Egypt: Small Scale Cogeneration

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Notes before to go

Energy Efficiency Technologies include:-

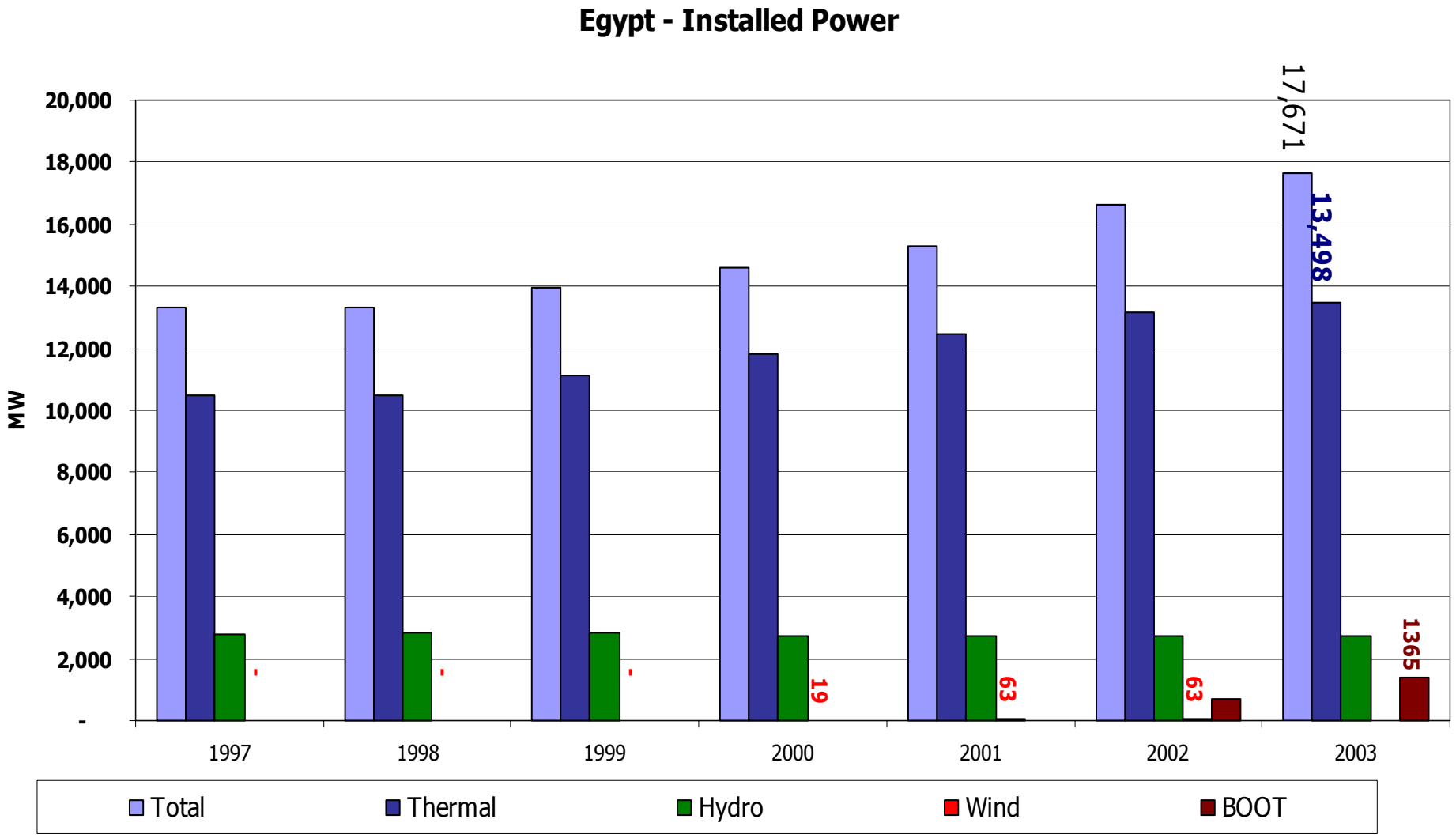
- WHR, COG, HEI, HEL, HEM, EMS, SSI, HER, CCS, … etc

Cogeneration

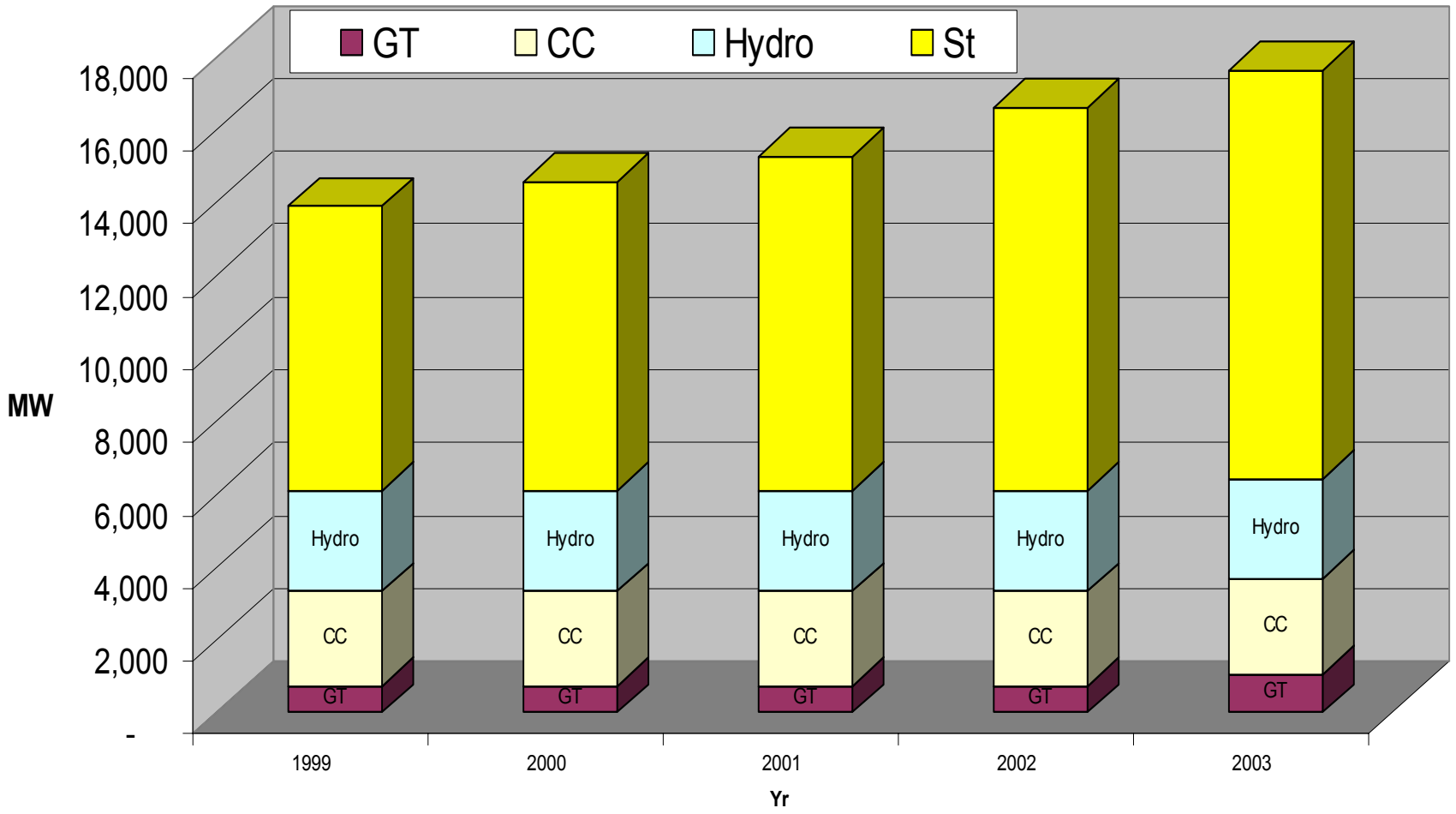
- You do not have to sell back electricity
- Which is to be covered and/or partially covered thermal or electrical energy

Egypt: Energy Situation (brief)

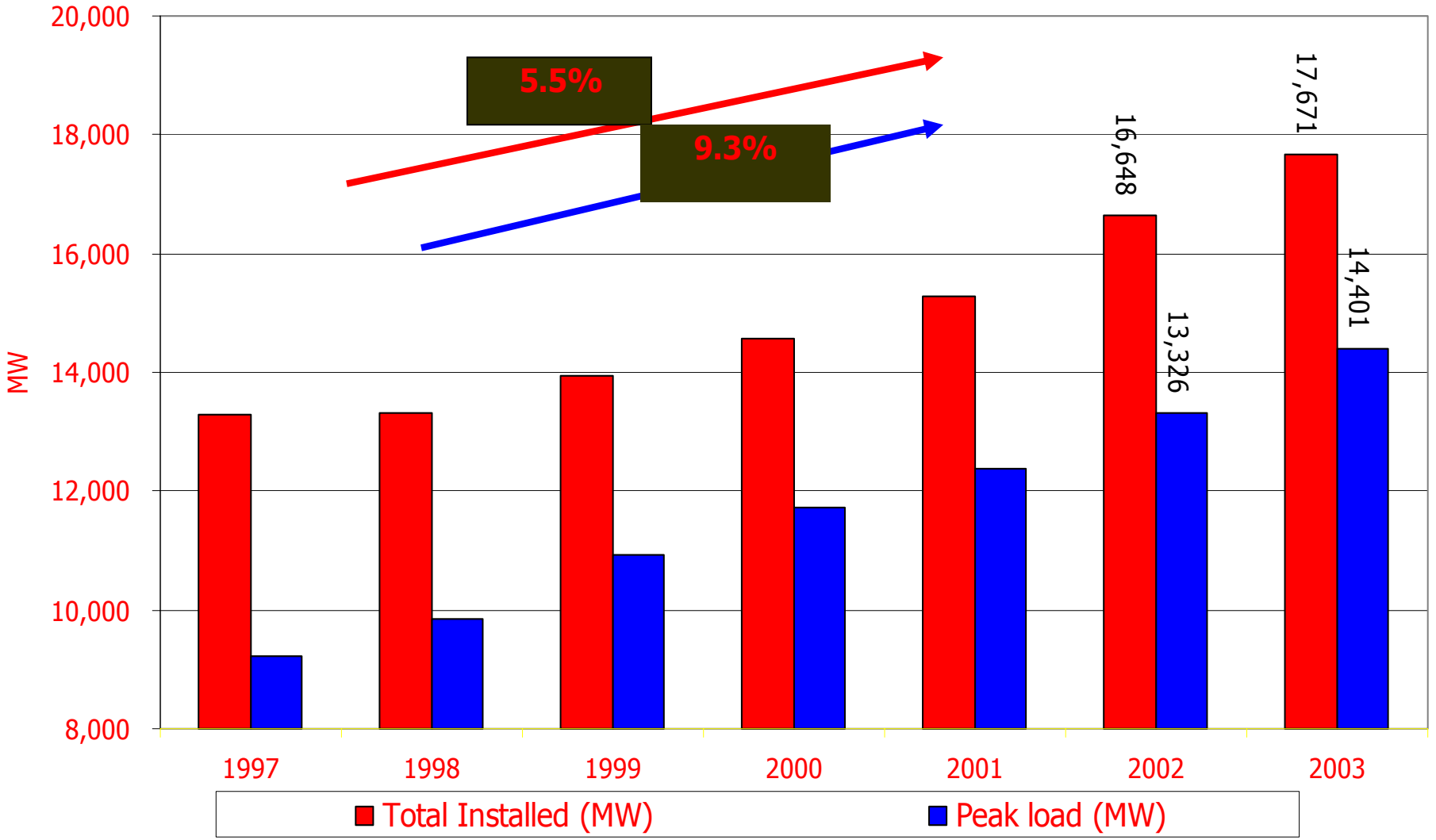
Egypt - Installed Power



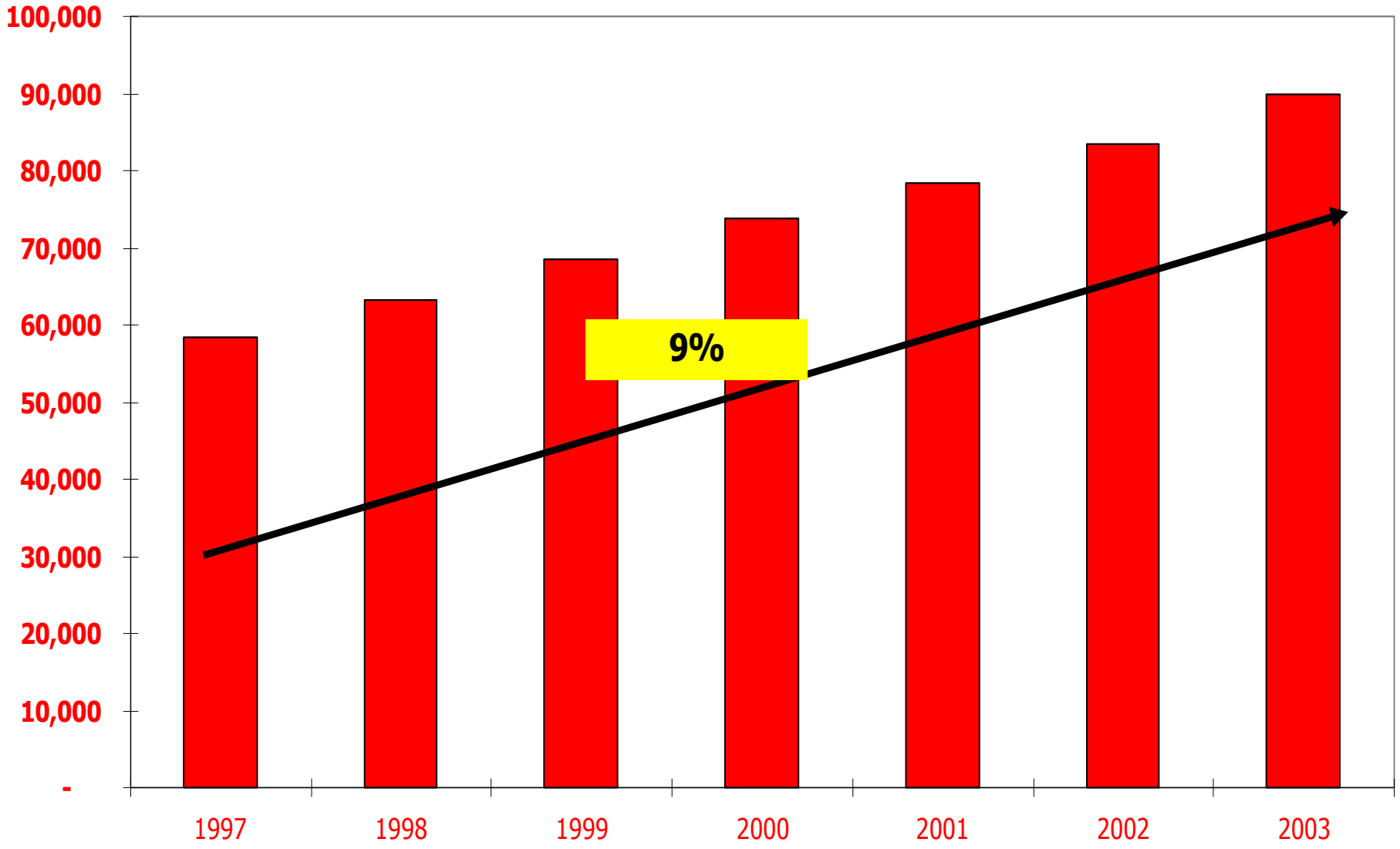
Egypt: PS Mix


GT
CC
Hydro
St
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
MW
Hydro
CC
GT
1999
2000
2001
2002
2003
Yr

Egypt Annual Installed & Peak Power

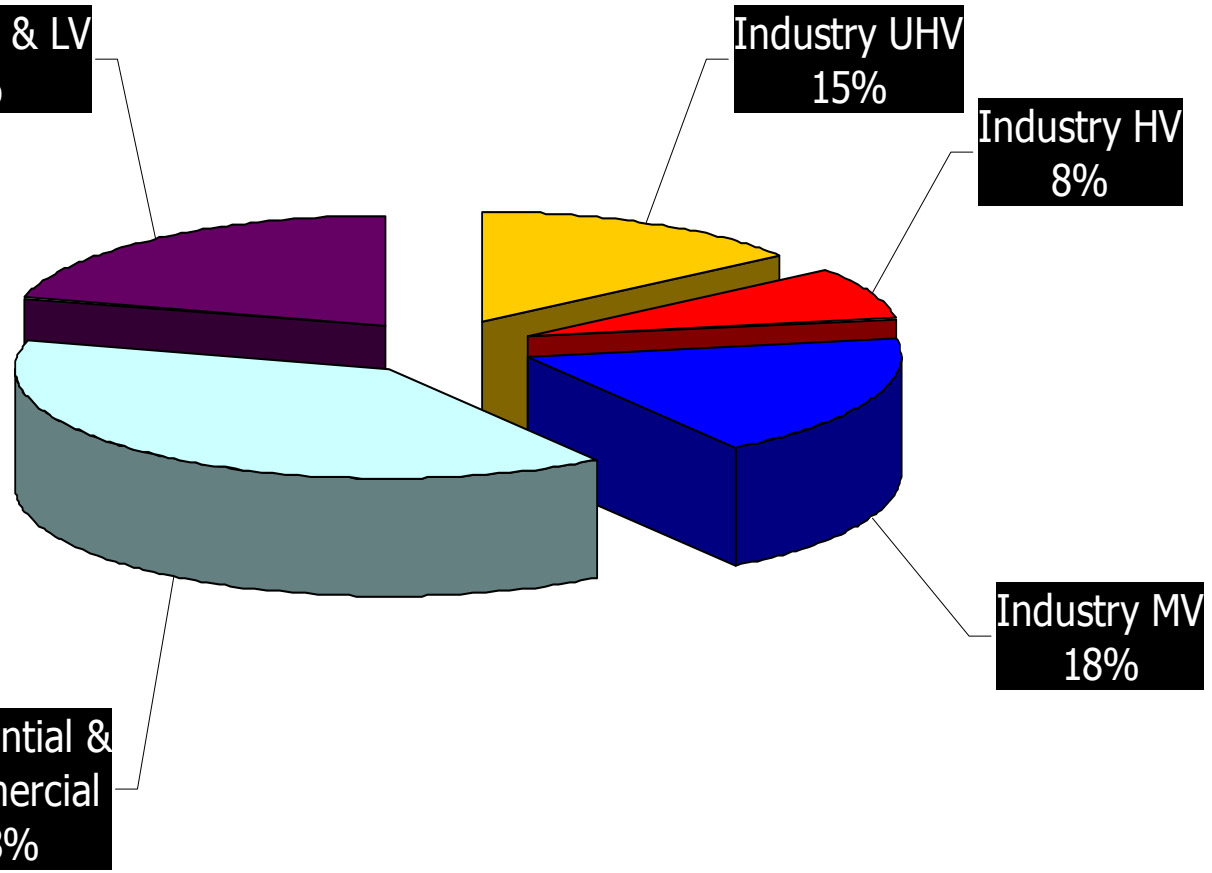


Egypt Annual Energy Consumption (GWh)

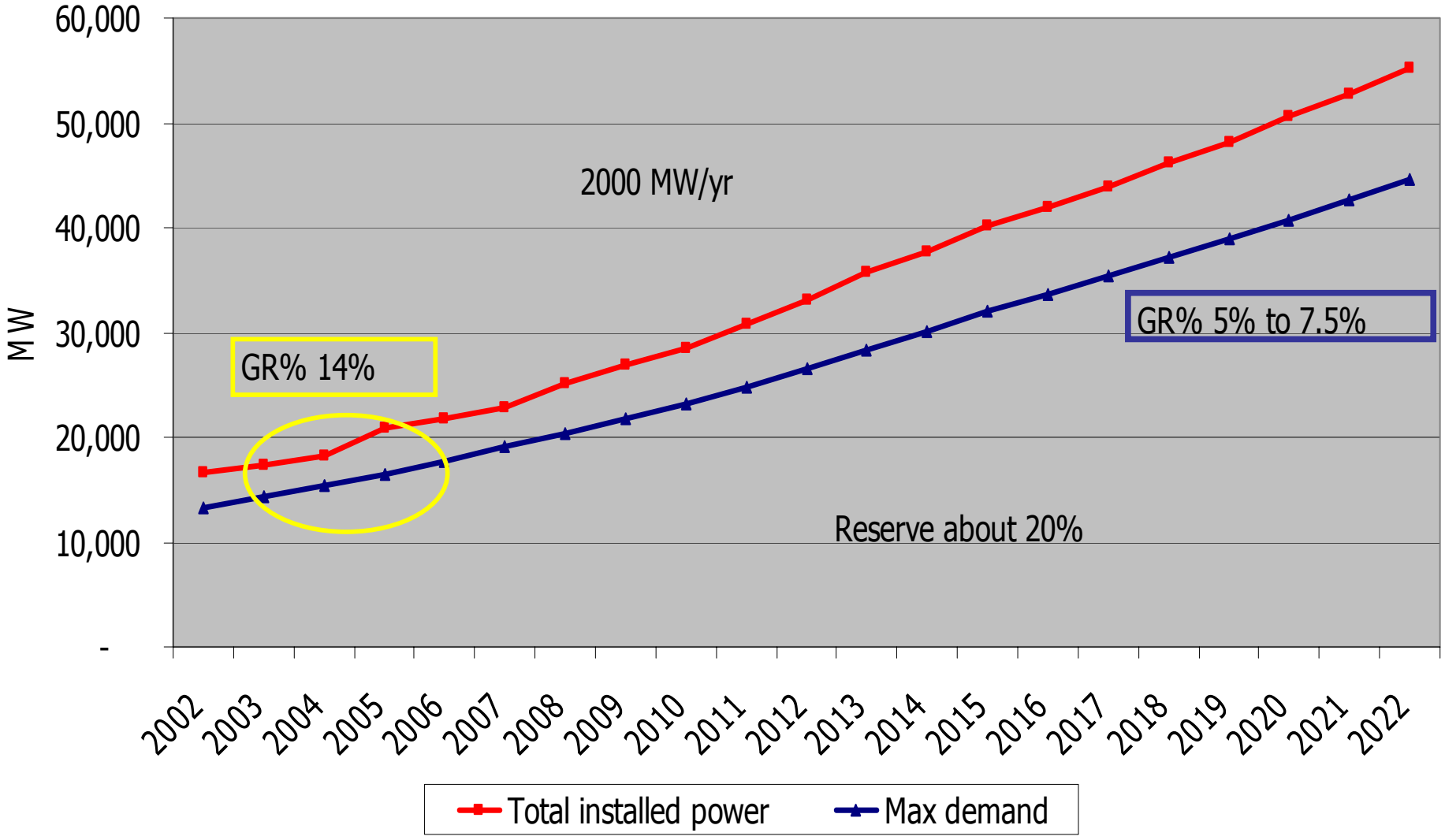


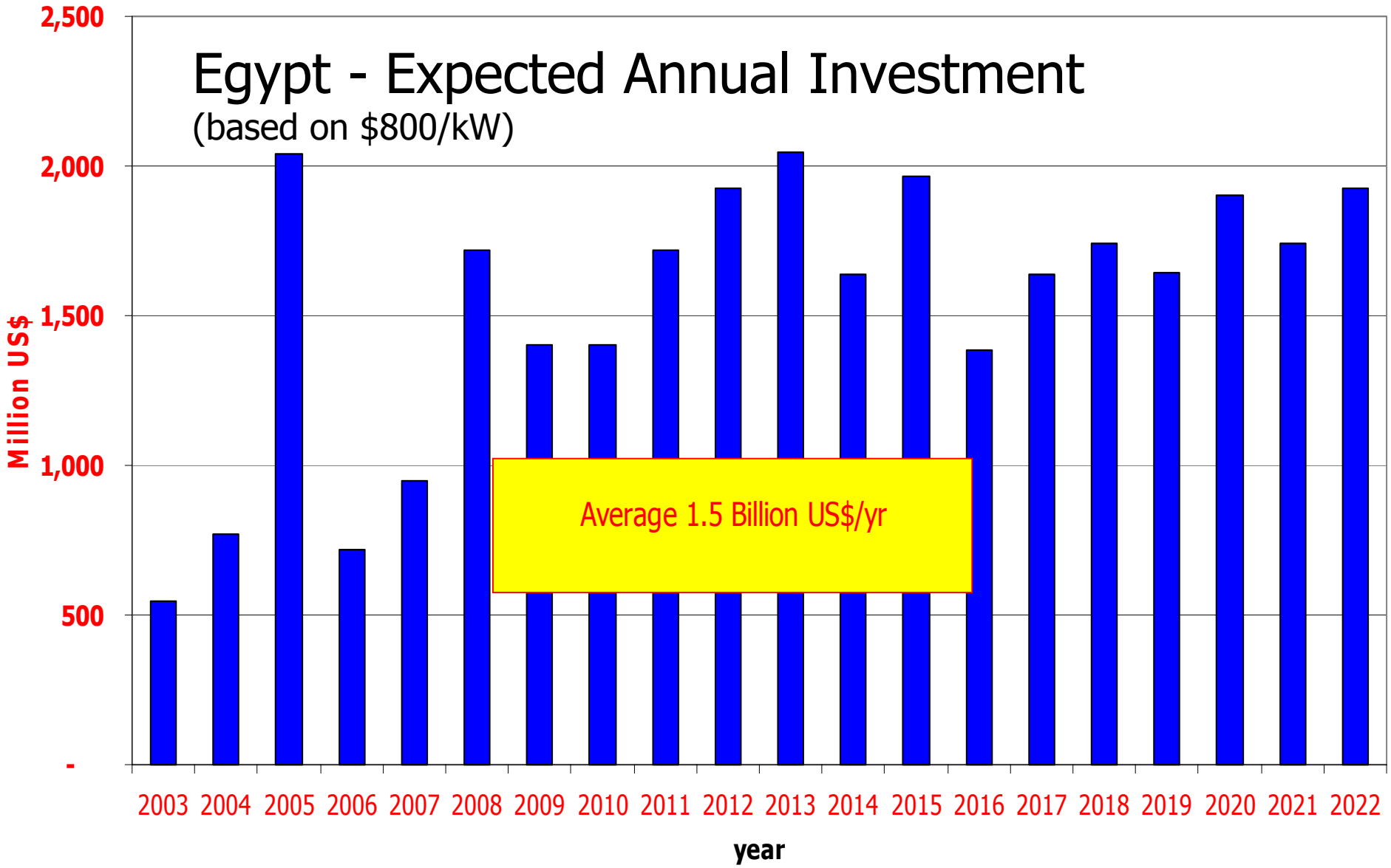
Egypt - Sectorial Energy Consumption (Typical)

About 16000 GWh

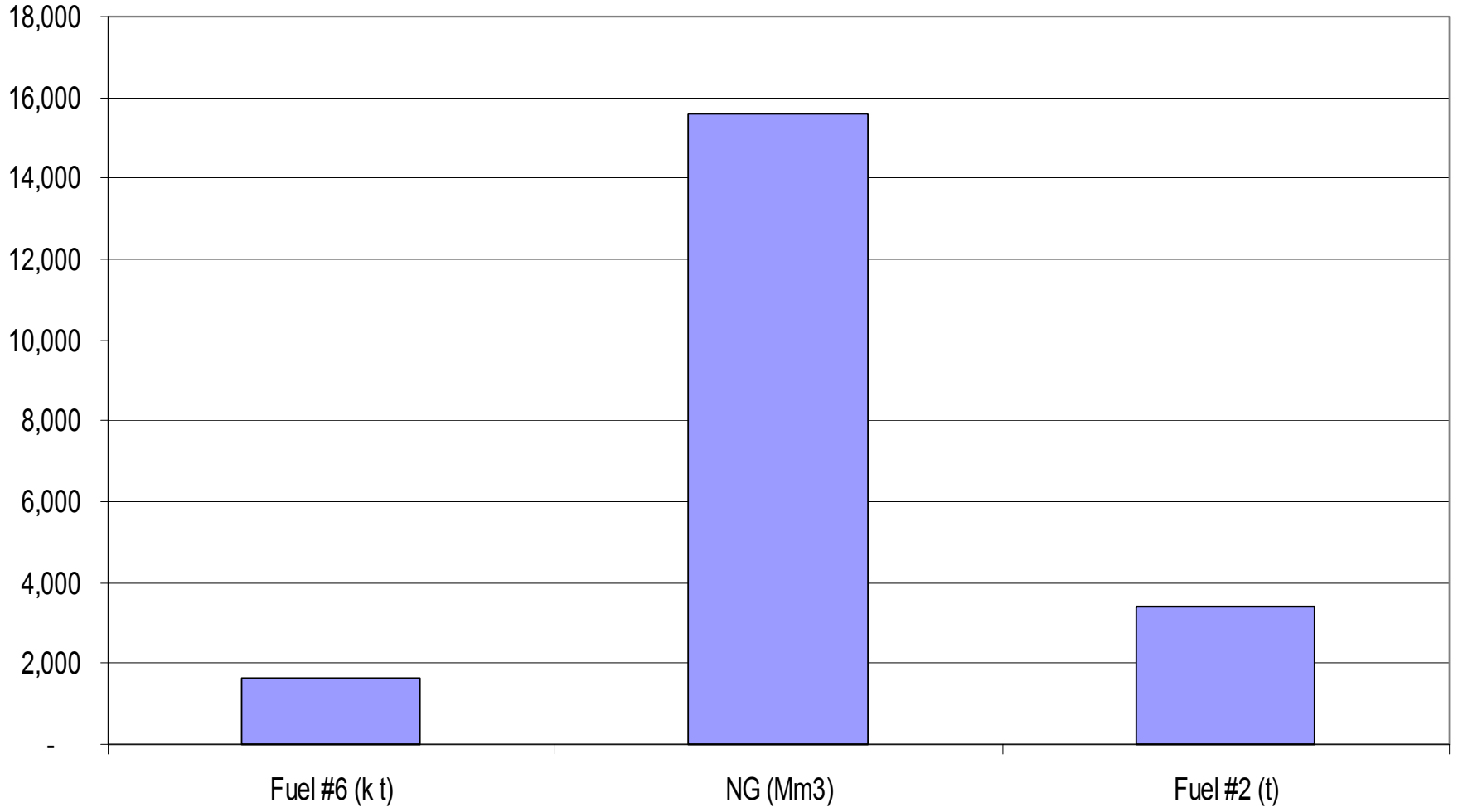


Egypt - Planned Installed Power & Maximum Demand

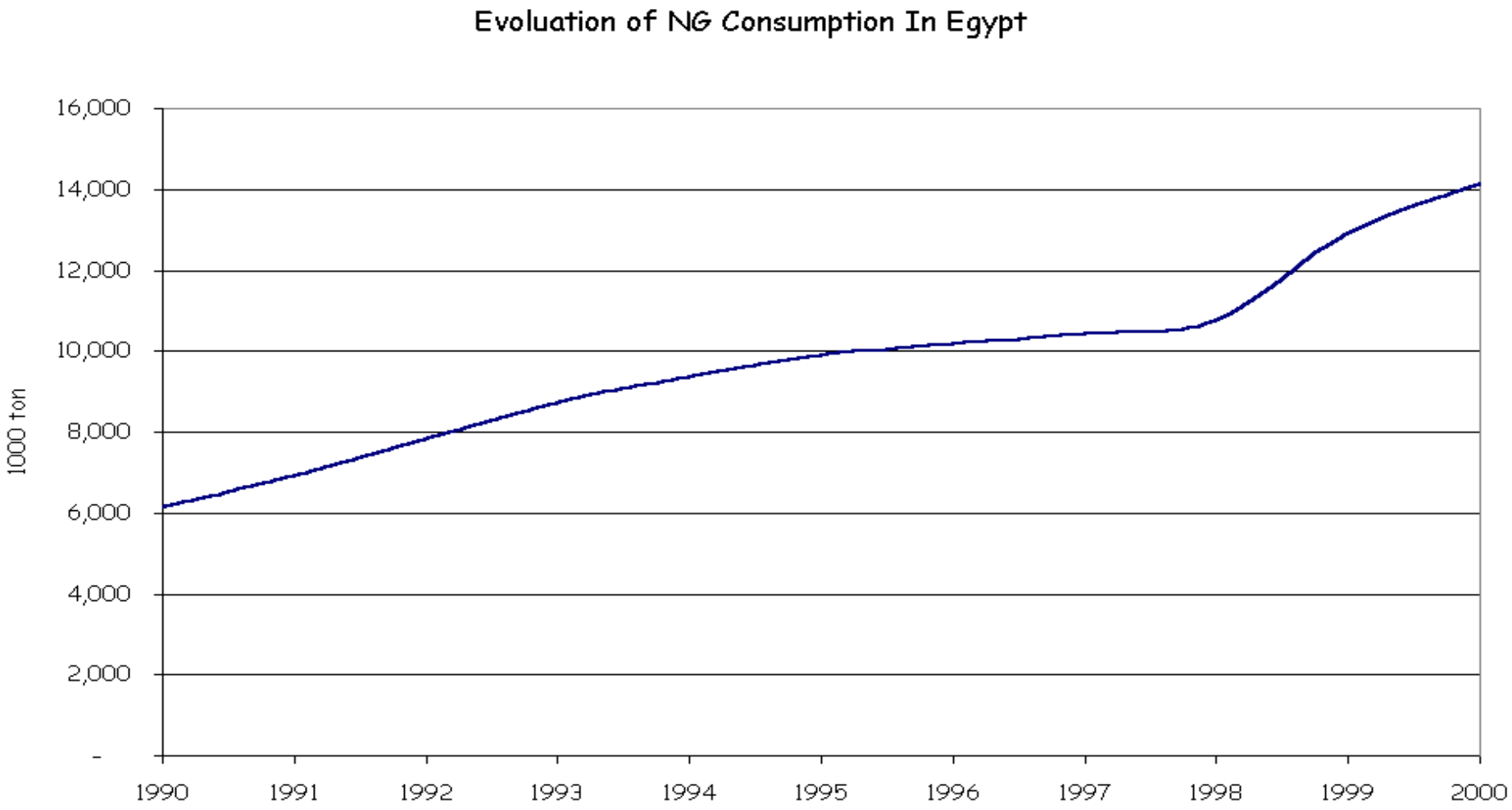



Egypt - Expected Annual Investment
(based on $800/kW)
Million US$
2,500
2,000
1,500
1,000
500
-
Average 1.5 Billion US$/yr
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
year

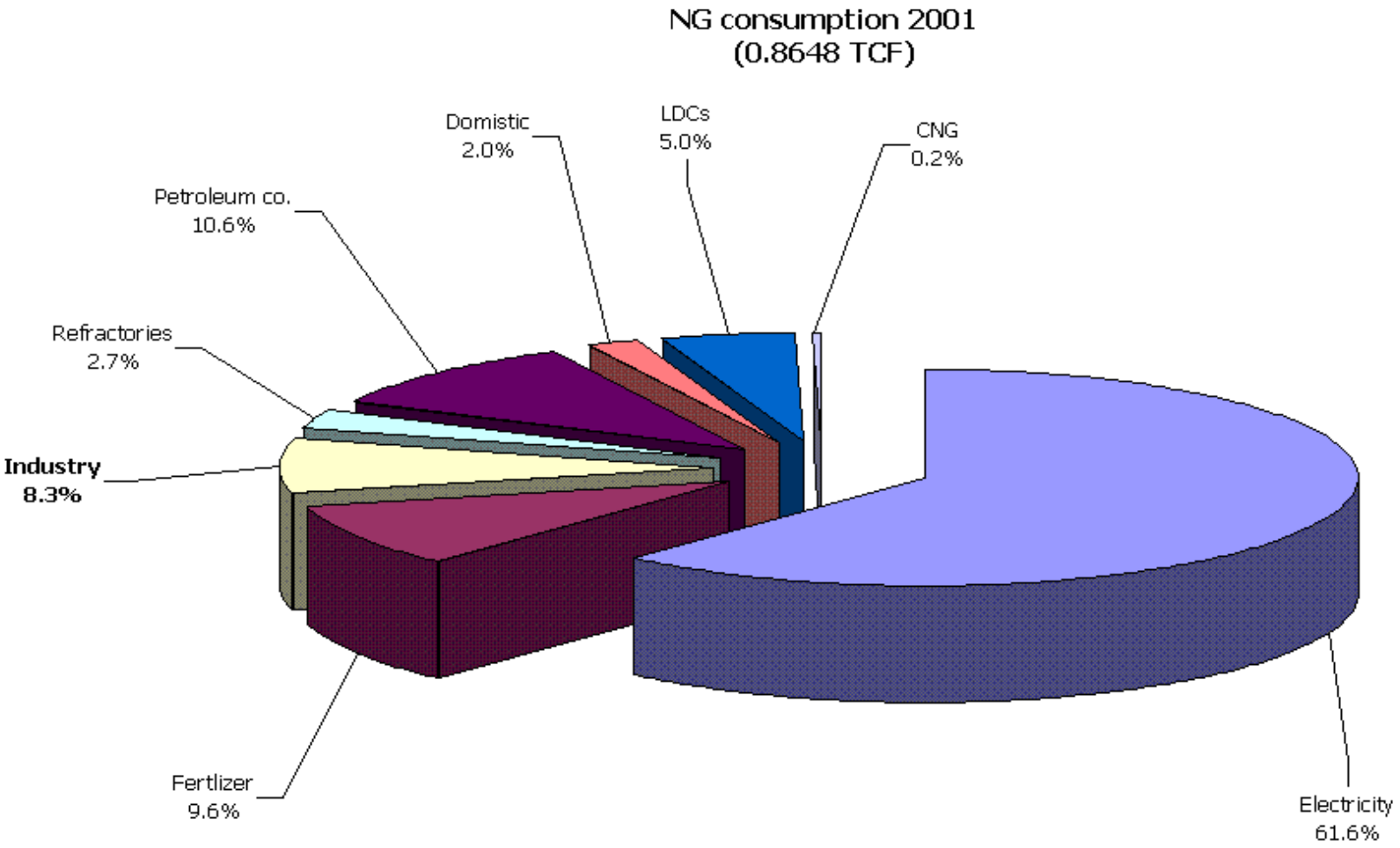
Fuel Mix in 2003



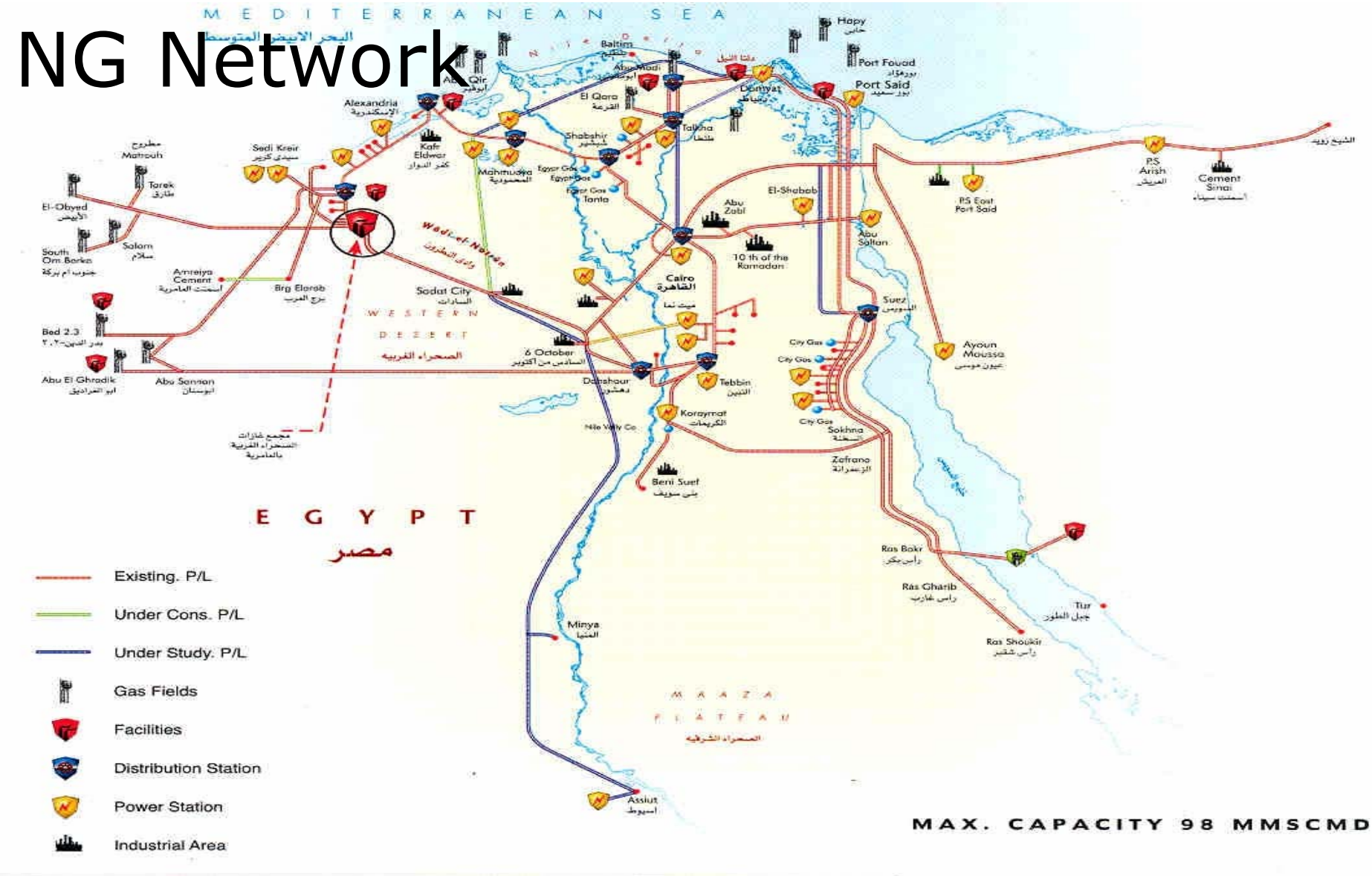
NG Consumption



Sectorial NG Consumption



NG Network


MEDITERRANEAN SEA
البحر الأبيض المتوسط
Hapy
Port Fouad
Port Said
Damyat
Baltim
Abu Qir
Alexandria
El Qara
Talkha
Shabshir
Kafr Eldwar
Mahmudya
Egyptian Gas
Tanta
Sedi Kreir
Matrouh
Tarek
El-Obyed
South Om Barka
Salom
Amreiya Cement
Brg Elarab
Wadi el-Natrun
Sadat City
WESTERN DESERT
Bed 2.3
Abu El Ghradik
Abu Sennan
Cairo
6 October
Dahshour
Tebbin
Korayrnat
Nile Valley Co
Beni Suef
Minya
Assiut
El-Shabab
Abu Zabl
10 th of the Ramadan
Abu Sultan
Suez
City Gas
Sokhna
Zafrana
Ayoun Mousa
PS Arish
PS East Port Said
Cement Sinai
Ras Bakr
Ras Gharib
Tur
Ras Shoukir
MAAZA PLATEAU
EGYPT
مصر
Existing. P/L
Under Cons. P/L
Under Study. P/L
Gas Fields
Facilities
Distribution Station
Power Station
Industrial Area
MAX. CAPACITY 98 MMSCMD

Industrial End-user Fuel Prices

Fuel	Local Price	Price in (LE/GJ)	Price in (LE/MBTU)	% Difference to Natural Gas Price
Natural Gas	0.141 LE/m3	4.0	4.2	Base
Mazout (fuel oil #6)	185 LE/ton	4.7	4.9	+17%
LPG	320 LE/ton	6.8	7.1	+70%
Solar (fuel oil #2)	463 LE/ton	10.4	10.9	+160%

CHP or Co-generation

Cogeneration *is the simultaneous generation of usable heat and power, usually electricity, in a single process from the same fuel.*

CHP is not a new technology

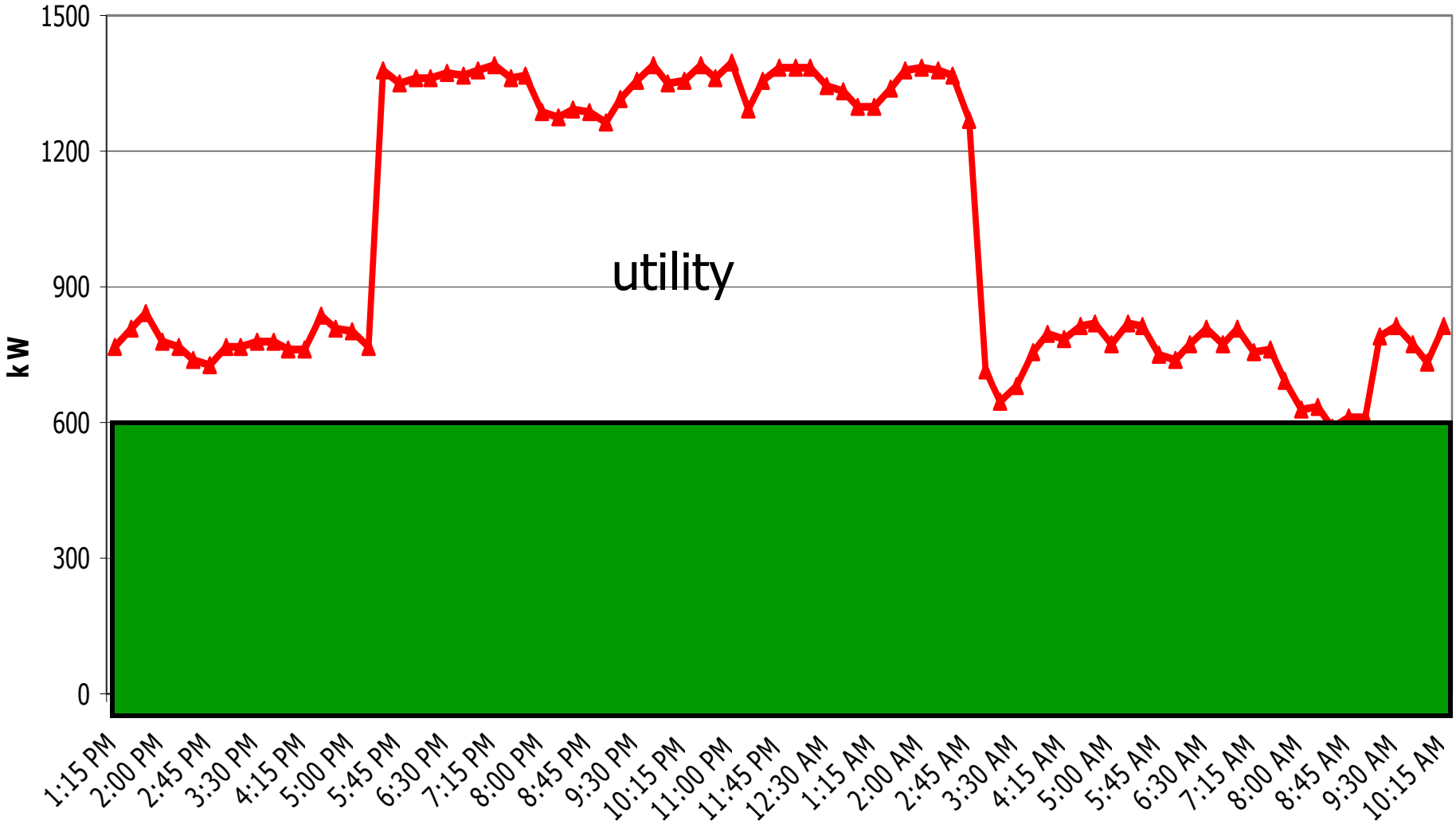
Used in Thomas Edison's first electric generating plant in 1891

Cogeneration: Principle

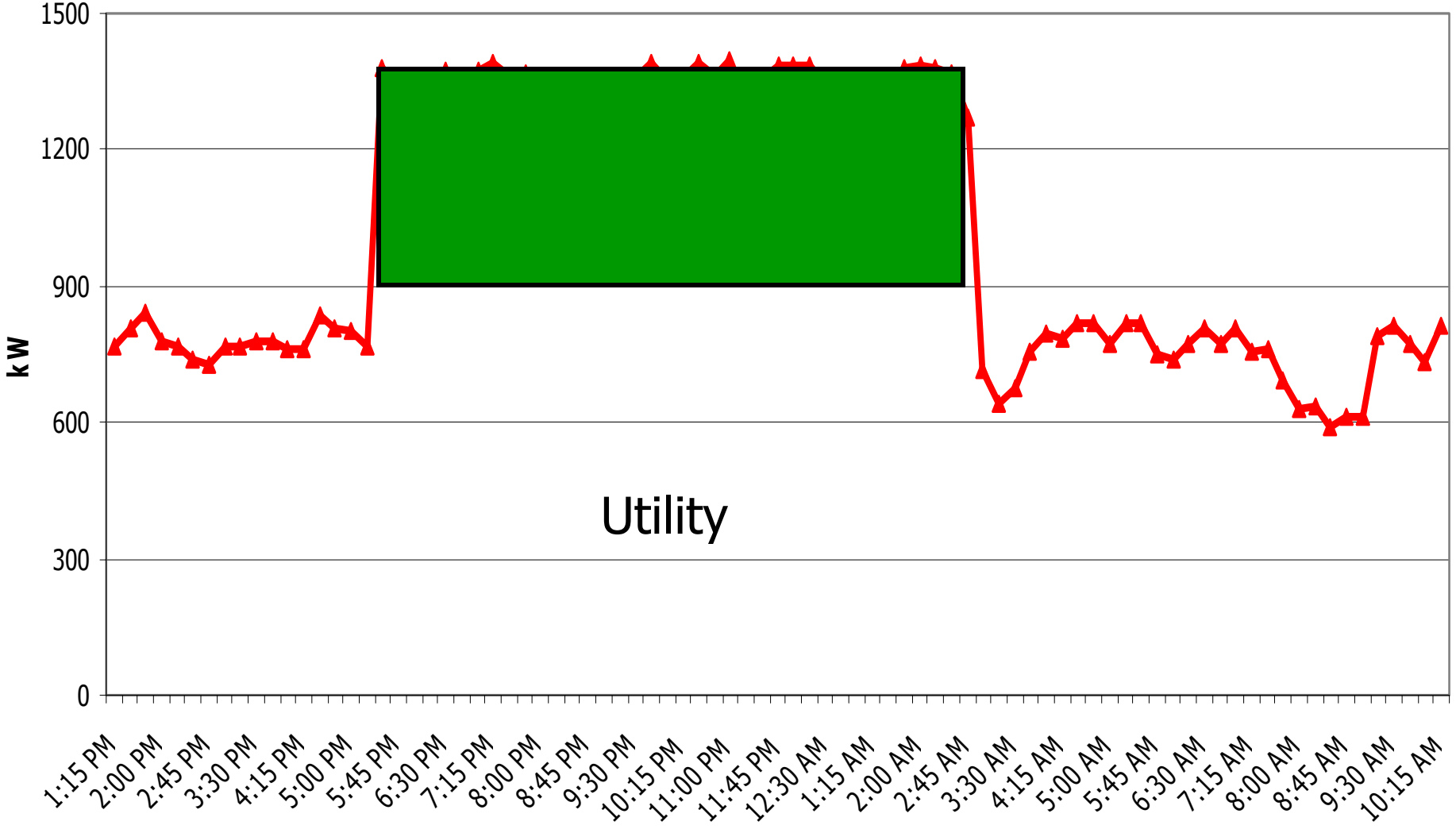
The principle behind cogeneration is simple. Conventional power generation, on average, is only 35-40% efficient – up to 65% of the energy potential is released as waste heat.

More recent combined cycle generation can improve this to 55%, excluding losses for the transmission and distribution of electricity. Cogeneration reduces this loss by using the heat for industrial & commercial plants.

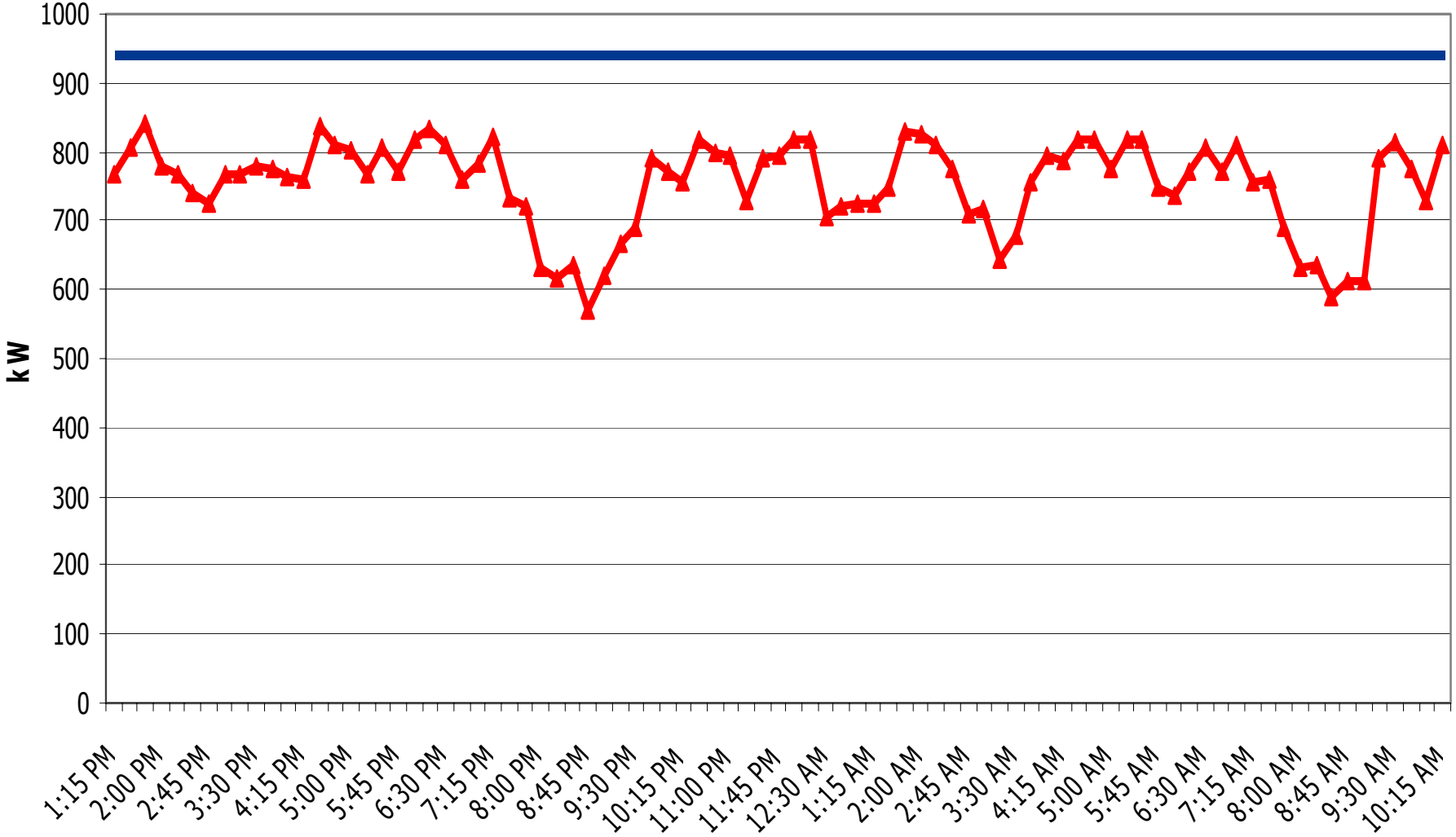
Power Generation -Base load

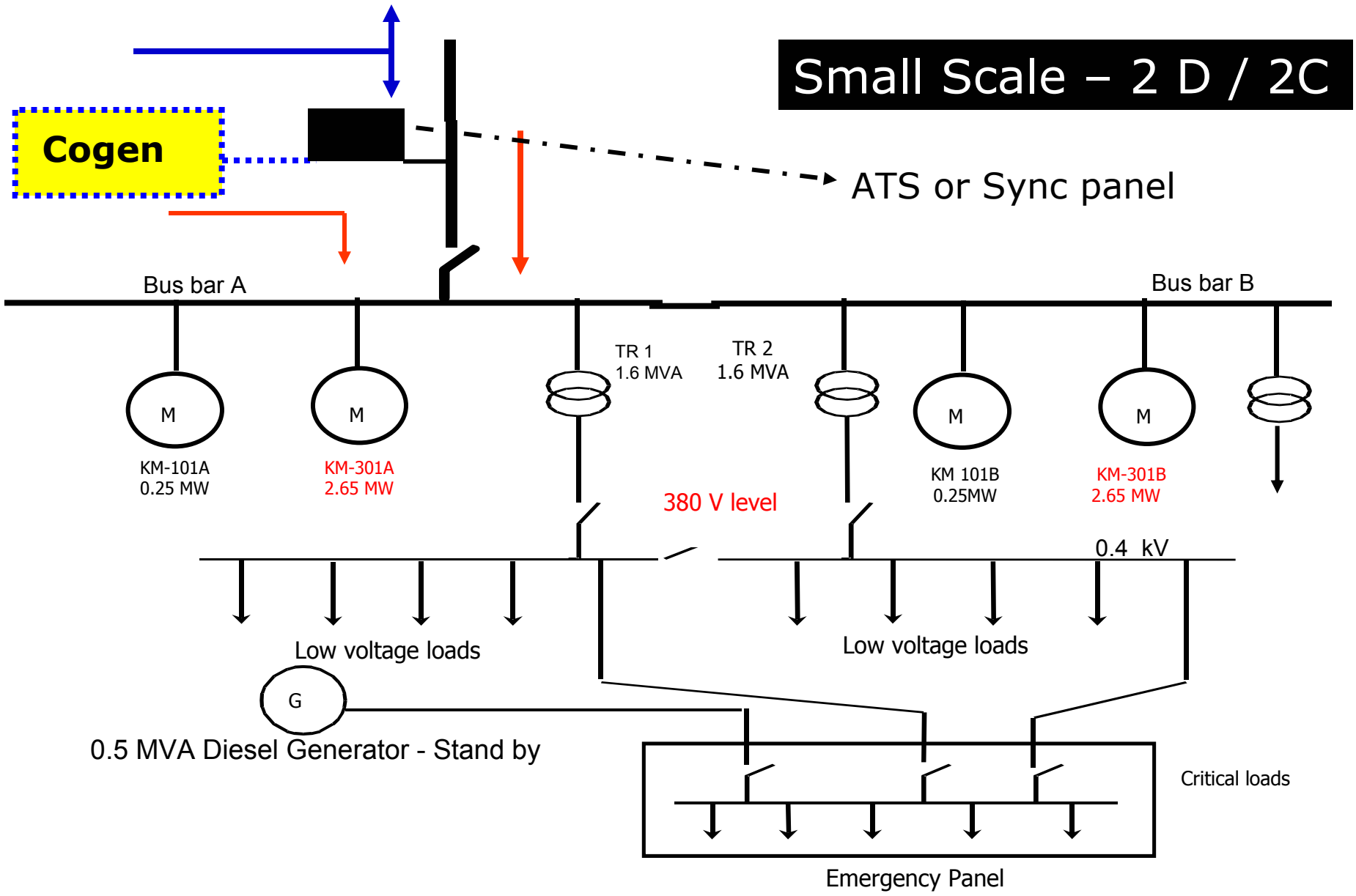


Power Generation- Peak shaving

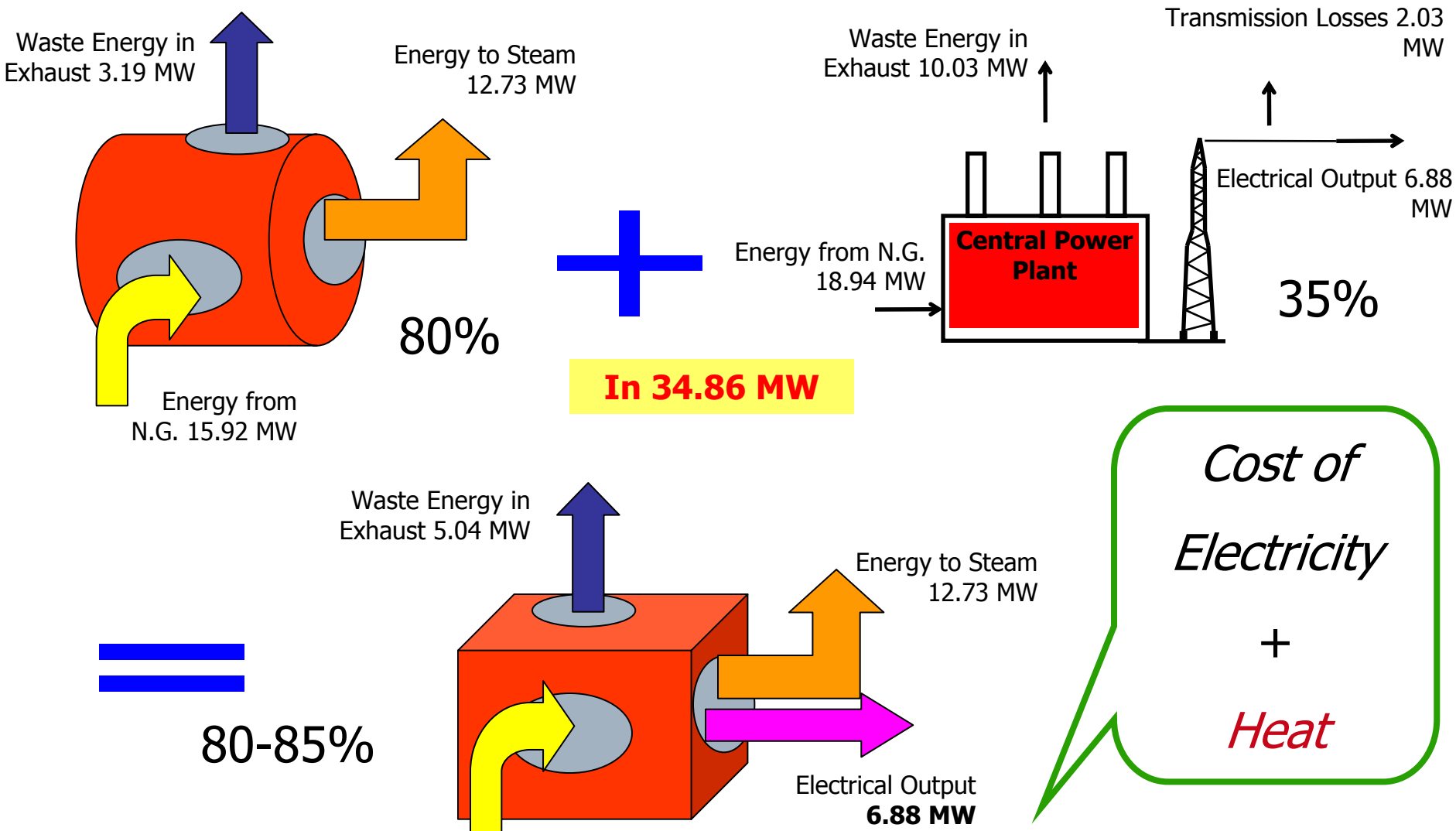


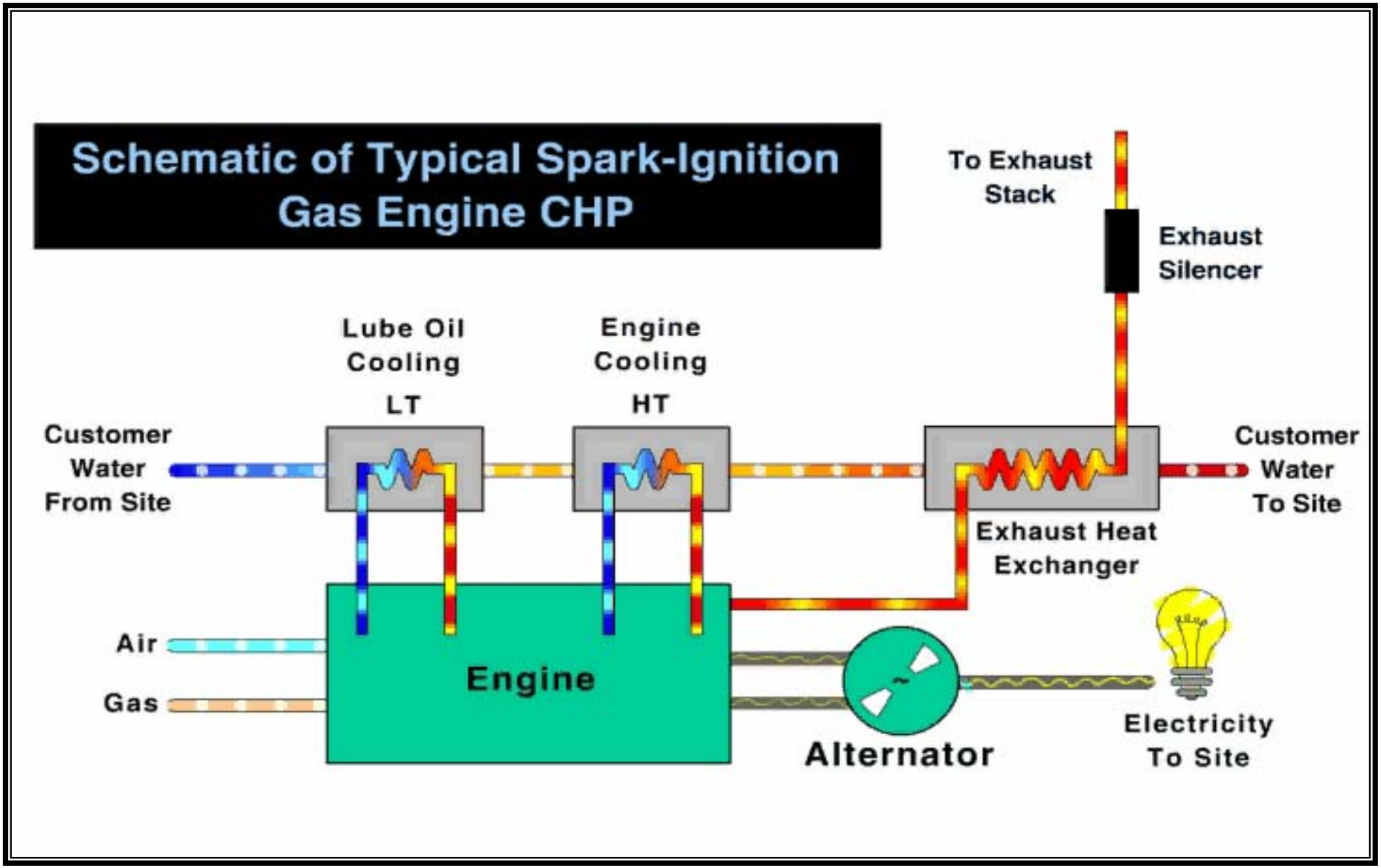
Power Generation- Self Generation




Small Scale – 2 D / 2C
Cogen
ATS or Sync panel
Bus bar A
Bus bar B
TR 1
1.6 MVA
TR 2
1.6 MVA
M
M
M
M
KM-101A
0.25 MW
KM-301A
2.65 MW
KM 101B
0.25MW
KM-301B
2.65 MW
380 V level
0.4 kV
Low voltage loads
Low voltage loads
G
0.5 MVA Diesel Generator - Stand by
Critical loads
Emergency Panel

Cogeneration Vs Conventional System




Schematic of Typical Spark-Ignition Gas Engine CHP
To Exhaust Stack
Exhaust Silencer
Lube Oil Cooling LT
Engine Cooling HT
Customer Water From Site
Customer Water To Site
Exhaust Heat Exchanger
Air
Gas
Engine
Alternator
Electricity To Site


Is CHP good option for this plant?

Applications

- Power Generation
  - Base load
  - Peak shaving
  - Self generation
- Turbo-expansion

- Co-generation
  - Hot Water
  - Steam
  - Hot Water and Steam
  - Heat
  - CO_2
  - (HVAC) Absorption Chilling

Advantages of Cogeneration

- Plant perspective:
  - Fuel/energy savings and its associated cost savings
  - Improve the environment through the reduction of harmful emissions

Advantages of Cogeneration (contd.)

- From National Perspective:
  - Avoid distribution losses, which represents 10-12% of the total power tansmitted.
  - More cost effective than a central power station
  - Reduce the grid peak demand
  - Reduce air pollution due to the improvement in fuel utilization
  - Creates diversity, resulting in a more robust and reliable electricity system
  - Reduce emissions

Small Scale Cogeneration Systems Alternatives

- Gas turbine-based cogeneration system
  - Gas turbine with direct use of exhaust gases
  - Gas turbine with waste heat boiler/Absorption chiller
- Reciprocating engine-based cogeneration system (gas or Diesel)
  - Engine with waste heat recovery system/Absorption chiller

Parameters Affecting the Selection of Cogeneration System Type

- Plant thermal to electric ratio
- Plant electrical and heat demands
- Heat quality
- Type of fuel available

Selection Criteria of Cogeneration Prime-mover

Type	Available Process Heat	Thermal to Electric Ratio	Fuels
Steam Turbine	120-400 C	2:1 up to 30:1	Any
Gas Turbine	120-500 C	1.2:1 up to 4:1	Oil-based Gaseous
Reciprocating Engine	80-120 C	0.8:1 to 2:1	Oil-based Gaseous

Techno-economical Aspects of Cogeneration Systems

- Cogeneration system is sized according to the plant electrical and thermal demands.
- Selecting and sizing a cogeneration system is done as follows:
  - Develop the plant annual and daily electrical load profiles as well as the corresponding load duration curves.
  - Identify plant max, average electric load
  - Identify the thermal load types (i.e. hot gases, hot air, steam, hot water) as well as their corresponding conditions (pressure, temperature, quality)
  - Develop the thermal load profiles of the identified thermal load as well as the corresponding load duration curve
  - Identify the type of fuel supply available to the plant.

Techno-economical Aspects of Cogeneration Systems (contd.)

- According to the plant thermal to electric ratio, type of the thermal load and its required conditions, maximum electric demand, plant average demand and type of fuel available, both type and size of the cogeneration system can be identified.
- The savings is calculated as the difference in the cost between purchasing electricity and generated electricity as well as the avoided fuel cost which is used to the satisfy the thermal load. Selling back
- The cost of the equipment are defined. This cost can be varied according to the type and size of the unit.
- The running cost are defined including both the fixed and the variable one.

Techno-economical Aspects of Cogeneration Systems (contd.)

- To evaluate the project economically all the economical indicators such as; simple payback period (SPP), the internal rate of return (IRR), the net present value (NPV) and the life cycle cost (LCC) should be calculated.
- Since the cogeneration project is capital intensive project, a financial plan should be developed based on the available funds and scheme of implementation.
- Future plant expansion is considered

Regulatory Framework in Egypt

- Till now there is no clear regulatory framework for cogeneration activities in Egypt.

- Some efforts have been done to encourage cogeneration as an energy efficiency measure in industrial and commercial plants.

Current & Potential Cogen

- There is a very good opportunities for cogeneration projects as there are a huge number of textile, food, chemical, commercial plants.

Barriers in brief

- Awareness
- High investment
- Financing mechanism
- Financial indicators

Overview of the Project Portfolio

Project Code	Project	Investment (M$)	ASC (ton)	CSC ($/tC)	SPBP (yrs)
IV. Energy Efficiency					
IV.3 Cogeneration					
IV.3.1	Beni Soeif Cement Cogen	8.3	6,336	-125	8.5
IV.3.2	Industrial Investments Co. (Chemical Industry)	0.3	185	-174	7.8
IV.3.3	Misr Elmonifia Cogen (Textile)	1.6	911	-237	6.3
IV.3.4	Mohm cogen (metal works)	0.3	369	-133	5.5
IV.3.5	Egypt Air Hospital (Building)	0.3	59	-488	8.5