG/HFO	750	691.1	500	250																	
Atfe	West Delta	CCGT	NG/HFO	750	691.1	500	250																	
Sharm El-Sheik	West Delta	CCGT	NG/HFO	750	691.1				750															
Alexandria East	West Delta	CCGT	NG/HFO	750	691.1						500	500	500											
Combined Cycle 750MW		CCGT	NG/HFO	750	691.1						500	500		500	500	500	1000	500	500	500	500	500		
Open Cycle GT 250 MW		OCGT	NG/HFO	250	232.8																			
Abu Qir	West Delta	ST	NG/HFO	650	624.0			650	650															
Suez	East Delta	ST	NG/HFO	450	432.0					450														
Steam Units 450MW		ST	NG/HFO	450	432.0						1350	450	450		450	450				450	900	900	1350	450
Cairo West Ext.	Cairo	ST	NG/HFO	350	336.0			700																
Tebbin	Cairo	ST	NG/HFO	350	336.0		700																	
Ayoun Musa Ext.	Upper Egypt	ST	NG/HFO	350	336.0				350															
Steam Units 650MW		ST	NG/HFO	350	336.0					1300		650		1300	1300	1300	1300	650	1950	650	1300		1300	1300
Borg El-Arab		Solar/Thermal		300										300		300								
Kurimat	Upper Egypt	Solar/Thermal	NG/HFO	150		150																		
Dabaa Nuclear		Nuclear		1000									1000					1000		1000		1000		1000
New Naga Hammadi		Hydro		64		64																		
Assiut		Hydro		40						40														
Damietta		Hydro		13				13																
Zefta		Hydro		5.5					5.5															
Zafarana	East Delta	Wind		125		125																		
Zafarana / Gabal El-Zait	East Delta	Wind					130	160	200	200	200	200	200	200	200	200	200	200	200					

Table 1.5-1 - EEHC Generation Expansion Plan from 2008 until 2027.

1.6 ENVIRONMENTAL CONCERNS

The Egyptian electrical system planning takes into account in its major steps the improvements concerning environmental protection. It can be notice on the reduction of demand (demand side management, reduction of losses, etc.) and the environmental friendly supply options. An important program is carried out to implemented new & renewable sources of energy as well as thermal generation emitting lower quantities of GHG.

1.7 REVIEW OF THE TRANSMISSION MASTER PLAN

The proposed transmission expansion scheme provides a list of new equipments expected by 2010 and 2015. The 500 kV network is expended to the west side, from Cairo to Saloum, via Sidi-Krir and Dabaa, and in the Delta Zone, with the creation of North Delta 500/220 kV substation. Two new 500/220 kV substations are created in Heliopolis (Cairo) and in Sohag. The 220 kV is reinforced in the Delta zone and around Cairo. The ELTAM project proposes a reinforcement of the existing interconnection with Libya by a 500/400 kV circuit.

2. ORGANISATION OF THE REPORT

Module 3 deals with the future evolution of the demand and identification of supply and interconnection options. The findings of this Module will constitute the base on which the regional investment plan will be determinate.

This Module is organized in five Volumes:

- Volume 1: Executive summary of Module M3
- Volume 2: Energy Sector Profile & Projections for Egypt
  - Review and update of previous demand forecast.
  - Potential trade opportunities.
  - Review of the existing Generation Expansion Plan.
  - Identification of generation supply options.
  - Review of existing transmission master plan.
- Volume 3: Energy Sector Profile & Projections for Ethiopia
  - Review and update of previous demand forecast.
  - Potential trade opportunities.
  - Review of the existing Generation Expansion Plan.
  - Identification of generation supply options.
  - Review of existing transmission master plan.
- Volume 4: Energy Sector Profile & Projections for Sudan
  - Review and update of previous demand forecast.
  - Potential trade opportunities.
  - Review of the existing Generation Expansion Plan.
  - Identification of generation supply options.
  - Review of existing transmission master plan.
- Volume 5:
  - Fuel prices Projections.
  - Interconnection options.
  - First evaluation of economic profitability of exports from Sudan-Ethiopia.

The present Volume 2 is focussed on the Energy and Sector Profile & Projections in Egypt.

3. REVIEW AND UPDATE OF DEMAND FORECAST

3.1 REVIEW OF PAST EVOLUTION

3.1.1 FISCAL YEAR AND TIME ZONE

Egypt is in the GMT+2 time zone, with an yearly change for summer time (01/05 to 30/09).

All demand data given in this section refer to fiscal year going from July 1^{rst} to June 30th.

3.1.2 ANNUAL ENERGY DEMAND AND PEAK LOAD EVOLUTION

In Egypt, peak demand increased from 5.4 GW (1986) to 17.3 GW (2006). **Figure 3.1-1** shows their evolution over the last 21 years. In the same period, energy generated changed from 32,3 TWh to 108 TWh. **Table 3.1-1** synthesizes demand figures for the last 5 years.

Data from July 1989 to 30 June 2006 (**Figure 3.1-2**) shows a persistent energy growth above 3% per year, even during the crisis period between 1992 and 1994. Afterwards, the energy growth presents an average rate around 7% per year, with higher values between 1997 and 1999. During the same period, peak load growth rate varied strongly, with an average value around 7% in the last ten years.

Date Fiscal Year	Peak Load (MW)	Energy Sales (GWh)	Energy Generated (GWh)
01/02	13 326	69 181	83 002
02/03	14 401	74 990	88 951
03/04	14 735	80 565	94 918
04/05	15 678	86 091	100 996
05/06	17 300	90 290	108 304

Table 3.1-1 - Peak load, sales, and energy generated from July 2001 to June 2006.

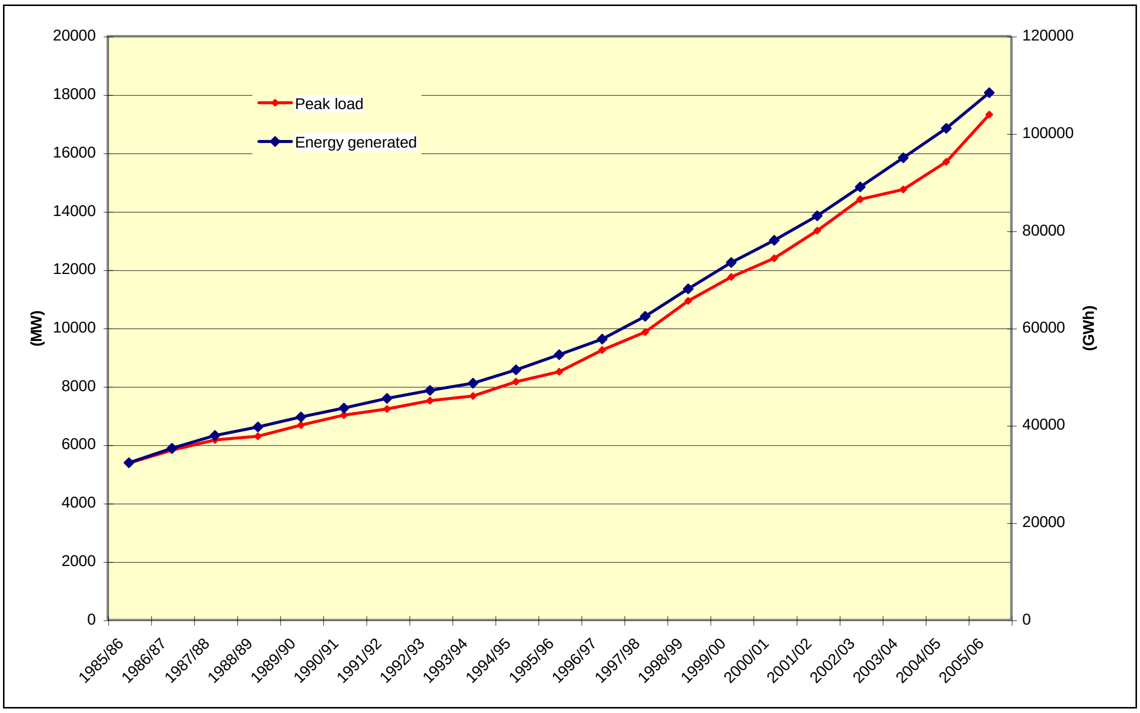

Figure 3.1-1 - Past evolution of peak load and generated energy.

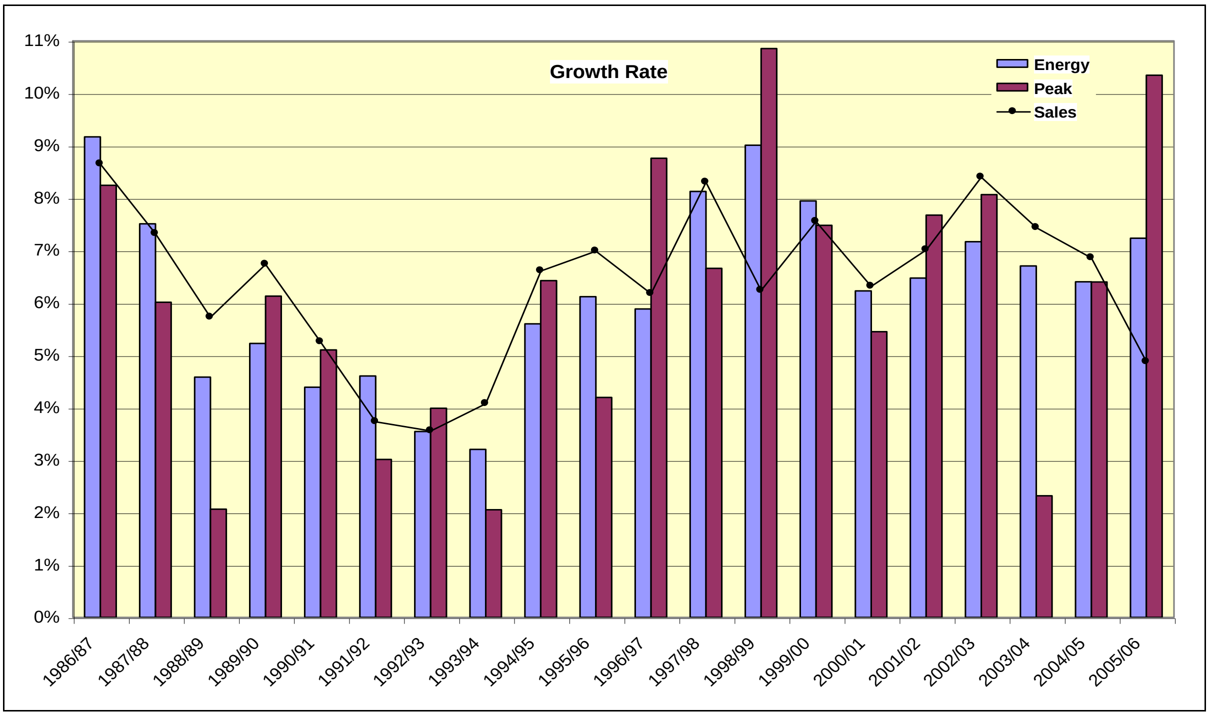

Figure 3.1-2 - Growth rate evolution for energy, sales, and peak load in Egyptian electric system.

Energy consumption by consumer sector (EEHC econometric model) has changed in the last 20 years. **Figure 3.1-3** shows the difference in sector share from fiscal year 1981/1982 to fiscal year 2005/2006, with the industry sector decreasing from 55% to 35% and residential sector increasing from 23% to 37%.

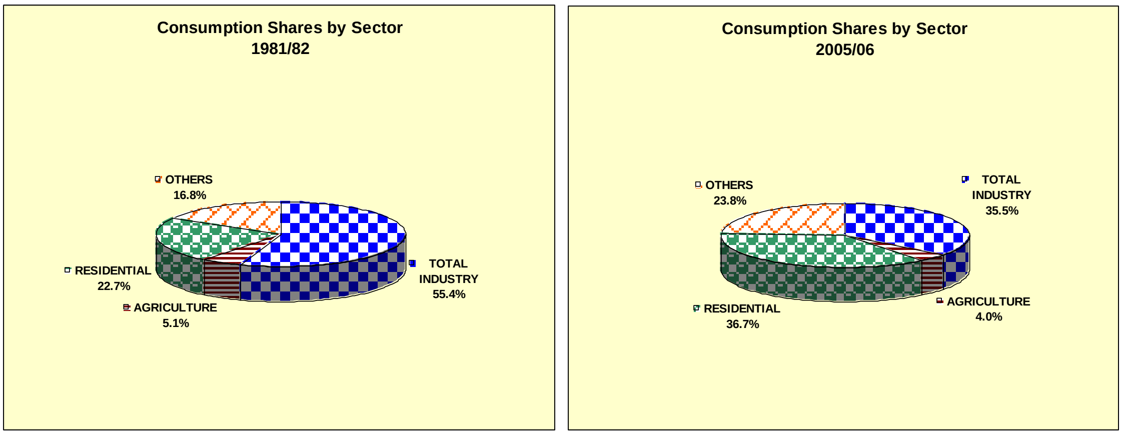

Figure 3.1-3 - Egyptian energy consumption from 1981/82 to 2005/06 by consumer sectors.

3.1.3 LOAD FACTOR

The load factor depends on the hourly variation of the load during the day and also on the variation of the daily maximum demand during the year. As mentioned in the preceding section, the residential consumption which represents about 36.7% of the total country consumption includes a high component of air conditioning, i.e. summer cooling and winter heating, with long periods of high temperature in summer. This leads to a high load factor. Industrial consumption, representing 35.5% of the total country consumption, lead also to a reasonably high load factor especially with the three daily shifts of the heavy industries.

Accordingly, the load factor of Egypt during the past decade has been reasonably high, varying between 70.5% and 73.5%. The average value of 72% calculated for the last 21 years doesn't change significantly for the last 5 years.

3.1.4 LOSSES

Electrical energy losses has been the concern of the Ministry of Electricity and Energy for the past three decades. The aim was to improve the efficiency of the system as has been indicated in M2 Vol 2 report.

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 (which is now merged with the Egyptian Electricity Holding Company) has entrusted the Electric Power Systems Engineering Company (EPS) to carry out a study for investigating the electric energy losses in the distribution networks and give recommendations for the design and rehabilitation of the distribution networks for the optimization of the electric energy losses.

At that time, 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 light loading of distribution transformers. As well as 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 to as low as 5.8% in some distribution companies. Early in the year 2000, the Egyptian Electricity Transmission Company realized the high 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 15.0% in the year 2004/2005.

During the past decade, the total losses of the electric power system has been reduced from 17% in the year 1991/1992 to 14.7% in the year 2005/2006 (**Figure 3.1-4**).

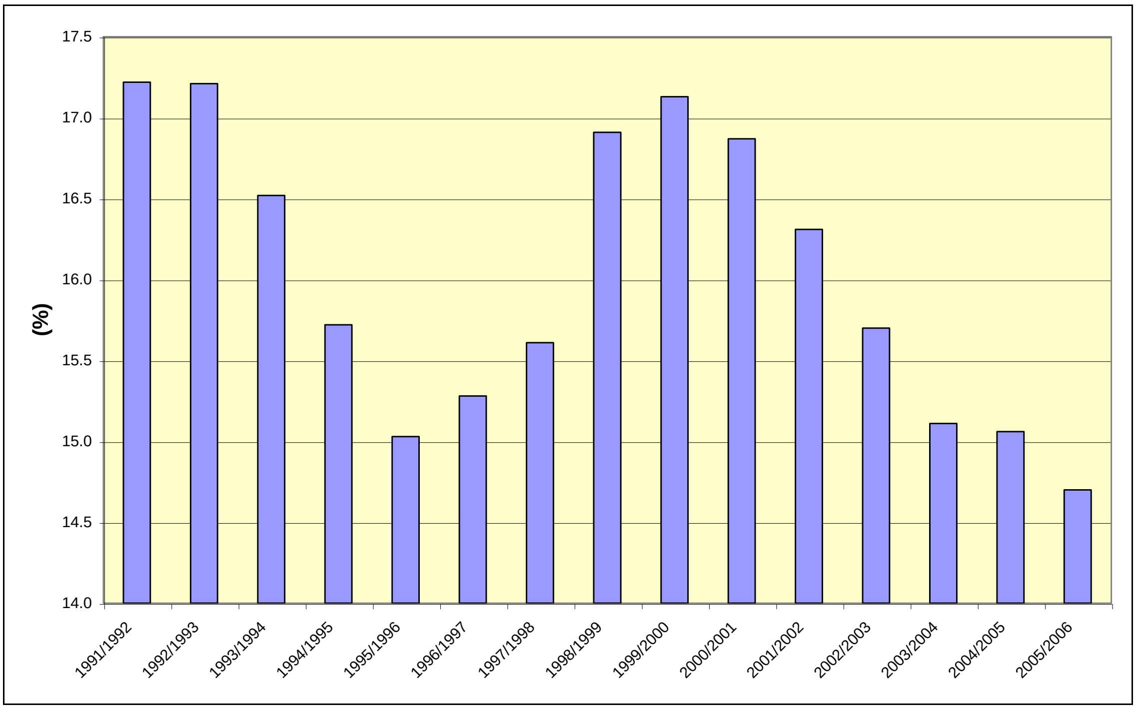

Figure 3.1-4 - Loss rate evolution (technical and non technical) in Egyptian electric system.

3.2 DEMAND VARIATION PATTERNS

3.2.1 DAILY LOAD VARIATION

Two major seasons affecting electricity demand can be observed in Egypt: summer and winter. Typical weeks of each season are described here after.

Winter hourly load data (**Figure 3.2-1**) shows two different patterns during the week, with a typical curve for working days (Sunday-Wednesday) and another one for week-end days (Friday-Saturday). Peak hour is similar for both, at 19h00.

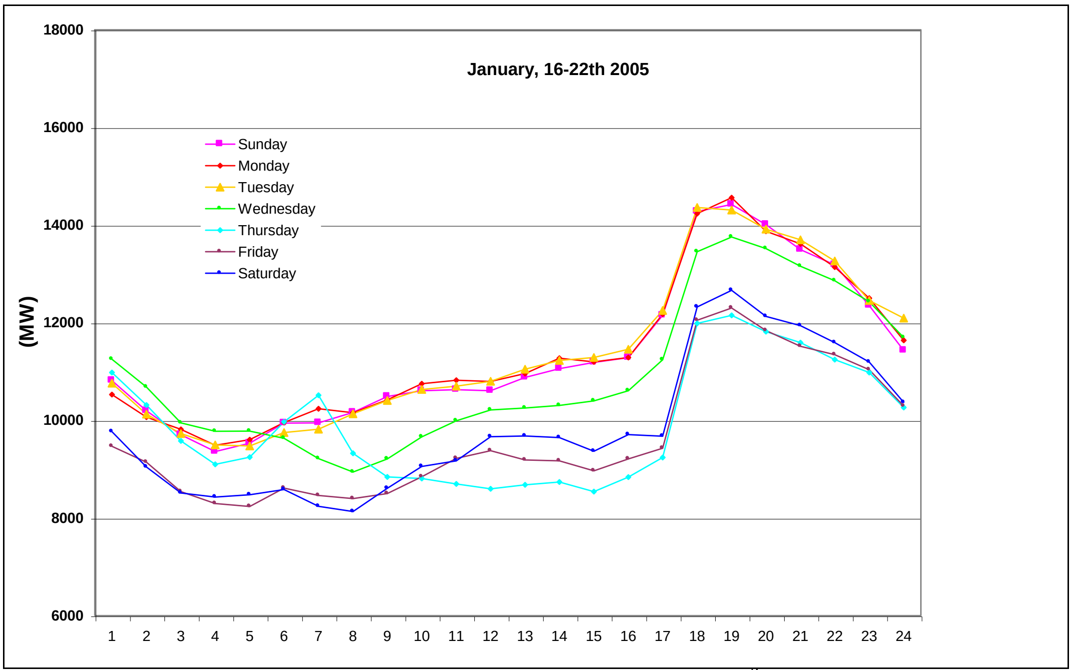

Figure 3.2-1 - Hourly load on January 16-22th 2005.

During the summer (**Figure 3.2-2**), Friday has still a week-end pattern while the other days have a similar pattern of working days. The peak day of the year 2005 is on august 15th, with 16 650 MW at 21h00, shifted +2h from the winter peak (of which + 1h00 is due to summer time).

In 2006, the peak was of 18 160 MW in August 22nd (Tuesday) at 21h00. In 2004 the peak day was on July, 14th (Wednesday) with 15 491 MW, and in 2003 it was on September 2nd (Tuesday) with 14 723 MW.

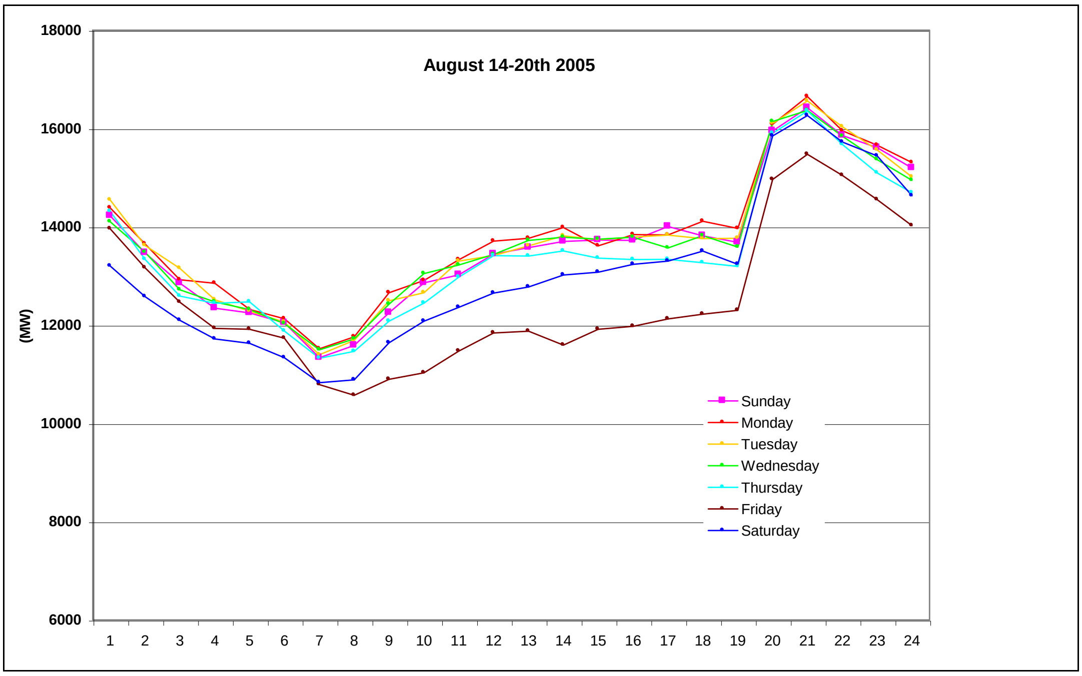

Figure 3.2-2 - Hourly load on August 14-20th 2005.

3.2.2 SEASONAL VARIATION

Daily energy demand along the year (**Figure 3.2-3**) shows a pronounced seasonality; it is clearly higher during the summer, increasing around 20% from January to the peak months July - August. The influence of the air conditioning in the consumption, as well as all the other cooling appliances, has been studied but no results are published until now.

Three important holydays in the year (January, April, October) show a steep decrease on demand (**Figure 3.2-3**). The date of these holydays changes every year.

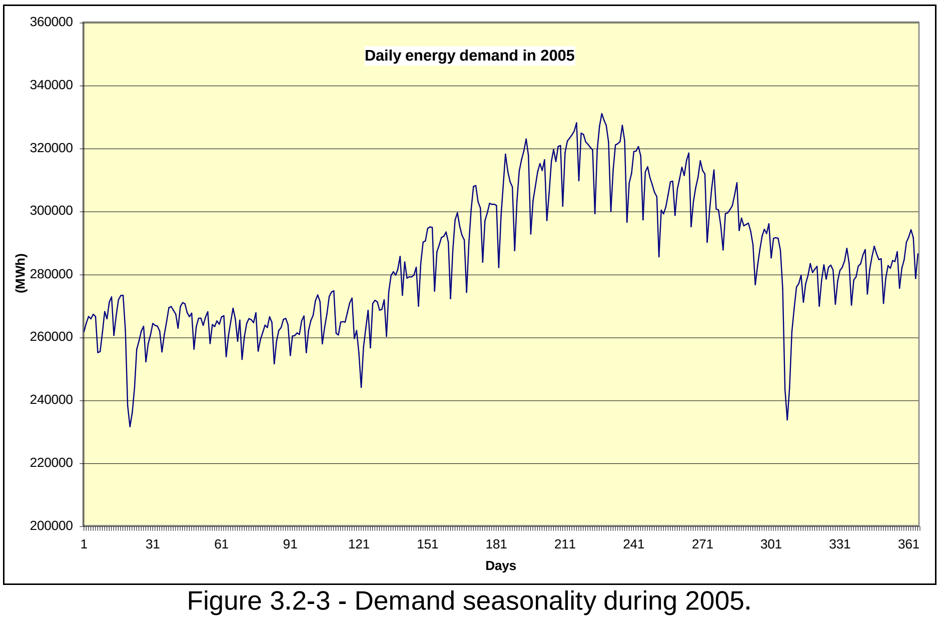

Figure 3.2-3 - Demand seasonality during 2005.

3.2.3 LOAD DURATION CURVE

The load duration curve for 2005 with a peak of 16 650 MW (21h00 on August 15th) is presented on **Figure 3.2-4**.

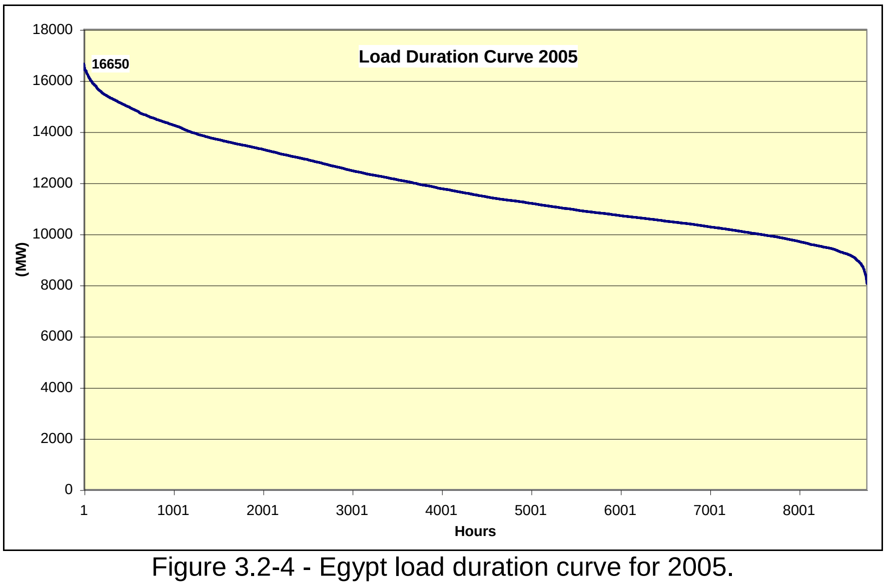

Figure 3.2-4 - Egypt load duration curve for 2005.

3.3 REVIEW OF THE DEMAND FORECAST

Since the isolated systems consumption in Egypt is negligible (0.8% of interconnected system), demand forecast considered it in the total consumption. The isolated areas are assumed to be completely absorbed by the interconnected system in 2007.

3.3.1 METHODOLOGY

The Egyptian Electricity Holding Company (EEHC) carries out a demand forecasting for each planning cycle of five years. Regression analysis (based on historical data) is used to relate the total energy consumption as a dependent variable to a set of independent or explanatory variables, i.e. the electricity sales per sector to one or more of the different econometric factors as Gross Domestic Product (GDP), GDP per sector, population and electricity price. The EEHC report is presented in Appendix 1.

The total energy generated is calculated by adding up the forecasted sector sales to the system losses. Evolution of losses is estimated taking into consideration the impact of the network expansion, rehabilitation and the power factor improvement on system losses reduction. Peak load is calculated by a load factor estimated for each forecasting scenario.

In general, each scenario of demand is based on assumptions of social-economic evolution (GDP, demography, population income, etc.), network developments, electrification rate evolution, electric appliances consumption rates, etc. The blend of all hypothesis in the econometric model gives different energy growth rates that leads to the construction of different demand scenarios.

Since the three scenarios determined in the EEHC forecasting exercise are affected by many uncertainties, the Department of Load Planning recommended to consider the medium scenario as the reference scenario for the generation expansion planning.

3.3.2 DEMAND FORECAST

The forecast developed by the Egyptian Electricity Holding Company (EEHC) is based on the econometric method. This method is applied to forecast the electric energy demand as a function of economic of historical data. These data are used to relate the total energy consumption as a dependent variable to a set of independent variables. These independent variables are the electric energy sales per category to one or more of the different econometric factors as the Total Gross Domestic Production (GDP), the GDP per consumption sector, the population and the electricity price. The full Report of the study of EEHC is presented in Appendix 1.

EEHC determined three demand scenarios (high, medium, and low) for the period from 2006/2007 to 2021/2022. A recent update (December 2006) extended these projections until 2029/2030. A reinforcement of the growth rates can be observed from the former exercise. **Figure 3.3-1** shows the future evolution of the peak load forecasted for three scenarios.

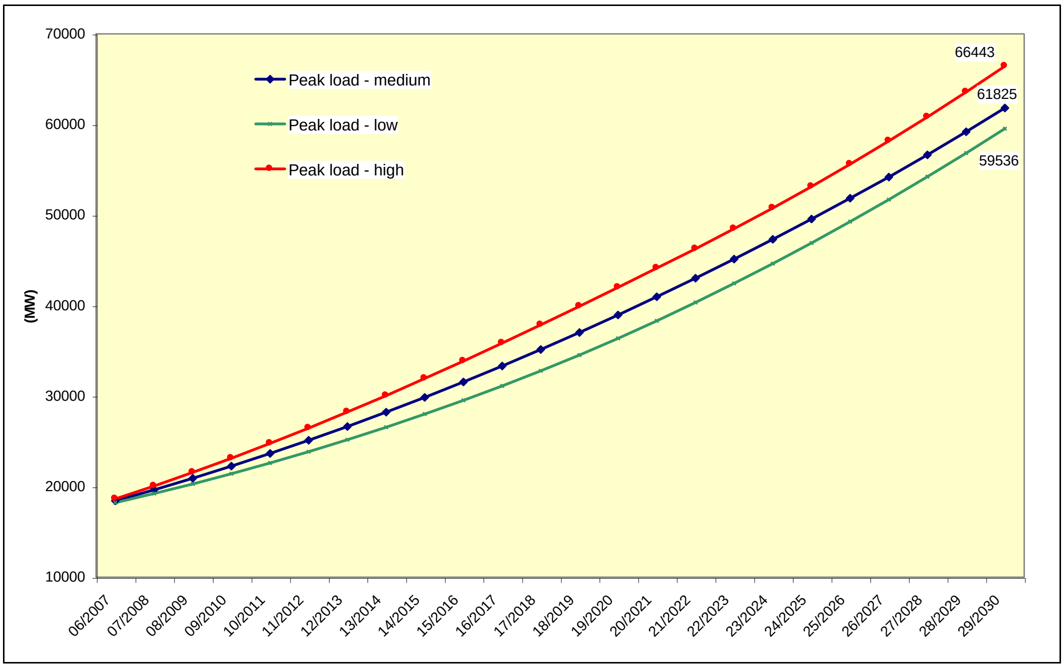

Figure 3.3-1 - Peak load forecast from 2006/2007 to 2029/2030 for three scenarios.

Figures for six years 2007/2008, 2010/2011, 2015/2016, 2020/2021, 2025/2026, and 2029/2030 are highlighted in **Table 3.1-1**. The peak load is produced in the beginning of the fiscal year (summer of the first year). Thus, the value for 2030 (summer peak) has to be evaluated.

Demand Forecast		07/2008	10/2011	15/2016	20/2021	25/2026	29/2030
TOTAL GENERATED ENERGY (GWh)	High	125653	155512	213438	279753	358909	437696
	Medium	123065	148538	198960	259708	334639	407272
	Low	120470	141901	186111	242846	317964	392195
PEAK LOAD (MW)	High	20059	24769	33860	44125	55610	66443
	Medium	19646	23658	31564	40963	51850	61825
	Low	19232	22601	29525	38304	49266	59536

Table 3.3-1- Total generated energy and peak load forecasted for six dates of the medium scenario.

An extension of 2029/2030 values to 2030/2031, using growth rates of the two last years, is presented in **Table 3.3-2**.

Demand forecast scenario	Growth rate from 2029/2030 to 2030/2031 (%)		GENERATED ENERGY (GWh)	PEAK LOAD (MW)
	Energy	Peak load		
High	**5**	**4.5**	**459654**	**69433**
Medium	**5**	**4.5**	**427554**	**64584**
Low	**5.3**	**4.8**	**412856**	**62364**

Table 3.3-2 - Extension values to 2030/2031 for energy and peak load demand.

Appendix 1 shows the whole results of demand forecast for the high, medium, and low scenarios. Annual growth rates of each scenario for total generated energy during the period from 2006/2007 to 2029/2030 are 5.9% (high), 5.6% (medium), and 5.5% (low). Growth rates per sector are quite similar, varying from 7% for Commercial sector to 5% for Agriculture and Government sectors (medium scenario). Annual growth rates for peak load are 5.7% (high), 5.4% (medium), and 5.3% (low).

Load factor changes from currently figure of 72% to 75% in 2029/2030. Losses decrease slightly from 14% to 13% during this period.

Forecasted energy consumption (without losses) per sector is shown in **Figure 3.3-2** for the period from 2006/2007 to 2029/2030 for the medium scenario.

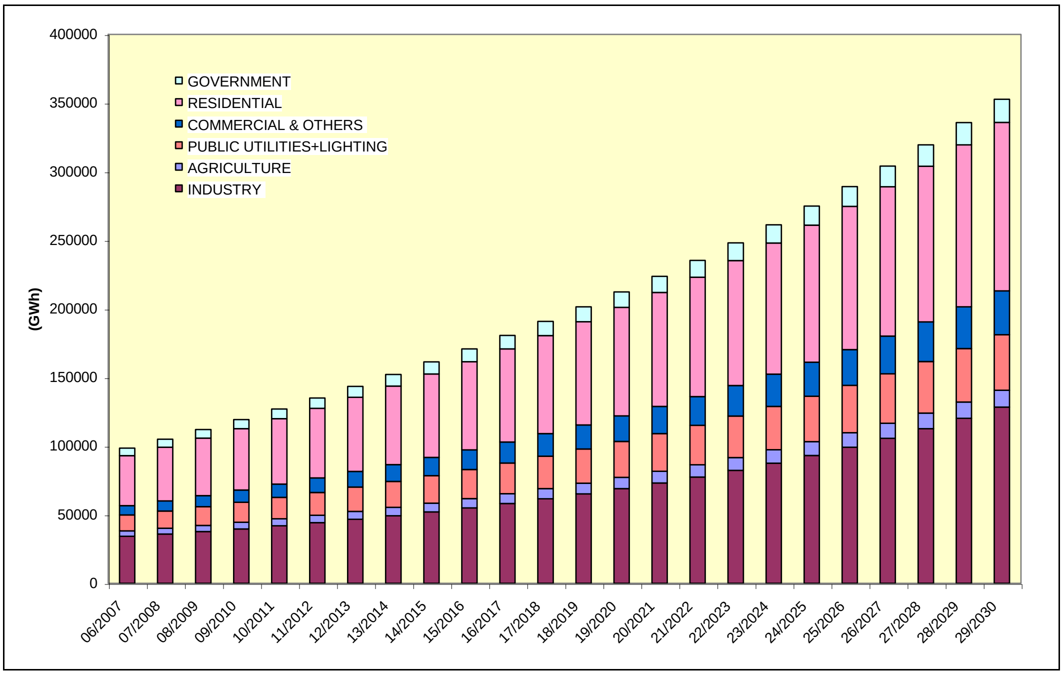

Figure 3.3-2 - Medium scenario forecast for generated energy.

3.4 TARIFF STRUCTURE AND TECHNOLOGY FOR METERING ELECTRICITY

3.4.1 TARIFF

The electric energy tariff structure is made in accordance with the same unified basis on which prices of electrical energy are set all over the world, taking the following into consideration:

- ✓ **Voltage levels:** prices get higher as voltage decreases to include costs of the losses of energy and the installation and operation of corresponding transmission and distribution networks.
- ✓ **Use of energy:** on low voltages as prices for production sectors are not the same as housing, commercial and public illumination uses.

The current tariff structure has been in application for all purposes since 1992 with due consideration to the varied income levels to observe the social dimension. It is essential to state that EEHC sets the tariff rates which must be approved by the Government (Cabinet of Ministers).

There tariffs are heavily subsidized in low voltage (residential user) and to much lower extend in high voltage. The **Figure 3.4-1** gives the electricity historical prices by sectors for years 1991/1992 until year 2005/2006.

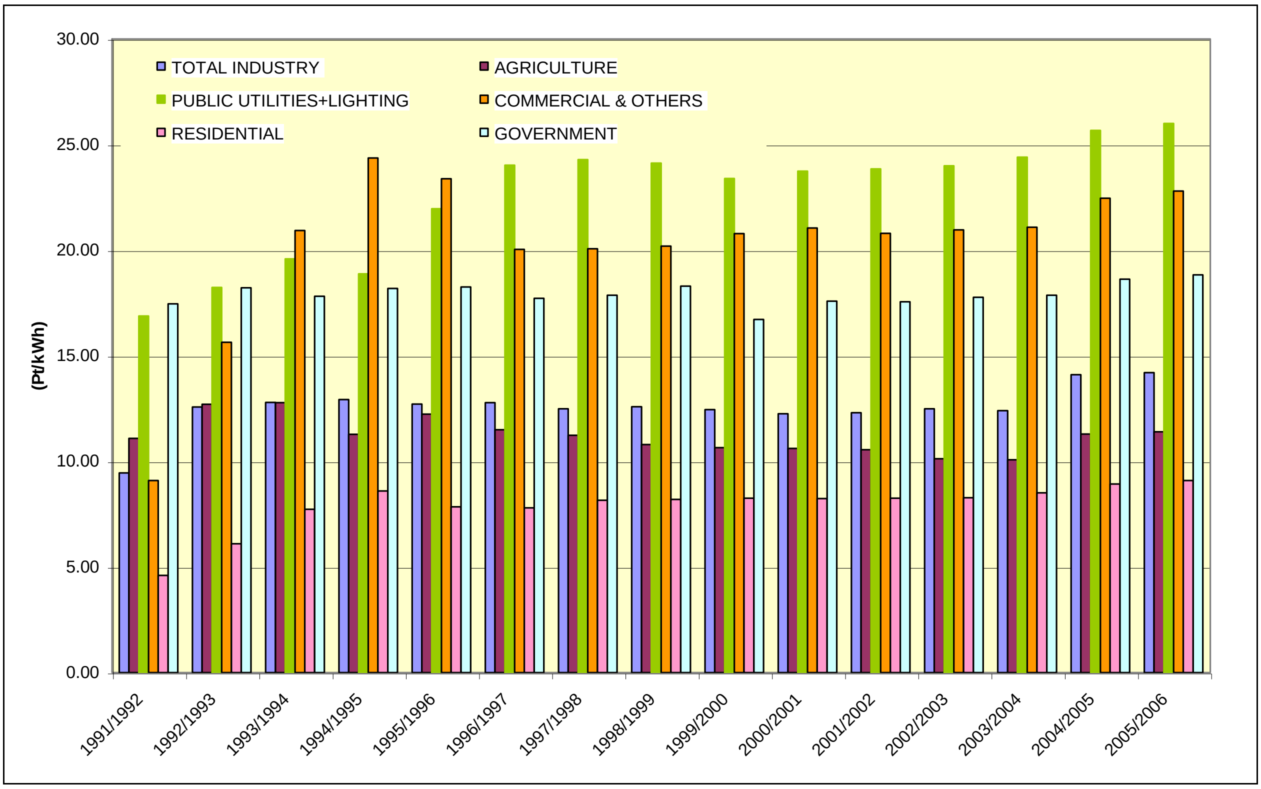

Figure 3.4-1 - Electricity historical tariff by sector.

According to EEHC, a Government Programme was established to increase fuel (principally NG) price to an economic level from 2006 to 2013/2014 (1.3 USD/MBTU for NG); electricity price has also to be increased to reach an economic level covering all development costs. To achieve this target NG should rise 9% per year while electricity should be increased by 7.5% per year. A first step toward this goal was done in 2004 with an electricity price increase of 8%, afterwards a step of 5% more in 2005, and another of 7.5% on October 2006, with different percentage of price increment applied according to the customer sector. **Table 3.4-1** presents tariff structure for year 2005.

Description	Price (Pt/kWh) Year (2005)
1- Power service on Ultra- High Voltage:	
• KIMA Company	4.70
• Metro – Ramsis	6.80
• Phosphate Abu-Tartour	6.80
• Sumed	22.00
• Other Customers	10.30
2- Power service on High voltage:	12.50
3- Housing Companies	12.00
4- Power service on Medium & Low voltage:	
• More then 500 KW:	
- Demand charge (LE/KW- month)	8.00
- Energy rates	17.00
• Up to 500 KW:	
- Agriculture & land reclamation	9.00
- Energy Rates (pt/kWh)	109.0
- Annual Charge/ fedan for Irrigation by Groups (LE)	
- Other purposes	20.00
5- Residential:	
- First 50 kWh Monthly	5.00
- 51 -200 kWh Monthly	9.20
- 201-350 kWh Monthly	12.50
- 351-650 kWh Monthly	18.00
- 651-1000 kWh Monthly	25.50
- More than 1000 kWh Monthly	31.00
6- Commercial:	
- First 100 kWh Monthly	19.80
- 101-250 kWh Monthly	28.70
- 251-600 kWh Monthly	36.60
- 601-1000 kWh Monthly	45.30
- More than 1000 kWh Monthly	47.50
7- Public lighting	33.10

Table 3.4-1 - Tariff structure in 2005. Source: Research in Electricity Sector, EPS, 2006. (Pt= piastres)

Figure 3.4-2 gives the tariff details and its future changes as received from the Egyptian Electricity Holding Company. It gives the total average price for the years 2006/2007 up to 2029/2030 for each of the electricity sectors, namely: industry, agricultures, public utilities, commercial, housing companies, residential and governmental.

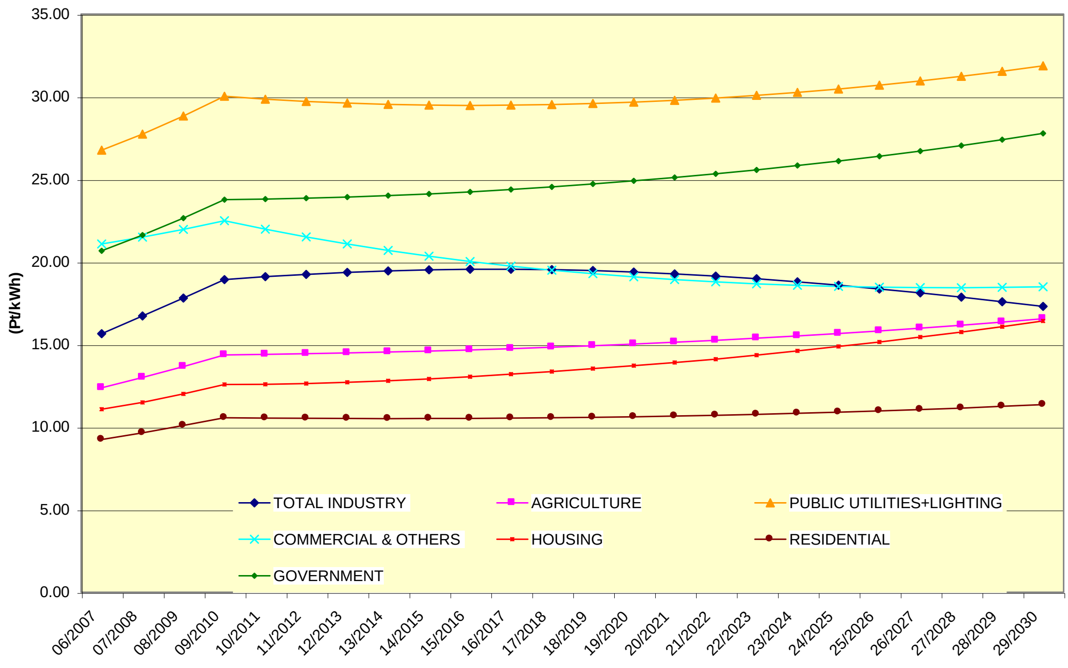

Figure 3.4-2 - Tariff evolution from 2006/2007 to 2029/2030 by sector.

3.4.2 TECHNOLOGY FOR METERING ELECTRIC ENERGY

Electricity metering in Egypt is generally carried out by electromechanical and digital energy meters. They consist of a set of voltage and current coils that make a metal disc rotate in proportion to the electric energy going through the meter. There is as set of magnets that act as brakes to the rotation of the disc and insure that the number of disc revolutions is proportional to the energy. The number of the disc revolutions is counted by a gear mechanism and displayed on the meter register. Electro mechanical energy meters are now manufactured in Egypt.

The electricity distribution companies have testing and calibration laboratories. Regular testing and necessary calibrations are carried out regularly and also upon the request of the customer.

Depending on the magnitude and type of the load of the customer, the electricity energy meter is either a single-phase meter or a three-phase meter.

Pre-payment electronic energy meters were recently introduced. Their use is still very limited to some residential districts, especially in summer resorts where the houses are occupied for a few months in summer time.

Metering Development of Electrical Networks

Since 2001 substantial efforts have been made to set-up metering protocol at the boundaries of the production plants, transmission lines and distribution networks as briefed hereunder:

1. High accuracy class 0.5 energy, active power, reactive power and frequency digital meters at power plants. The same set of meters except the frequency meters at the outgoing feeders. The meters are of Intelligent Electronic Devices (IEDs) type. New technologies for substation automation, control, metering and protection are being used for the power plants. Transducers for the same metering functions are installed for telemetry to NECC and RCCs.
2. High accuracy Class 0.5 Bidirectional Energy meters are installed at substations for 220 kV and 500 kV outgoing and/or Incoming transmission lines to measure interchanged energy between transmission companies. NECC and RCCs have their own transducers installed at the substations.
3. At substations, energy meters are installed at medium voltage outgoing feeders for measuring distribution companies' consumptions.
4. Digital meters have been installed at the outgoing feeders of 220 kV, 66 kV and 11 kV for individual large customers connected at extra high, high and medium voltage sources.
5. Electromechanical meters are the dominant meters for the majority of low voltage customers with 2% accuracy; however, a transition to digital meters of high accuracy and standard communication protocols has been started in the new installations.
6. The meters are providing active power, reactive power and power factor for tariff adjustment.
7. In the coastal areas and summer houses, prepaid meters are used.

Industrial and Large Commercial Customers

Large consumers are charged by the two rate tariff, the consumed electric energy in kWh and also the maximum kVA demand. Electro mechanical demand registers are installed for consumers with a demand higher than 500 kVA.

In order to limit the power factor on the electricity distribution system, the electricity companies has set a penalty on consumers with a power factor less than 0.92. For this purpose kWh and kVARh are installed. In case these large customers are supplied at the medium voltage level, voltage transformers are installed to step down the voltage to the meter voltage level. Current transformers are used whenever necessary.

4. POTENTIAL TRADE OPPORTUNITIES

The purpose in this task is to identify the potential of power trades between Egypt and the neighbouring countries (except Sudan and Ethiopia, which is one of the main focus of Module 6).

Potential of power and energy trade between the Egyptian electric utility and those of neighbouring countries could be affected through the formation of four regional power pools with Egypt as common member. These power pools are the following:

(i) The Middle East PP

Which includes Egypt, Jordan, Syria, Lebanon, Palestine, Iraq, Turkey and Iran.

This power pool has already started operation with the interconnection between Egypt, Jordan, Syria and Lebanon. Contractual agreements has already been in effect with all countries except Iran. Energy exchanges are already taking place.

(ii) The North Africa PP

Which includes Egypt, Libya, Tunisia, Algeria, Morocco and Mauritania. The interconnection system is already existing between them except Mauritania. Power and energy exchanges are already taking place between Tunisia, Algeria and Morocco. Synchronization of Egypt and Libya systems is underway.

(iii) The River Nile PP

Which includes Egypt, Sudan, Ethiopia, Kenya, Uganda, Eritrea, Djibouti and Somalia. This is one of the issues of this Study.

(iv) The Arab Power Pool

Which includes Egypt, Saudi Arabia, Yemen and the Gulf States namely: Kuwait, Bahrain, Qatar, the United Emirates and Oman. An Authority for the Gulf States Interconnection has been established and the project studies has been completed. The interconnection studies of Egypt with Saudi Arabia has started and is underway. Interconnecting Yemen with Saudi Arabia will follow.

4.1 ELTAM INTERCONNECTION

Currently, energy exchanges between the ELTAM (Egypt - Libya - Tunisia - Algeria - Morocco) countries are much smaller than the current operational capacities: 150 MW to Libya and 500 MW to Jordan (**Figure 4.1-1**). For example, in 2000 there were no exchanges greater than 130 GWh in a given direction. In 2004/2005, Egypt exported 680 GWh to Jordan and 20 GWh to Libya.

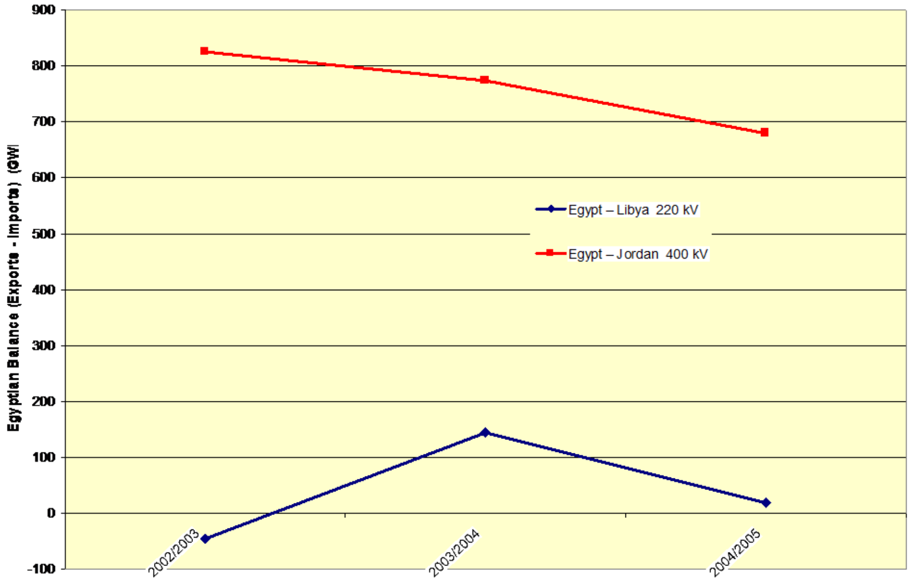

Figure 4.1-1 - Egyptian energy balance on interconnections with Libya and Jordan.

An EEHC study for increasing the exchanged electric energy among Egypt, Libya, Tunisia, Algeria, and Morocco to 400/500 kV was completed, as a part of the technical cooperation between Egypt and the Maghrib region to increase the capacity of transferred energy among the mentioned companies due to the existing interconnection voltage 220 kV.

An agreement was signed between these countries to implement the recommendations of the study. The Council of the Arab Ministers for Energy and Electricity is responsible for the global plans for the interconnection projects while countries utility coordinates with each other for the technical details:

- ✓ Ensuring the frequencies compatibility of the Egyptian Grid with the other interconnected Arab network (measurements and tests of the Tunisian - Libyan interconnection).

- ✓ Activating the tasks of the Coordinating Committee for Operating the Arab Interconnected Networks and deciding on its tasks in the operation, performance evaluation, and development and information systems for the year 2004/2005.

- ✓ Initiating the Eastern African power pool in order to develop the technical cooperation among these countries in the field of securing the energy supply and the optimal usage of the available energy resources in the region, and extending the electric service to the areas which don't have it yet. Also, the aim is to reduce the cost of producing the electricity in the east country of the Nile basin and studying the possibility of electric interconnection among these countries to exchange the energy and to work on the good coordination among the existing initiatives working producing, transmitting and exchanging the energy. In addition, the aim is to create an investment pool to finance the energy projects in these countries as part of the New Initiative Program for African Development (NIPAD).

- ✓ Establishing a dispatch centre similar to that of the European grid (Laufenbourg in Switzerland).

4.2 ARABIC – EUROPEAN INTERCONNECTION

The West interconnection from Morocco to Spain, using a marine cable, was fulfilled in August 1997.

The development of the 400 kV interconnection between the Arabic countries and Europe continues through two axes:

- To the East: through Turkey, following the interconnection between Syria and Turkey.
- To the centre: alternatives for connection the Italian network with one of the North African countries.

4.3 EGYPT – ARABIC COUNTRIES INTERCONNECTION

Certainly, after completion of the interconnection projects between the Arabic countries, the level of power exchanged will be increased, and there may be some necessity to transform the marine cable (part of the Egyptian Jordanian interconnection) to DC instead of AC, this will need converting stations (AC/DC) on both ends of this marine cable. As a result, power exchange through this cable could reach 1 100 MW.

4.4 POWER IMPORT FROM LARGE- HYDRO PLANTS IN AFRICA

It may be mentioned, that Large-Hydro resources exist of Africa which are not yet exploited (only 4% of the resources are used). An example is the Enga falls at Kongo river, where a plant of total capacity 40 000 MW might produce about 200 TWh/year electric energy. Most of this power could be transmitted to North Africa and, theoretically, to Europe through international interconnections.

Currently, investment is not available to carry out this project, and the economic feasibility is not proven, and there is no expectation to have this interconnection within the horizon of this Study.

4.5 POWER TRADE PROSPECTIVE

Trade opportunities between Egypt from one side and Jordan and Libya on the other side will be based on the present agreements, which took place in 1993 and 1998 (EPS, 2007). Anticipated energy and power trade in future depends on the demand forecast and the generation expansion plans of both Jordan and Libya, as well as competitive generation plus transmission costs in each of these countries.

The current transmission capacity is limited by 500 MW at the Jordan side and 150 MW at Libya side. The future capacity shall be raised to about 1 100 MW to Jordan side if they convert A.C submarine cables to operate on D.C. double circuit instead of single circuit.

On the Libya side the interconnection shall be upgraded by a 500 kV line so the future capacity will be raised to about 600 MW. Electric energy trade between Egypt and Jordan will depend also on the competition in trade opportunities between electricity and natural gas. Egypt will export natural gas to Jordan which will be partly used for firing generating stations. Hence, plans of power trade depend mainly on generation plans of Jordan and also competition between Egypt and Syria for supplying the requirement of Jordan. As for Libya, the Libyan power system is interconnected to Tunisia and then to Algeria, Morocco and Spain. Libya has its own primary energy resources and prepares its electric energy plans accordingly. While power exchanges depend on emergency requirement, the energy exchanges will depend on the electric energy generation cost, in the two countries.

Another possibility for trade is the electric energy export to the Kingdom of Saudi Arabia, especially the Western Regions. An interconnection study is now under way between Egypt and Saudi Arabia. EPS suggests an H.V.D.C. Link across the Straits of Tiran to interconnect the power system of Egypt to the power system of the Western Region of Saudi Arabia, which is not interconnected until now to the Central Region nor the Eastern Region where they have the oil fields. The cost of hydro-electric energy or even the cost of thermal energy supplied from Egypt might be competitive with the cost of energy based on oil transport from the east to the west of Saudi Arabia.

4.6 SUMMARY TABLE

In spite of available information and the local consultants expertise, the establishment of trade opportunities figures remains an speculative exercise. It is widely known that opportunities of trade depend on future plans of neighbouring countries as well as the other interconnections in the considered country (e.g. Sudan and Ethiopia and its transmission to Egypt and its neighbours). Nevertheless, according to the stable trend of the last 3 years measurement (**Figure 4.1-1**), a tentative long term exchange hypothesis can be based on the following assumptions:

- ✓ Egypt will continue to present an export balance;
- ✓ Exports will be quite similar in both directions;
- ✓ Energy exported will be stable over the time according to the future long term contracts.

A conservative export hypothesis is considered in the present Study:

Annual balance	2007		2008		2009		2010		2015		2020		2030	
	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)	(GWh)	(MW)
Egypt -> Libya	800	200	800	200	800	200	800	200	800	200	800	200	800	200
Egypt -> Jordan	800	200	800	200	800	200	800	200	800	200	800	200	800	200

Table 4.6-1 - Power export hypothesis

It is important to note that the amount of exported power have no impact in the result of the present Study (profitability of the interconnection between Egypt - Ethiopia - Sudan).

Indeed, increasing (or decreasing) the volume of exports (between Egypt and Libya or Jordan) would result in increasing (or decreasing) the number of CCGT power plants to be committed in the Egyptian generation expansion plan. The volume of power trade (between Egypt, Ethiopia and Sudan) would remain the same, because it is basically limited by the interconnection capacity. The specific savings (USD/MWh) from the interconnection would remain the same, because they result from the substitution of energy generated by CCGT in Egypt by hydro power generated Ethiopia of Sudan.

In this context, the major result of this Study - the evaluation of the profitability of power exchanges between Egypt, Ethiopia, and Sudan - will be constraint by the capacity and cost of the interconnection, the cost of CCGT and Natural Gas in Egypt, and the economical characteristics of HPP in Sudan and Ethiopia. This is discussed in more details in Module M3 Vol 5.

5. FUEL PRICES FOR POWER GENERATION

The current fuel prices provided by EEHC doesn't include transport price inside Egypt since Natural Gas is a national resource and petroleum is imported from Middle East. These fuel prices are identical for all TPP, what leads to conclude that transport cost to each TPP inside the country is negligible or is not included in the price announced. For the three types of fuels consumed in thermal power plants, the current prices are significantly subsidized:

- NG 0.66 $/MBTU or 2.3 US$/MWh
- HFO 0.81 $/MBTU or 2.8 US$/MWh
- Diesel oil 13.4 $/MBTU or 45.7 US$/MWh

For comparison, the market price of Natural Gas for the European market was between 5 to 6 USD/MBTU in 2006.

According to EEHC, a Government Programme is established to increase fuel (principally NG) price at an economic level from 2006 to 2013/2014. To achieve this target NG should rise 9% per year. At this rate, in 2014 NG price will achieve a level of 1.3 US$/MBTU (or 4.6 US$/MWh), which is quite below the market price estimated at 6.4 US$/MBTU in 2015 (see Module 3 Vol 5).

The fuel costs considered in the Study will be the international costs (see discussion and justifications in Module 3 Vol 5).

6. GENERATION SUPPLY OPTIONS

The purpose of this section is the identify the potential generation candidates to be considered in Module 6 economic study. The ranking and screening of these power candidates will be carry out in Module M4 (for large HPP) and Module 6 (for TPP).

The information relative to these supply options have been gathered by EPS and the Consultant.

6.1 THERMAL POWER PLANT CANDIDATES

The thermal candidates identified from EEHC data for the development of the Egyptian generation are:

- 750 MW dual-fired (NG or HFO) CCGT for base load,
- 250 MW dual-fired (NG or HFO) fired OCGT for peak-load,
- 350 MW /450 MW /650 MW dual-fired (NG or HFO) steam turbine.

Given the large amount of Natural Gas in Egypt, the economic study in Module 6 will considered these plant burn on natural gas.

The Consultant confirms that these candidates are the best candidates for Egypt.

The development of Dabaa nuclear power plant (base-load generation) is included in EEHC long term development of the generation mix. In the economic study (Module 6), the Consultant will consider this plant committed along the same schedule as in EEHC expansion plan.

Name of the plant	Plant site location	Type of generation unit	Fuel(s) types	Heating value (GJ/ 1000Nm3)	Installed capacity (MW)	Capacity derating	Auxiliary consump.	Net available capacity (MW)	Forced outage rate (%)	Planned outage rate (days/year)	Efficiency (%)	Fixed O & M costs ($/kW-year)	Variable O & M costs ($/MWh)	Life time of the plant	Investment generation cost ($/kW)
Sidi Krir	East Delta	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	512
Kurimat (3)	Upper Egypt	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	483
Nobaria (3)	West Delta	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	464
Atfe	West Delta	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	567
Sharm El-Sheik	West Delta	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	576
Alexandria East	West Delta	CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	600
Combined Cycle 750MW		CCGT	NG/HFO	36.3	750	37.5	21.4	691.1	6	28	52	16.3	0.2	25	600
Open Cycle GT 250 MW		OCGT	NG/HFO	36.3	250	12.5	4.8	232.8	6	21	38	16.3	0.2	25	500
Abu Qir	West Delta	ST	NG/HFO	36.3	650		26.0	624.0	4	28	42	2.3	0.2	40	752
Suez	East Delta	ST	NG/HFO	36.3	450		18.0	432.0	4	28	42	2.3	0.2	40	750
Steam Units 450MW		ST	NG/HFO	36.3	450		18.0	432.0	4	28	42	2.3	0.2	40	900
Cairo West Ext.	Cairo	ST	NG/HFO	36.3	350		14.0	336.0	4	28	40	2.3	0.2	40	571
Tebbin	Cairo	ST	NG/HFO	36.3	350		14.0	336.0	4	28	40	2.3	0.2	40	720
Ayoun Musa Ext.	Upper Egypt	ST	NG/HFO	36.3	350		14.0	336.0	4	28	42	2.3	0.2	40	980
Steam Units 650MW		ST	NG/HFO	36.3	650		26.0	624.0	4	28	42	2.3	0.2	40	941
Borg El-Arab		Solar/Thermal			300				4	21		72.5	0.6	25	1024
Kurimat	Upper Egypt	Solar/Thermal	NG/HFO		150				4	21		72.5	0.6	25	1024

Table 6.1-1 - Technical characteristics for TPP candidates. Source: EEHC, EPS, and Consultant references.

It can be noted that the investment generation cost of CCGT is lower (in the range of 450 to 500 USD/kW) when a new unit is installed in an existing site (e.g. Kurimat, Nobaria) already provided with all basic equipment. In contrast, new sites (e.g. Sharm El Sheik) require additional equipments and installations. Accordingly, the investment cost reaches in that case 600 USD/kW.

The efficiency of CCGT giving in the previous table (52%) is typical for modern CCGT in the Egyptian temperature condition.

The following typical values were considered: 5% derating due to temperature for CCGT and OCGT; auxiliary consumption: 4% for ST, 3% for CCGT and 2% for OCGT. Where needed, net available capacities were calculated using these values.

The disbursement schedule for each type of thermal power plant is the following:

TPP	Disbursements				
	Year - 4	Year - 3	Year - 2	Year - 1	Year 0
OCGT	-	-	50%	50%	Commissioning
CCGT, Solar	-	39%	40%	21%	Commissioning
Steam Turbine	25%	25%	25%	25%	Commissioning

Table 6.1-2 - Disbursement schedule for Thermal Power Plants candidates.

6.2 HYDRO POWER PLANT PROJECTS

Few significant hydro projects still exist in the Egyptian Nile basin. Only run of the river HPP are projected, with a clear priority of the water resource use given to irrigation. A new hydro power plant (64 MW) is currently under construction in the Naga-Hammadi site. It is included in the list of existing plants (Module M2) since it is expected to end on 2008. Three other plants are planned until 2012/2013:

- ✓ Delta Barrage - Damietta branch on River Nile of 13 MW capacity. Construction starts on 2007. Commissioning is expected on FY 2010.
- ✓ Zefta Barrage - on Damietta branch of River Nile, of 5.5 MW capacity expected starting execution works on 2009. Commissioning is expected on FY 2011.
- ✓ Assiut Barrage - capacity of 40 MW. Commissioning is expected on FY 2012.

These projects will be considered committed as described above in the economic study (Module 6).

6.2.1 PRESENTATION OF EACH PROJECT

Table 6.2-1 summarizes the main technical characteristics for each project collected by EPS with the collaboration of the Water Resources and Irrigation Ministry.

Name of Hydro Plant Project	Damietta	Assiut	Zefta
Energy coefficient in kWh/m3 (function of stock level for storage facilities, average for the other facilities)			
Number of turbines	3	4	1
Maximum capacity of each turbine in MW		10	
Maximum physical discharge of each turbine in m3/s	110	283	150
Total maximum capacity (MW)	13	40	5.5
Total maximum discharge (m3/s)	330		
Environmental constraints (biological life, fish recovery) or multipurpose constraints (irrigation, drinking water)	Irrigation	Irrigation. Headpond level fixed 80% year	Irrigation
Fixed annual operating expenses			
Expected average generation	84	262	40
Earliest operation date	2011	2012	2013
Expected life duration (years)		100 (civil), 50 (M&E)	
Investment schedule			
Generation investment cost (M€)		114.2	

Table 6.2-1 - Technical characteristics of HPP candidates. Source: Water Resources and Irrigation Ministry, and EPS.

6.2.2 SCHEMATIC CONFIGURATION OF RIVER SYSTEM

In the existing HPP Nile cascade, there are: High Dam with lake Nasser, then right downstream there are two other HPP, Aswan I and II with a small intermediate lake, afterwards, there are the others run of the river HPP, Esna and Naga-Hammadi. Downstream three others run of river HPP are in project: Assiut, Damietta and Zefta (the last two of them in the Delta of the Nile). **Figure 6.2-1** illustrates the hydropower plants cascade planned in Egypt.

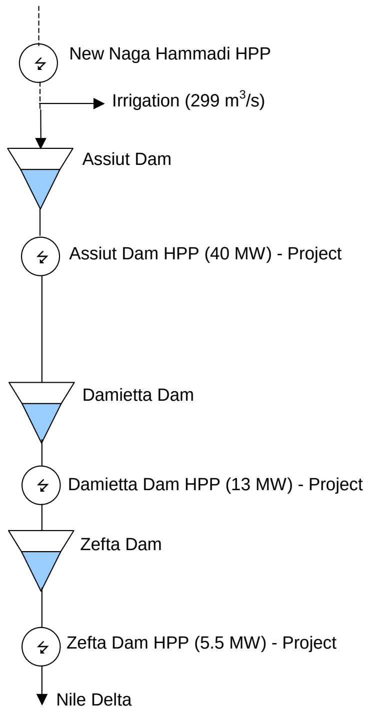

Figure 6.2-1 - Scheme of HPP projects in Egypt.

6.2.3 INFLOWS REFERENCE SERIES

Hydrological data[1] for Assiut, Damietta and Zefta HPP projects is presented in **Figure 6.2-2**. Appendix M2 Vol 2, item 8 presents detailed data concerning flows.

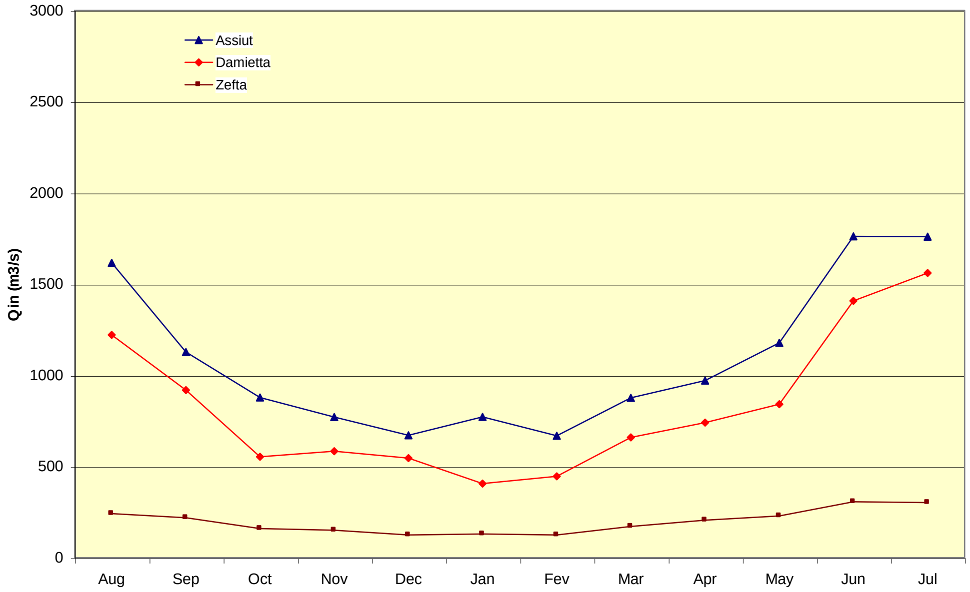

Figure 6.2-2 - Mean inflow to Assiut, Damietta and Zefta HPP projects from 1980 to 2000. Source: Fahmy, A. 2006.

It is important to note that with the large new projects, as the irrigation project Toshka (on the west bank of Lake Nasser) and the downstream Salaam canal, Egypt experiences a water re-distribution which also requires that present crop patterns along the Nile and in the Delta are changed at large scale. The result of such changes is that historical discharge patterns will not be valid in the future, e.g after implementation of the hydropower projects.

If further information from Water Resources and Irrigation Ministry is not available, these changes will not be considered in the economic study (Module 6).

6.3 WIND ENERGY

The NREA Plan targets to increase the installed capacity to around 3 000 MW in 2020. According to EPS, the following additional wind farms are either under implementation or committed:

Total Installed Wind Capacity per Fiscal Year (MW)																
2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
225	280	430	555	685	845	1 045	1 245	1 445	1 645	1 845	2 045	2 245	2 445	2 645	2 845	3 045

Table 6.3-1 - Total installed Wind Capacity

If the private sector was called for participation, an additional 300 MW capacity per year might be expected, reaching a total capacity (private and non private sector) of 7 000 MW in 2020.

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

In the economic study (Module 6) a conservative approach is considered with around 3 000 MW target in 2020 as described above (without private sector). Based on Module 2 Vol 2 Assessment, the Consultant will assumed a 40% load factor.

6.4 SOLAR THERMAL ENERGY

A conceptual design for the first Solar Thermal Combined – Cycle Power plant of 150 MW capacity to be installed at El-Kureimat, 90 km south Cairo, was concluded. Short lists for pre-qualified contractors of both solar and combined cycle islands are under preparation. The project is expected to be operated by mid 2009. Based on the results of the performance of this first prototype plant and technology achievements in the field, a program for a series of similar plants might be prepared, targeting a 750 MW generating capacity by the year 2020.

According to EPS, the following solar power generation will be implemented:

2009/2010	El-Kureimat	150 MW
2016/2017	Borg El-Arab	300 MW
2018/2019	Borg El-Arab Add	300 MW

These projects will be considered as described above in the economic analysis. The Consultant will assume the same technical characteristics presented for Kureimat in **Table 6.1-1** for all solar power plants.

6.5 OTHER TYPES OF POWER CANDIDATES

The following projects are either of small capacity or at a very early stage of analysis in Egypt (no technical or economic study available). They are mentioned only for information and will not be considered in the economic study (Module 6).

6.5.1 PUMPING – STORAGE

In order to face peak load conditions of the electric network, pumping – storage power plants rely on the idea of making use of the difference between the daily (or weekly) minimum and peak load in the network to pump water from a lower level reservoir to other reservoirs at higher level, then using the stored water to generate electricity during peak load conditions. The pump/ turbine cycle is economical founded provided the amplitude between minimum and peak load is large enough. If this condition is achieved, this will result in improving the quality of power supply, saving fossil fuel, better stability conditions of the network.

Some locations potentially suitable for such projects have been proposed at Ain-Sokhna, Naga-Hammadi, Ataka South of Suez City (which is the most suitable location) where a plant of 2 100 MW capacity might be installed.

These projects are only at a very early stage of analysis (no technical or economic studies available) accordingly, the Consultant will not considered them in the economic study (Module 6).

6.5.2 MINI HYDRO PROJECTS

About 22 locations in Egypt are under study to be used for electric energy production through mini-hydro technology (**Table 6.5-1**). Total installed capacity can reach to 24 MW.

Site	HEAD m	FLOW m^3/sec	POWER MW
Rosetta Barrage	7.00	110.0	6.70
Tawfiki Barrage	1.86	134.1	2.45
Edfina Barrage	1.96	96.3	1.85
Assiut Reg	1.33	229.5	2.99
Gamgara	1.94	50.1	0.95
Abbasi Rayah	1.48	127.1	1.84
Ibrahimia Canal Intake	1.38	114.3	1.55
Beheri Rayah	1.20	187.9	2.21
Bagouria Canal	1.84	34.0	0.81
West Naga Hammadi	1.21	81.2	0.96
Bahr Mouais	1.23	86.5	0.82
Mansuria Canal	1.30	74.3	0.94

Table 6.5-1 - Mini Hydro planned power plants.

The studies have to include making survey of the proposed locations, making feasibility studies and ranking them according to some priority, mainly based on economic conditions.

Considering their small capacities, these projects will not be considered in the economic study (Module 6).

6.5.3 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 (New & Renewable Energy Authority) 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:

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

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

Taking into account the early state of development of this kind of energy resource, the Consultant will not consider these projects in the economic study.

7. REVIEW OF THE EXISTING GENERATION EXPANSION PLAN

EEHC develops five-year plans for the generation expansion and network expansion including substations and transmission. These plans are presented to the Ministry of Electricity and Energy before submission to the Ministry of Planning for the integration of these plans into the National Development Plans. Regarding the financing, the generation plans depends mainly on international financing. The locally financed projects are approved by the Board of Directors of each concerned company, while the internationally financed projects must be approved by EEHC.

The present plan is the 5^{th} plan (2002 to 2007), the 6^{th} plan (2007 to 2012), the 7^{th} plan (2012 to 2017) and 8^{th} plan (2017 to 2022). These plans are subjected to modification due to several factors, the main factors are the change of the expected peak load and the availability of the financing to the proposed projects, which usually changes the time schedule of the project to be advanced or postponed to a later years.

It is worth mentioning that the least cost generation plan (techno economical model EGEAS) has been prepared for the 5^{th} and 6^{th} plans i.e. up to the year 2011/2012. For the later plans, no techno economical model was used.

All information concerning Generation Expansion Plan for Egypt comes from EEHC and EPS.

7.1 6TH GENERATION EXPANSION PLAN (2006/2007 – 2011/2012)

This plan was issued by EEHC in 2003 and endorsed by its Board of Directors.

Albeit the Consultant was not able to get the EEHC Generation Expansion Plan Report,

Table 7.1-1 synthesizes the most recent generation expansion data prepared by EEHC (soft files collected on December 2006) and EPS.

						Implementation schedule				
Name of the plant	**Plant site location**	**Type of generation unit**	**Fuel(s) types**	**Installed capacity (MW)**	**Net available capacity (MW)**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**
Sidi Krir	East Delta	CCGT	NG/HFO	750	691.1	500	250			
Kurimat (3)	Upper Egypt	CCGT	NG/HFO	750	691.1	500	250			
Nobaria (3)	West Delta	CCGT	NG/HFO	750	691.1	500	250			
Atfe	West Delta	CCGT	NG/HFO	750	691.1	500	250			
Sharm El-Sheik	West Delta	CCGT	NG/HFO	750	691.1				750	
Alexandria East	West Delta	CCGT	NG/HFO	750	691.1					
Combined Cycle 750MW		CCGT	NG/HFO	750	691.1					
Open Cycle GT 250 MW		OCGT	NG/HFO	250	232.8					
Abu Qir	West Delta	ST	NG/HFO	650	624.0			650	650	
Suez	East Delta	ST	NG/HFO	450	432.0					450
Steam Units 450MW		ST	NG/HFO	450	432.0					
Cairo West Ext.	Cairo	ST	NG/HFO	350	336.0			700		
Tebbin	Cairo	ST	NG/HFO	350	336.0		700			
Ayoun Musa Ext.	Upper Egypt	ST	NG/HFO	350	336.0				350	
Steam Units 650MW		ST	NG/HFO	650	624.0					1300
Borg El-Arab		Solar/Thermal		300						
Kurimat	Upper Egypt	Solar/Thermal	NG/HFO	150		150				
Dabaa Nuclear		Nuclear		1000						
New Naga Hammadi		Hydro		64		64				
Assiut		Hydro		40						40
Damietta		Hydro		13				13		
Zefta		Hydro		5.5					5.5	
Zafarana	East Delta	Wind		125		125				
Zafarana / Gabal El-Zait	East Delta	Wind					130	160	200	200

Table 7.1-1 - EEHC implementation schedule of the generation expansion plan until 2012.

7.2 7TH AND 8TH GENERATION EXPANSION PLAN (2011/2012 – 2026/2027)

A techno economical study was not carried out to prepare these plans. Supply options are a matter of government strategic options. **Table 7.2-1** summarizes some recent data prepared by EEHC (soft files collected on December 2006) and EPS.

Name of the plant	Plant site location	Type of generation unit	Fuel(s) types	Installed capacity (MW)	Net available capacity (MW)	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Sidi Krir	East Delta	CCGT	NG/HFO	750	691.1	500	250																	
Kurimat (3)	Upper Egypt	CCGT	NG/HFO	750	691.1	500	250																	
Nobaria (3)	West Delta	CCGT	NG/HFO	750	691.1	500	250																	
Atfe	West Delta	CCGT	NG/HFO	750	691.1	500	250																	
Sharm El-Sheik	West Delta	CCGT	NG/HFO	750	691.1				750															
Alexandria East	West Delta	CCGT	NG/HFO	750	691.1						500	500	500											
Combined Cycle 750MW		CCGT	NG/HFO	750	691.1						500	500		500	500	500	1000	500	500	500	500	500		
Open Cycle GT 250 MW		OCGT	NG/HFO	250	232.8																			
Abu Qir	West Delta	ST	NG/HFO	650	624.0			650	650															
Suez	East Delta	ST	NG/HFO	450	432.0					450														
Steam Units 450MW		ST	NG/HFO	450	432.0						1350	450	450		450	450				450	900	900	1350	450
Cairo West Ext.	Cairo	ST	NG/HFO	350	336.0			700																
Tebbin	Cairo	ST	NG/HFO	350	336.0		700																	
Ayoun Musa Ext.	Upper Egypt	ST	NG/HFO	350	336.0				350															
Steam Units 650MW		ST	NG/HFO	650	624.0					1300		650		1300	1300	1300	1300	650	1950	650	1300		1300	1300
Borg El-Arab		Solar/Thermal		300										300		300								
Kurimat	Upper Egypt	Solar/Thermal	NG/HFO	150		150																		
Dabaa Nuclear		Nuclear		1000									1000					1000		1000		1000		1000
New Naga Hammadi		Hydro		64		64																		
Assiut		Hydro		40						40														
Damietta		Hydro		13				13																
Zefta		Hydro		5.5					5.5															
Zafarana	East Delta	Wind		125		125																		
Zafarana / Gabal El-Zait	East Delta	Wind					130	160	200	200	200	200	200	200	200	200	200	200	200					

Table 7.2-1 - EEHC Generation Expansion Plan from 2008 until 2027.

7.3 BALANCE BETWEEN SUPPLY AND DEMAND

The following table (**Table 7.3-1**) describes the future evolution of the balance between supply (installed capacity) and demand (peak-medium scenario forecast) according to EEHC Generation Expansion Plan.

Capacity (MW)	06/2007	07/2008	08/2009	09/2010	10/2011	15/2016	20/2021	24/2025	26/2027
Peak load	18435	19646	20921	22259	23658	31564	40963	49550	54200
Total	20563	22213	24552	26382	27905	37550.5	49900.5	60250.5	63170.5
Margin ratio	12%	13%	17%	19%	18%	19%	22%	22%	17%

Table 7.3-1 - Balance between supply and demand up to 2012.

Figure 7.3-1 gives a graphic representation of the evolution of the installed capacity of the generation mix and its composition, compared to the annual peak demand from 2007 until 2027.

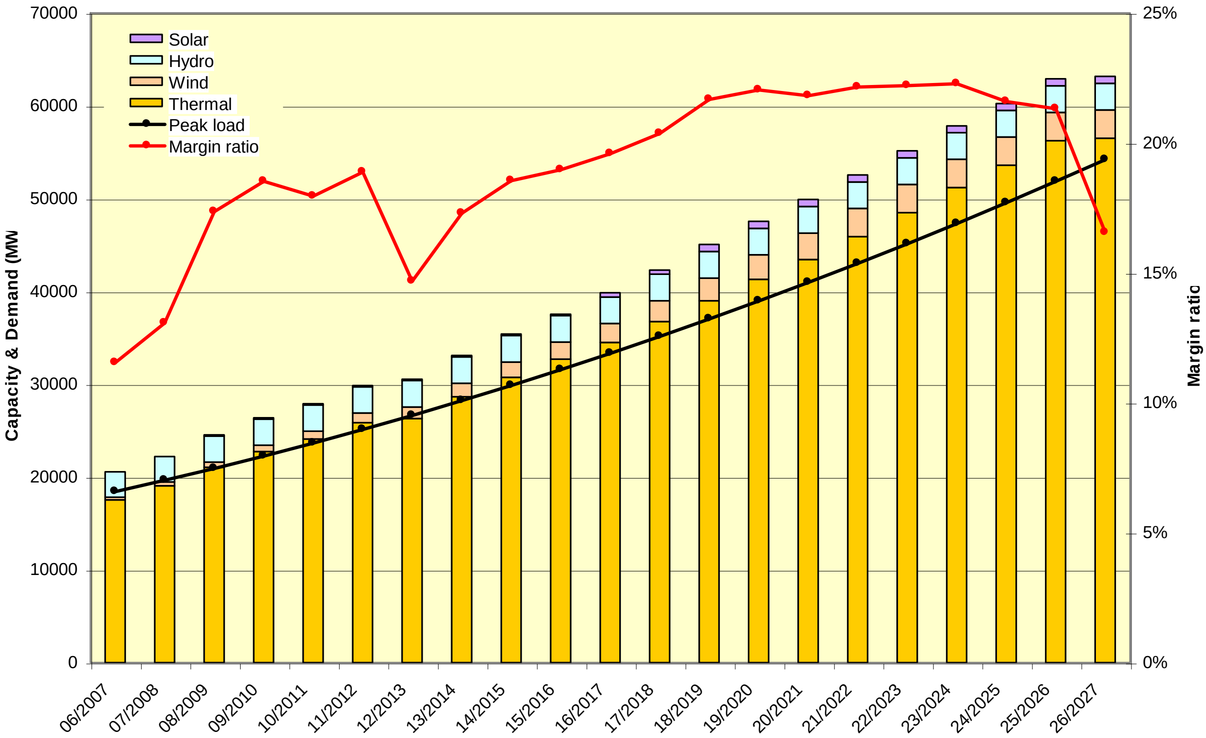

Figure 7.3-1 - Future balance between installed capacity and demand.

8. REVIEW OF THE EXISTING TRANSMISSION MASTER PLAN

See excel sheet: 2-5 EEHC Planned TL and substations till 2015-1.xls

Existing transmission system

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 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.

The system consists of more than 38 000 km of transmission lines, of which 2 262 km are at 500 kV level, 33 km at 400 kV level, 13 920 km at 220 kV level, 2 467 km at 132 kV level, 16 248 km at 66 kV and 2 725 km at the 33 kV levels respectively. 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.

Proposed Transmission Installation up to 2015 (see **Table 7.3-1** and **Table 7.3-2)**

This analysis is based on two lists of proposed equipment elaborated by the network expansion studies: the one put into services between 2005 and 2010, and the one between 2010 and 2015.

The main reinforcements are described here after.

- 500 kV system. About 570 km of double circuit line and 190 km of single circuit line will be commissioned by 2015:
    - a single circuit line from Cairo 500 to Nobaria by 2005;
    - a single* circuit line from Sidi Krir power station in west delta to Nobaria, by 2010;
    - a new 500/220 kV substation in North Delta, connected by a single 500 kV circuit to Abu Zaabal and to Nobaria, by 2010;
    - a single* circuit line from Sidi Krir to Dabaa, and from Dabaa to Saloum 500 by 2015;
    - creation of a 500/220 kV substation in New Heliopolis on the line Tabbin.500 to Abu Zaabal;
    - creation of a 500/220 kV substation in Sohag on the line Naga-Hammadi to Assiut.
- 220 kV system. The reinforcement of the 220 kV network is based on double circuit lines:
    - reinforcement of the 220 kV network with new lines in Delta zone, around Cairo and in Upper Egypt.

* the 2015 line list (with the lines' characteristics - Ref. Excel file 2-1 EEHC Transmission Lines Data) specified a single circuit line, whereas the file containing the 2015 lines' modifications (Ref. 2-5 EEHC Planned TL and substations) and presented in appendix, specified a double circuit line.

Interconnection reinforcement

In the ELTAM project, the reinforcement of the interconnection between Egypt and Libya is expected by a 500/400 kV system, with a 500/400kV transformation substation in Tobrouk and a single circuit line between Tobrouk and Saloum.

EXPECTED SUBSTATIONS UP YEAR 2015

ZONE	Substation Name	N\E	Voltage Ratio	Transformers No.	Capacity	Totl Installed Capacity (MVA)
CAIRO						
70	El Mokatm	N	220/66	3	125	375
71	Mostord	N	220/66	3	125	125
72	South Giza	N	220/66	3	125	375
73	Bashteel	N	220/66	3	125	375
74	Zaharra Nasr City	N	220/66	3	125	375
75	El Nahda	N	220/66	3	125	375
ALEXANDRIA						
143	Sidi Barani	N	220/66	2	125	250
952	Daba	E	500/220	2	375	750
953	El Saloum	E	500/220	1	375	375
144	El Montazah	N	220/66	2	125	250
DALTA						
76	Samanoud	N	220/66	2	125	250
77	Sherbin	N	220/66	2	125	250
78	Kafr Ziad	N	220/66	2	125	250
79	Shebin.K	N	220/66	2	125	250
80	N.Banha	N	220/66	2	125	250
CANAL						
105	N.Sharkia	N	220/66/11	2	125	250
809	Ras .Ghareb	N	220/66/11	2	125	250
104	Wadi Tecn	N	220/66/11	2	125	250
UPPER EGYPT						
5102	Ballat	N	220/66	2	125	250
	Mania. W	N	220/66	2	125	250
	B.Suif.W	N	220/66	2	125	250
	El Safa	N	220/66/11	2	75	150
	South Wadi	E	500/220	1	375	375
	Marsa Alam	N	220/66	2	75	150
	Quiser	N	220/66/11	2	75	150

Table 7.3-1 - Expected Substations up year 2015

Expected Transmission Line UP Year 2015

Zone	Transmission Line Name	Voltage Level (KV)	Length(KM)	No.of Circuits	Type & Cross Section
ALEXANDRIA	Construct T.L Daba500 - Sidi Krir 500	500	120	2	ACSR3*495
	Construct T.L Daba500 - Saloum 500	500	320	2	ACSR3*495
	Construct T.L Montza - Abo kir	220	5	2	Cable 1*1250
	Construct T.L Montza -Suif	220	5	2	Cable 1*1250
	Open T.L M.Matrouh - Saloum (in/out) to Sidi Barani	220	10	2	ACSR2*400
CAIRO	Open T.L Bahteem – Zagazig (in/out) to Mostorod	220	2	2	Cable 1*1250
	Mostorod - Bahteem	220	4	2	ACSR2*400
	Mostorod - Zagzig	220	53	2	ACSR2*400
	Open T.L Cairo East – Basateen (in/out) toMokatm	220	2	2	Cable 1*1250
	Cairo East - Mokatem	220	10	2	ACSR2*400
	Basateen - Mokatem	220	5	2	ACSR2*400
	Construct Giza - Soush Giza	220	4	2	Cable 1*1250
	Construct Motamadia - Soush Giza	220	7	2	Cable 1*1250
	Open T.L Motamadia – Basouss (in/out) to Bashteel	220	2	2	Cable 1*1250
	Basouss - Bashteel	220	20	2	ACSR2*400
	Motamadia - Bashteel	220	3	2	ACSR2*400
	Open T.L Saker - Cairo East (in/out) to Zahara Nasr City	220	2	2	Cable 1*1250
	Zaharra Nasr City - Sakr	220	7	2	Cable 1*1250
	Zaharra Nasr City - Cairo East	220	7	2	Cable 1*1250
	Construct Nahda - Obour	220	4	2	ACSR2*400

	Open T.L Abo Zabel - Helioplious (in/out) to Nahda	220	3	2	Cable 1*1250
	Nahda - Abo Zabel	220	12	2	ACSR2*400
	Nahda - Heliopes	220	12	2	ACSR2*400
DELTA	Construct T.L Banha - Kaloubia	220	35	2	ACSR2*400
	Construct T.L Banha - Mit Ghamer	220	40	2	ACSR2*400
	Construct T.L Shbin Kom - Quwesna	220	15	2	ACSR2*400
	Construct T.L Shbin Kom - Kafr Zaid	220	35	2	ACSR2*400
	Open T.L Domait (G) - Mahala (in/out) to Sherbin	220	30	2	ACSR2*400
	Open T.L Tanta - Itay Baroud (in/out) to Kafr Zaid	220	40	2	ACSR2*400
	Open T.L Tanta – Mahala (in/out) to Samanoud	220	20	2	ACSR2*400
CANAL	Open T.L Kantara East - Oun Mosa (in/out) to Wadi Tech.	220	20	2	ACSR2*400
	Open T.L Zafarana - Bhurgada (in/out) Ras Gharb	220	20	2	ACSR2*400
	Open T.L Sharkia - Manayfe (in/out) N.Sharkia	220	20	2	ACSR2*400
UPPER EGYPT	Open 1 ct.T.L Assuit500 - N.Ham 500 (in/out) to Sohag 500	500	20	1	ACSR3*495
	Construct T.L Marsa Alam - Wadi Naqraa	220	160	2	ACSR2*400
	Construct T.L Qursier - Wadi Naqraa	220	210	2	ACSR2*400
	Construct T.L B.SEUF West - Maghagha West	220	40	2	ACSR2*400
	Open T.L Riva - Assuit (in/out) to Safa	220	20	2	ACSR2*400
	Construct T.L Balatt - Abu Tartour	220	90	2	ACSR2*400
	Open T.L Samalout - Mallawi West (in/out) to Menia West	220	20	2	ACSR2*400

Table 7.3-2 - Expected Transmission Line UP Year 2015

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

EASTERN NILE POWER TRADE PROGRAM STUDY

AfDB

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)

ENERGY SECTOR PROFILE & PROJECTIONS

VOL 2 - EGYPT

FINAL APPENDIX

June 2007

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EGYPTIAN ELECTRICITY HOLDING COMPANY

LOAD AND ENERGY DEMAND FORECAST REPORT

Prepared by: Department of Load Planning

1 INTRODUCTION

Within the planning cycle, load & energy forecast is one of the several ways of stating objectives. The load & energy forecast is an alternate to foresee the quantities of electric energy needed by different consumers at different times.

Egyptian Electricity Holding Company has developed different load and energy forecast methodologies and models.

This forecast has been developed based on the econometric method to forecast the energy demand as a function of economic and demographic variables. Regression analysis (based on historical data) is used to relate the total energy consumption as a dependent variable to a set of independent or explanatory variables, i.e. the electricity sales per class to one or more of the different econometric factors as Gross Domestic Product (GDP), GDP/sector, Population (POP) and the electricity price.

2 STEPS TAKEN TO PRODUCE THE FORECAST

2.1 ANALYSES OF HISTORICAL DATA

Analysis of the historical electric power consumption of the different classes of customers during the period 1981/1982 to 2005/2006 indicates that the industrial sector consumption has decreased from 55.4% in fiscal year 1981/1982 to 35.52% in fiscal year 2005/2006 of the total consumption, also the agricultural sector consumption has decreased from 5.1% in fiscal year 1981/1982 to 4.03% in fiscal year 2005/2006 of the total consumption. While the residential sector consumption has increased from 22.7% in fiscal year 1981/1982 to 36.7% in fiscal year 2005/2006. For other consumption sectors (commercial, government, public utilities, sales for resale, street lighting) their consumption share has increased from 16.8% in fiscal year 1981/1982 to 23.8% in fiscal year 2005/2006 of the total consumption.

Analysis of the Egyptian economy represented by Gross Domestic Product (GDP) [total and per sector] reflected a strong correlation with the electric power consumption.

The Egyptian economy grew rapidly during the decade following the first oil price rise (1974-1986). The GDP has grown at an average annual rate of 7.17% during the period 1981-1986 due to many factors including oil exports, Suez Canal revenues and workers remittance. This high growth rate has slowed down until it reached the level of 1.98% in fiscal year 1991/92 and then started to pick-up again recently, due to the country policy of encouraging investment by the private sector.

The total energy consumption growth has generally mirrored the economy. The growth rates of the total energy consumption and peak demand have increased to reach 10.4% and 9.5% respectively in the interval 1981-1986. These high growth rates have slowed down until they reached the level of 5.7% and 4.5% in the interval 1987-1992. They continued to slow down for the total energy consumption and increase for the peak load and reached the level of 5.5% and 5.1% respectively in the interval 1992-1997. In marked contrast, the growth rates of the total energy consumption and peak demand started to pick-up again recently and reached 7.1% and 7.6% respectively in the interval 1997-2002.

2.2 DATA BASE

A database for the period 1980/1981 – 2005/2006 was established containing the following:

- Historical energy sales for the different customer classes / electricity companies.
- Historical figures for GDP / customer classes in constant prices.
- Population and electrified population.
- Current electricity price / customer classes.
- Historical total sales and consumer price indices.

2.3 ENERGY SALES FORECAST

For Commercial, Industries and Residential Customers

Step 1

The price elasticity and price coefficient are calculated by running the EViews model with econometric equations, which relate historical energy sales/customer/sector to the electricity price.

Step 2

Rerun the EViews program for the total consumption/sector adjusted to price to get the best correlation with the economic factors, which is used to forecast the sector energy consumption.

For Agriculture, Public and Government Customers

By running Reviews model to test the correlation between energy sales, electricity prices and economic factors, it was found that the agriculture has price elasticity while the public utilities and government customers have no correlation to price.

2.4 UPS SALES FORECAST

UPS energy sales forecast = Total sales (industrial + agriculture + residential + commercial + government + public utility + sales for resale)

2.5 ENERGY GENERATED FORECAST

The total energy generated was calculated by adding up the UPS sales to the system losses.

GROSS GENERATION = UPS SALES + TOTAL UPS LOSSES

Forecast of the system losses as a percentage of gross system generation was estimated taking into consideration the impact of the network expansion, rehabilitation and the power factor improvement on system losses reduction.

2.6 PEAKL LOAD FORECAST

An estimate was made to the load factor for the three scenarios of peak load forecast

Peak Load =Gross Energy Generation / (Load Factor X **8 760)**

3 SUMMARY OF RESULTS

All the considered assumptions and the details that describe the steps taken to project energy sales, energy generation and peak load for the three scenarios as well as the intermediary and final results of the model / regression are shown in next Tables.

4 RECOMMANDATION

Since there are some uncertainties in the load and energy demand forecast due to external factors such as world trade organization and GATT rules of liberalization, competition, effect of globalization on export growth, volatile financial markets affecting direct investment...etc., and their effects on the level of industrial and agricultural growth and consequently the future electricity demand, the medium scenario is chosen to be used for generation and transmission network expansions and tariff studies.

SECTORS (GWh)	06/2007	07/2008	08/2009	09/2010	10/2011	11/2012	12/2013	13/2014	14/2015	15/2016	16/2017	17/2018	18/2019	19/2020	20/2021	21/2022	22/2023	23/2024	24/2025	25/2026	26/2027	27/2028	28/2029	29/2030	Annual Growth Rate
TOTAL INDUSTRY	34620	36600	38894	41207	43845	46549	49466	52455	55669	59017	62582	66300	70248	74371	78721	83259	88428	93958	99894	106350	113395	120994	129168	137962	6.2%
AGRICULTURE	4022	4325	4658	4988	5342	5696	6073	6447	6836	7225	7623	8019	8420	8816	9212	9598	10025	10455	10891	11340	11806	12279	12758	13240	5.3%
PUBLIC UTILITIES+LIGHTING	11778	12835	13978	15111	16317	17531	18816	20099	21432	22771	24140	25506	26890	28262	29632	30976	32449	33937	35445	36998	38606	40240	41891	43557	5.9%
COMMERCIAL & OTHERS	6867	7604	8421	9258	10166	11104	12111	13142	14227	15339	16492	17663	18866	20079	21307	22532	23867	25228	26619	28059	29555	31086	32644	34228	7.2%
RESIDENTIAL	36836	39859	43163	46438	49946	53485	57250	61020	64952	68914	72983	77055	81195	85313	89440	93505	97972	102499	107099	111851	116783	121808	126899	132049	5.7%
GOVERNMENT	5510	5951	6431	6899	7397	7894	8417	8936	9473	10008	10553	11092	11637	12173	12706	13225	13796	14372	14953	15551	16169	16797	17429	18065	5.3%
TOTAL	99633	107174	115545	123902	133013	142259	152133	162100	172588	183273	194373	205635	217257	229015	241016	253095	266537	280448	294899	310148	326315	343204	360789	379102	6.0%
SALES FOR INTERCONNECTION+BOOT	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	0.0%
TOTAL ENERGY SALES	100408	107949	116320	124677	133788	143034	152908	162875	173363	184048	195148	206410	218032	229790	241791	253870	267312	281223	295674	310923	327090	343979	361564	379877	6.0%
TOTAL GENERATED ENERGY	116929	125653	135334	144990	155512	166183	177572	189059	201140	213438	226205	239149	252497	265991	279753	293592	308995	324925	341464	358909	377397	396700	416787	437696	5.9%
PEAK LOAD (MW)	18650	20059	21578	23120	24769	26462	28243	30052	31935	33860	35842	37857	39919	42008	44125	46255	48475	50764	53139	55610	58168	60827	63582	66443	5.7%
LOAD FACTOR	71.57%	71.51%	71.60%	71.59%	71.67%	71.69%	71.77%	71.81%	71.90%	71.96%	72.05%	72.11%	72.21%	72.28%	72.37%	72.46%	72.77%	73.07%	73.35%	73.68%	74.06%	74.45%	74.83%	75.20%	0.2%
TOTAL LOSSES	14.13%	14.09%	14.05%	14.01%	13.97%	13.93%	13.89%	13.85%	13.81%	13.77%	13.73%	13.69%	13.65%	13.61%	13.57%	13.53%	13.49%	13.45%	13.41%	13.37%	13.33%	13.29%	13.25%	13.21%	-0.3%

Figure 2.6-1 - High scenario - demand forecast for fiscal year from 2006/2007 to 2029/2030

SECTORS (GWH)	06/2007	07/2008	08/2009	09/2010	10/2011	11/2012	12/2013	13/2014	14/2015	15/2016	16/2017	17/2018	18/2019	19/2020	20/2021	21/2022	22/2023	23/2024	24/2025	25/2026	26/2027	27/2028	28/2029	29/2030	Annual Growth Rate
TOTAL INDUSTRY	34217	35841	37702	39663	41867	44174	46645	49244	52041	54996	58169	61533	65136	68965	73062	77421	82308	87548	93129	99140	105641	112651	120213	128353	5.92%
AGRICULTURE	3975	4235	4516	4802	5101	5406	5726	6052	6390	6733	7086	7443	7807	8176	8549	8925	9331	9742	10153	10571	10999	11433	11873	12318	5.04%
PUBLIC UTILITIES+LIGHTING	11641	12568	13550	14545	15581	16636	17743	18869	20035	21219	22438	23672	24933	26207	27502	28804	30203	31622	33044	34490	35966	37465	38986	40524	5.57%
COMMERCIAL & OTHERS	6787	7446	8163	8911	9708	10538	11421	12337	13300	14294	15329	16393	17493	18619	19775	20952	22215	23507	24816	26157	27534	28943	30381	31844	6.95%
RESIDENTIAL	36408	39033	41840	44698	47693	50756	53985	57285	60718	64220	67836	71514	75287	79112	83011	86948	91191	95506	99846	104269	108797	113409	118100	122852	5.43%
GOVERNMENT	5446	5828	6233	6641	7063	7491	7937	8389	8855	9326	9808	10295	10790	11288	11792	12297	12841	13391	13940	14496	15064	15638	16220	16807	5.02%
TOTAL	98475	104951	112004	119260	127013	135001	143456	152175	161338	170789	180666	190850	201448	212367	223691	235348	248088	261316	274928	289124	304000	319539	335774	352697	5.70%
SALES FOR INTERCONNECTION+BOOT	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	0.00%
TOTAL ENERGY SALES	99250	105726	112779	120035	127788	135776	144231	152950	162113	171564	181441	191625	202223	213142	224466	236123	248863	262091	275703	289899	304775	320314	336549	353472	5.68%
TOTAL GENERATED ENERGY	115581	123065	131214	139591	148538	157750	167496	177539	188087	198960	210317	222018	234189	246720	259708	273068	287669	302819	318399	334639	351649	369408	387952	407272	5.63%
PEAK LOAD	18435	19646	20921	22259	23658	25119	26640	28221	29863	31564	33324	35145	37025	38964	40963	43022	45130	47310	49550	51850	54200	56642	59183	61825	5.40%
LOAD FACTOR	71.57%	71.51%	71.60%	71.59%	71.67%	71.69%	71.77%	71.81%	71.90%	71.96%	72.05%	72.11%	72.21%	72.28%	72.37%	72.46%	72.77%	73.07%	73.35%	73.68%	74.06%	74.45%	74.83%	75.20%	0.22%
TOTAL LOSSES	14.13%	14.09%	14.05%	14.01%	13.97%	13.93%	13.89%	13.85%	13.81%	13.77%	13.73%	13.69%	13.65%	13.61%	13.57%	13.53%	13.49%	13.45%	13.41%	13.37%	13.33%	13.29%	13.25%	13.21%	-0.29%

Figure 2.6-2 - Medium scenario - Demand forecast for fiscal year from 2006/2007 to 2029/2030

SECTORS (GWh)	06/2007	07/2008	08/2009	09/2010	10/2011	11/2012	12/2013	13/2014	14/2015	15/2016	16/2017	17/2018	18/2019	19/2020	20/2021	21/2022	22/2023	23/2024	24/2025	25/2026	26/2027	27/2028	28/2029	29/2030	Annual Growth Rate
TOTAL INDUSTRY	33800	35079	36553	38167	39985	41946	44064	46335	48786	51429	54293	57390	60742	64368	68302	72563	77395	82583	88155	94187	100765	107849	115435	123591	5.8%
AGRICULTURE	3927	4145	4378	4620	4871	5133	5409	5695	5990	6296	6614	6942	7281	7631	7992	8365	8774	9189	9611	10043	10491	10945	11401	11861	4.9%
PUBLIC UTILITIES+LIGHTING	11499	12301	13137	13996	14881	15797	16761	17754	18782	19843	20943	22079	23251	24460	25710	26997	28401	29829	31279	32767	34306	35868	37437	39020	5.5%
COMMERCIAL & OTHERS	6705	7288	7914	8575	9271	10006	10789	11608	12468	13366	14308	15290	16313	17378	18487	19637	20889	22174	23491	24850	26263	27709	29174	30663	6.8%
RESIDENTIAL	35965	38203	40565	43012	45549	48195	50998	53900	56921	60054	63317	66700	70208	73838	77603	81493	85748	90090	94513	99059	103776	108575	113407	118294	5.3%
GOVERNMENT	5380	5704	6043	6390	6746	7113	7498	7893	8301	8721	9155	9602	10062	10536	11024	11526	12075	12632	13195	13772	14368	14972	15576	16183	4.9%
TOTAL	97276	102721	108590	114761	121303	128190	135519	143185	151249	159709	168629	178002	187858	198211	209118	220582	233281	246496	260245	274678	289970	305918	322429	339612	5.6%
SALES FOR INTERCONNECTION+BOOT	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	0.0%
TOTAL ENERGY SALES	98051	103496	109365	115536	122078	128965	136294	143960	152024	160484	169404	178777	188633	198986	209893	221357	234056	247271	261020	275453	290745	306693	323204	340387	5.6%
TOTAL GENERATED ENERGY	114184	120470	127242	134359	141901	149837	158278	167104	176382	186111	196364	207133	218451	230333	242846	255992	270553	285697	301443	317964	335461	353699	372569	392195	5.5%
PEAK LOAD (MW)	18213	19232	20288	21425	22601	23859	25174	26563	28004	29525	31114	32789	34537	36376	38304	40331	42445	44635	46911	49266	51705	54233	56836	59536	5.3%
LOAD FACTOR	71.57%	71.51%	71.60%	71.59%	71.67%	71.69%	71.77%	71.81%	71.90%	71.96%	72.05%	72.11%	72.21%	72.28%	72.37%	72.46%	72.77%	73.07%	73.35%	73.68%	74.06%	74.45%	74.83%	75.20%	0.2%
TOTAL LOSSES	14.13%	14.09%	14.05%	14.01%	13.97%	13.93%	13.89%	13.85%	13.81%	13.77%	13.73%	13.69%	13.65%	13.61%	13.57%	13.53%	13.49%	13.45%	13.41%	13.37%	13.33%	13.29%	13.25%	13.21%	-0.3%

Figure 2.6-3 - Low scenario - demand forecast for fiscal year from 2006/2007 to 2029/2030