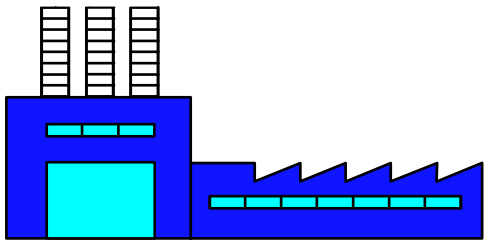
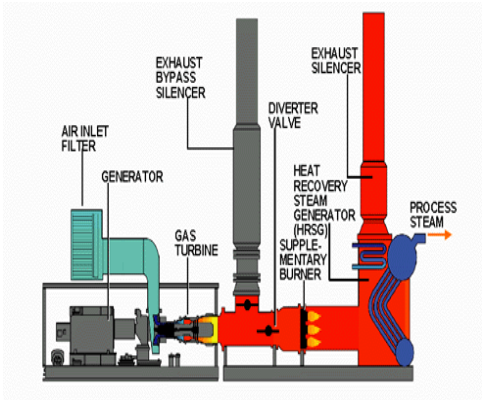
Assessment of the present status, hurdles and opportunities for developing cogeneration projects in Turkey

Twinning project: Improvement of energy efficiency in Turkey





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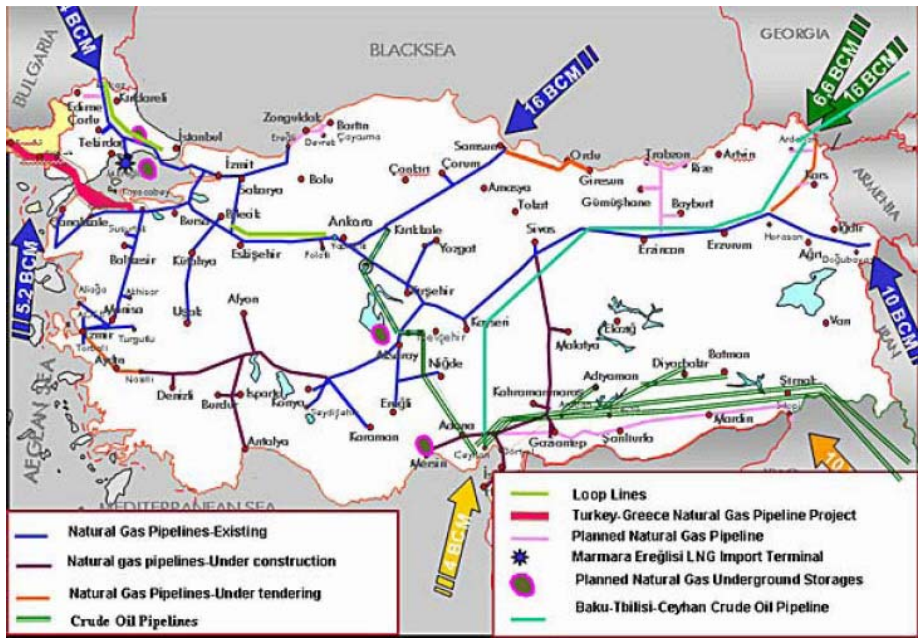
Ankara
10 July 2006

Energy situation in Turkey

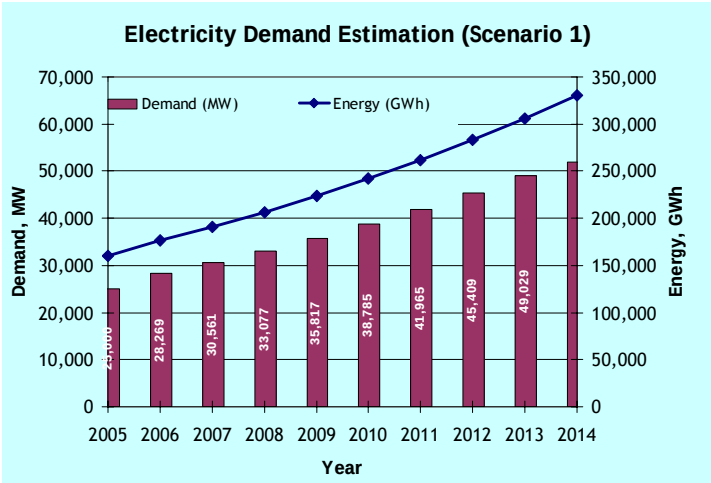
- Surrounded by oil and gas-rich countries (Azerbaijan, Iraq, Iran, Kazakhstan, Russia)
- Energy bridge between major oil producing Asian and Middle-East countries and Europe
- Energy imports represented 72% primary energy use in 2004 (expected to rise to 80% by 2020 – MENR)

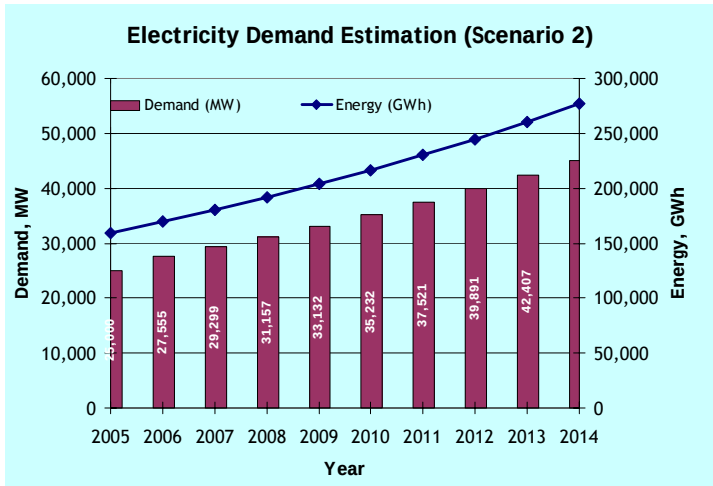


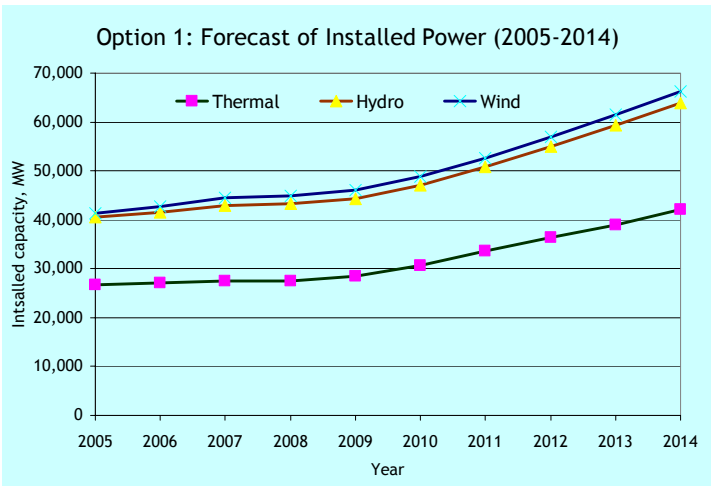
Status of the power sector

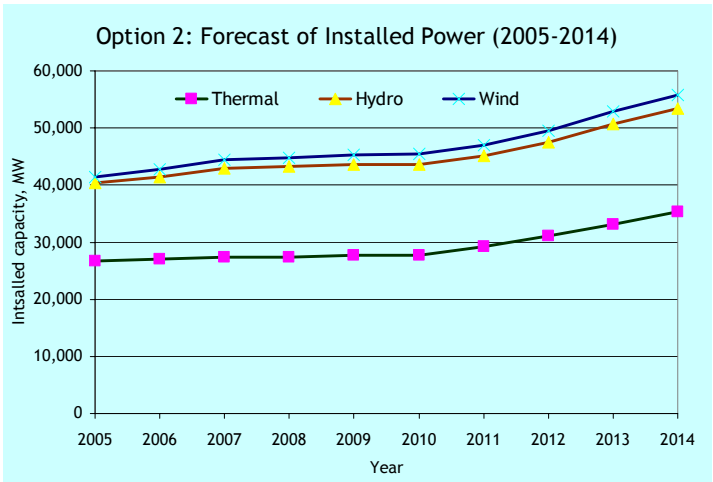
- High growth in electricity demand
  - 133 TWh in 2002
  - 150 TWh in 2004 - 160 TWh in 2005
  - Expected to rise to 566 TWh in 2020 (source: MENR)
- Need for massive investment
- Government with limited means encourages private sector investment to meet future growth in demand
  - 6 to 8% average growth per annum over the next 15 years
- Electricity Liberalization Law and Natural Gas Market Law adopted in 2001 to
  - End Public Monopoly in the energy sector
  - Attract foreign energy investments
- Energy market liberalised since 2003 and controlled by Electricity Market Regulatory Authority (EMRA)

Forecast of electricity demand



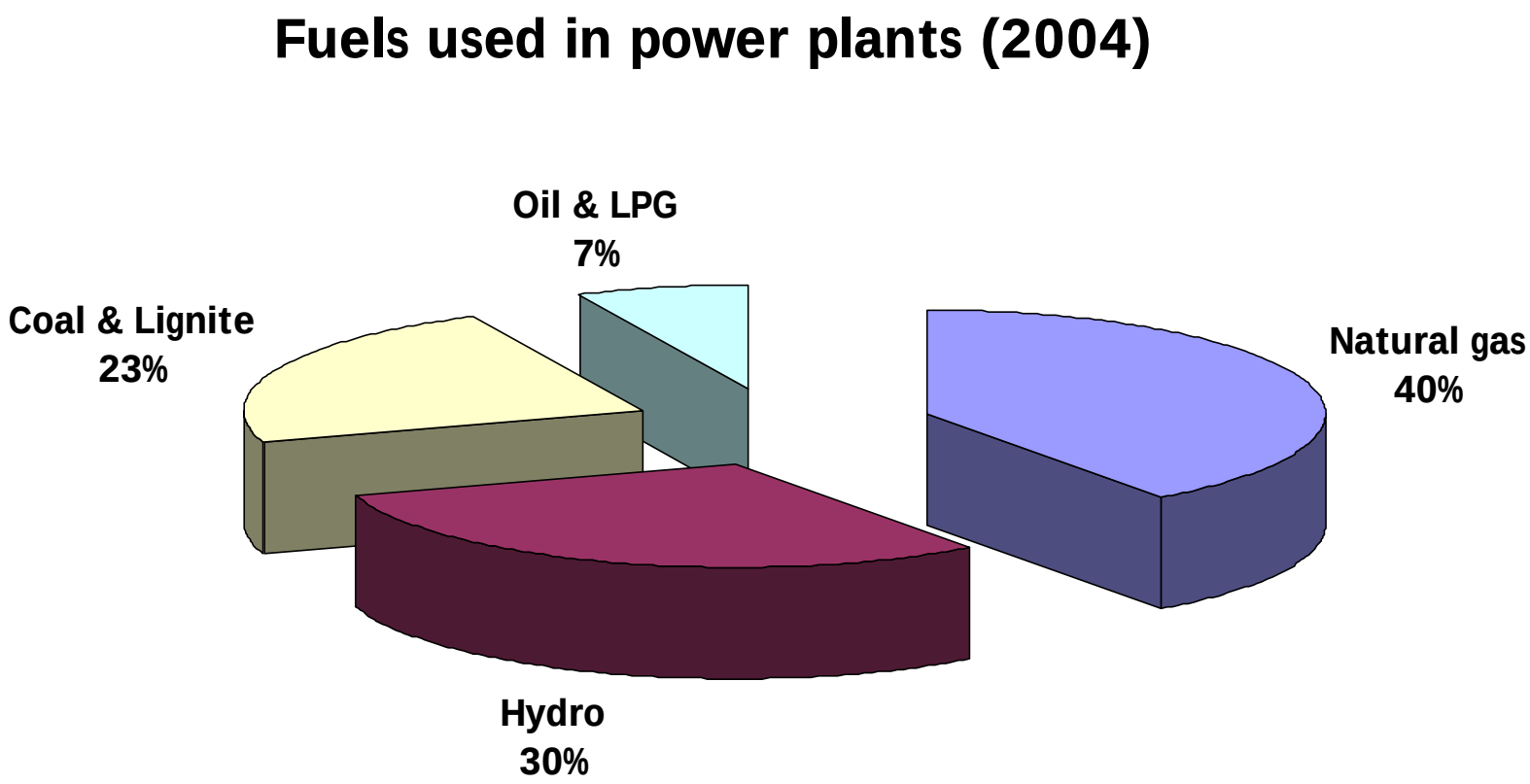






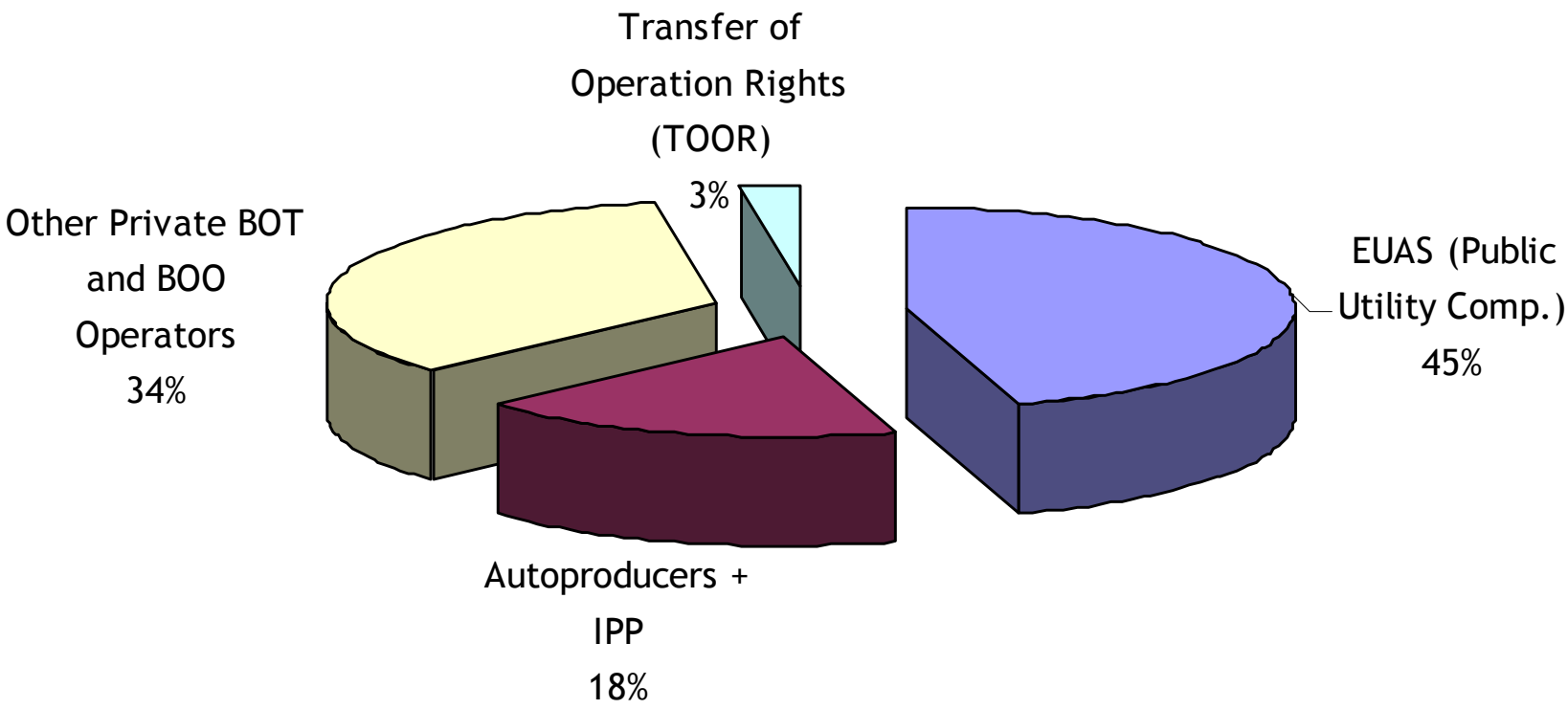
Source: TEIAŞ

Status of the power sector



Status of the power sector

Main players in the Power Sector (2004)



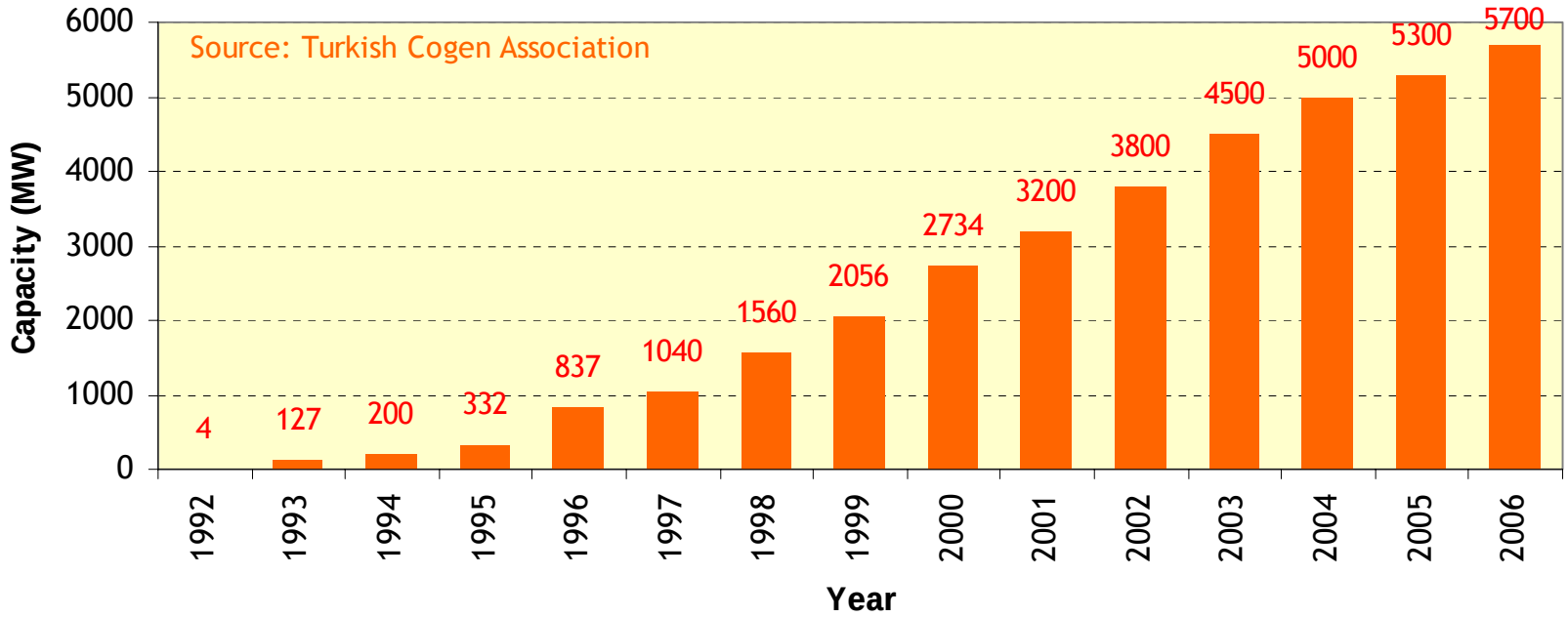
Definition of an autoproducer

According to Decree No. 85/9799, Autoproducer is the legal name of the facility owner who builds the cogeneration plant to meet the energy requirement of his facility.

- *"An Autoproducer and Autoproducer Group shall be entitled to sell a certain percentage (to be determined by the Board of the electricity - not exceeding 20% in any case) it has generated in a calendar year within a competitive environment. The Board, under extraordinary circumstances, can increase this percentage by half of the original ratio. In case the amount of the electricity sold in a calendar year exceeds the percentage set by the Board, the autoproducer or autoproducer group shall be obliged to obtain a generation license. The procedures and principles regarding the activities of autoproducers and autoproducer groups, the nature of their sales to their affiliates and sales of the electricity generation surpluses shall be governed by the regulations to be issued."*

Rapid growth of cogeneration

- First cogeneration application in a textile industry in 1992 (4 MW capacity)
- By 2005, total installed cogeneration capacity increased to 5,700 MW, with 214 units in operation
- Production of about 28 000 GWh in 2005 (plant load factor: 56%)

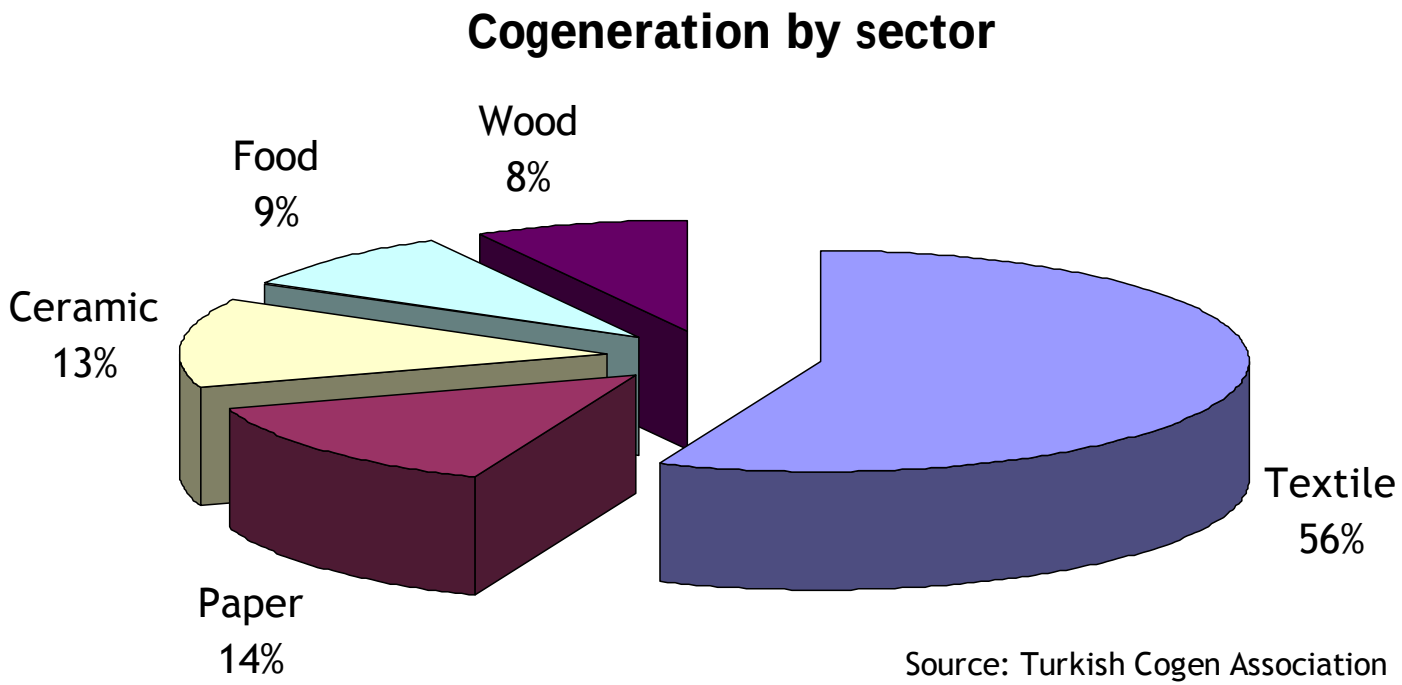


Rapid growth of cogeneration

- Reasons for the rapid growth
  - High electricity tariff for industrial customers
  - Poor power quality and frequent interruptions due to shortage in electricity supply
  - Law allowing private sector to build, operate, transmit and distribute electricity
  - Government incentives (tax deduction, custom relief, etc.)
  - Access to natural gas grid
  - Competitive investment cost compared to coal-fired plants or renewable energy plants, and high cycle efficiency
  - Short construction time, flexible operation and low operation & maintenance costs
  - Scope for setting up facilities close to high-heat users

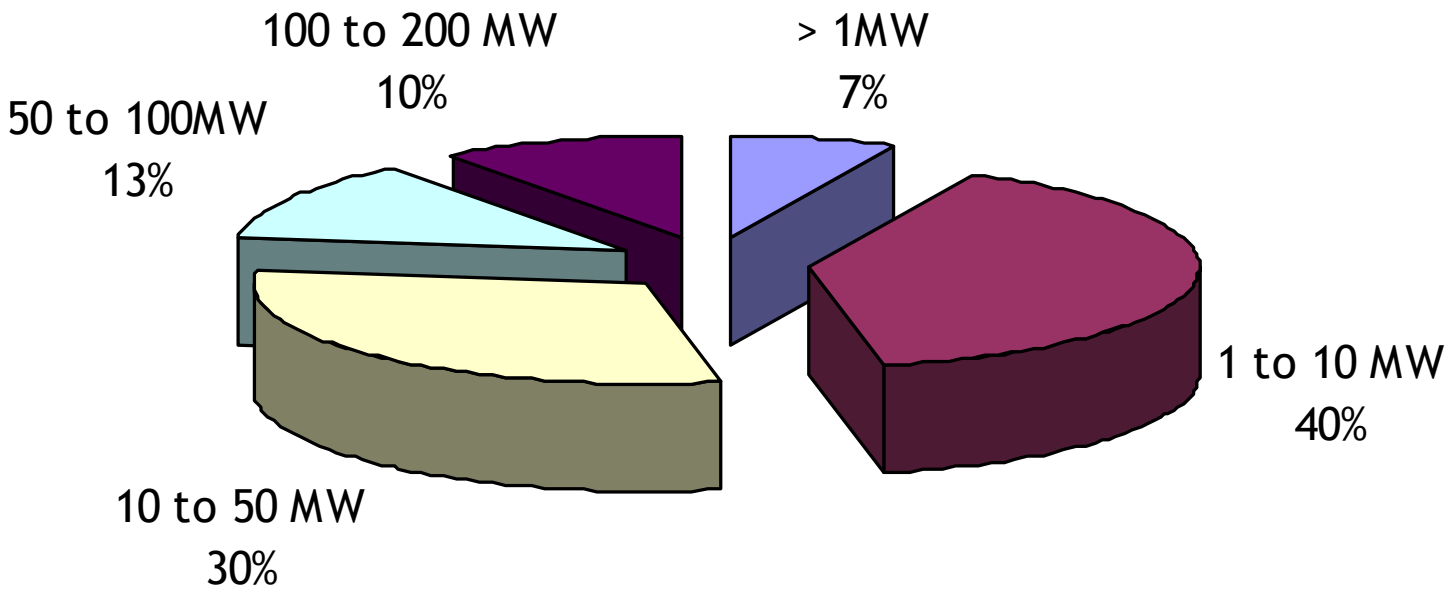
Application of cogeneration

- Mostly adopted in industries
  - About 70% of the cogeneration installed capacity is in textile and paper industries
  - Future scope of expansion in refineries and chemical industries



Source: Turkish Cogen Association

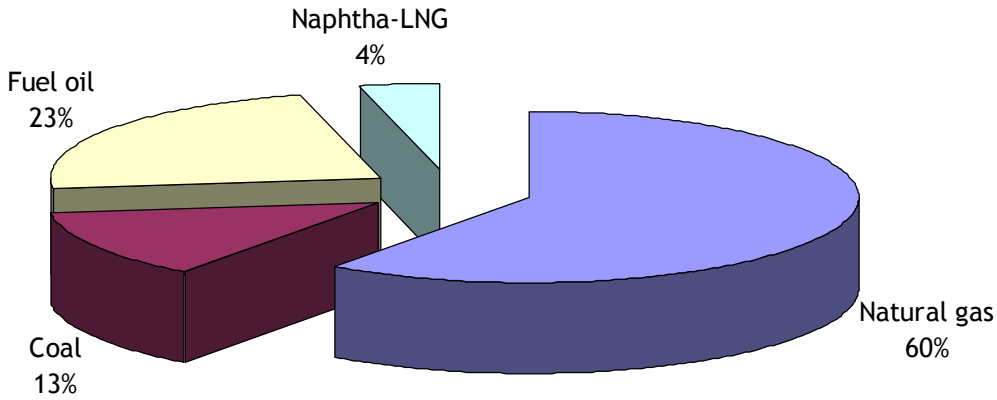
Capacities of cogeneration plants



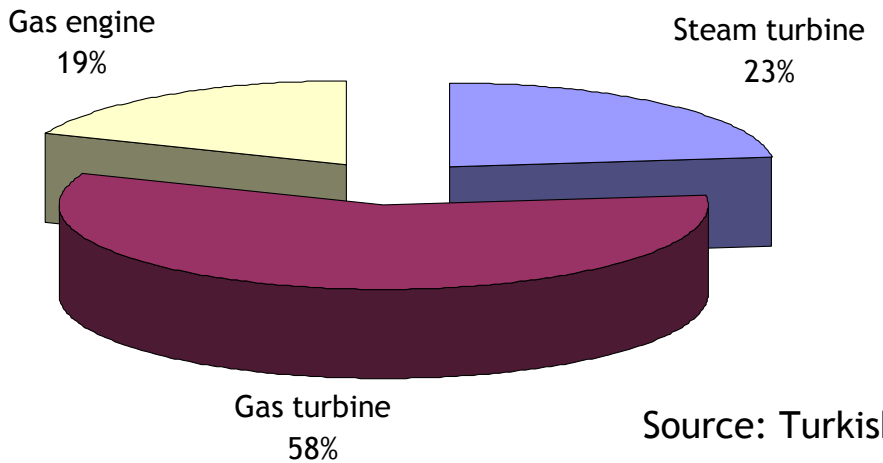
Source: Turkish Cogen Association

Cogeneration plants: types and fuel use

Fuels used in cogeneration plants (based on number of units)

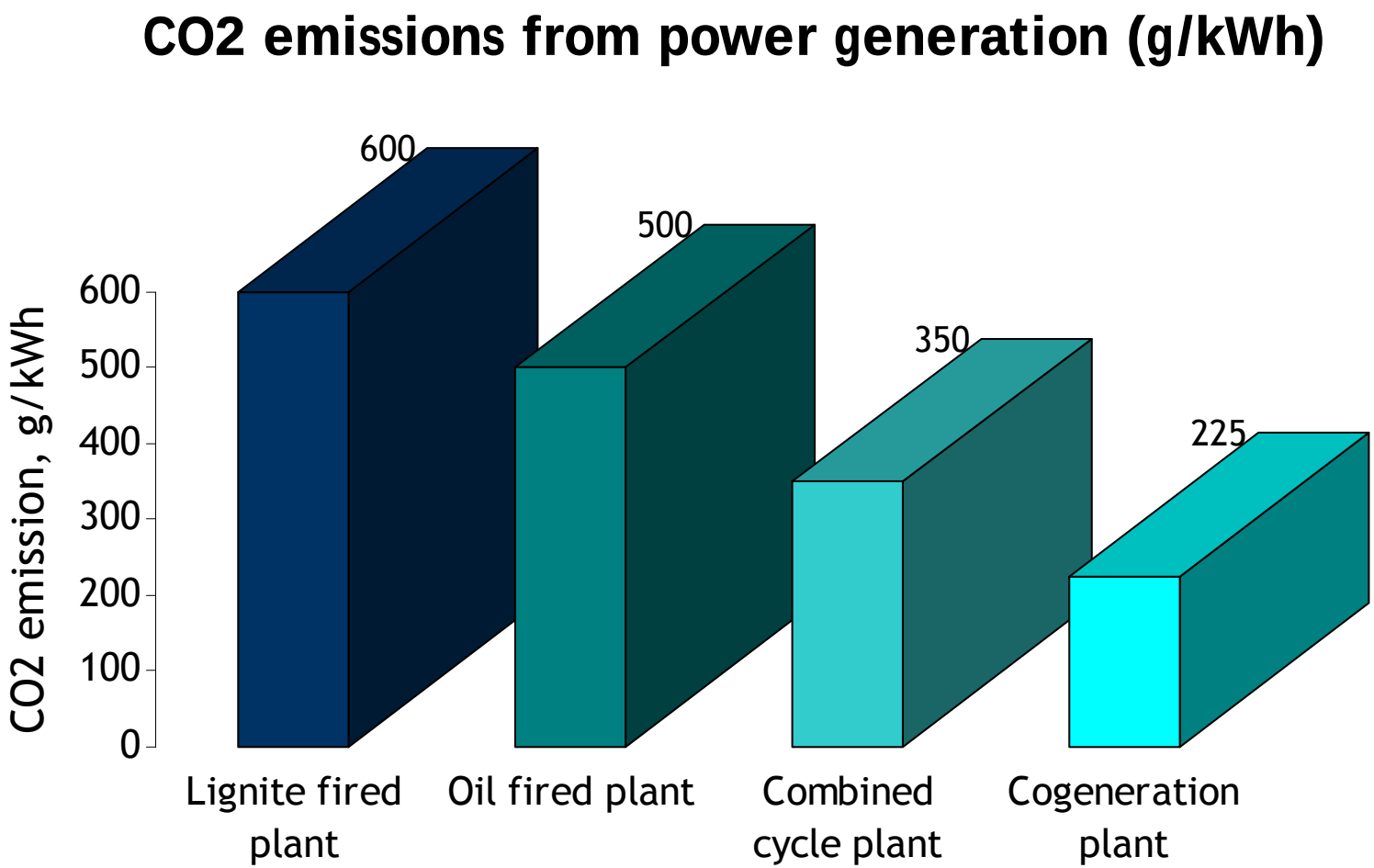


Cogeneration by prime mover

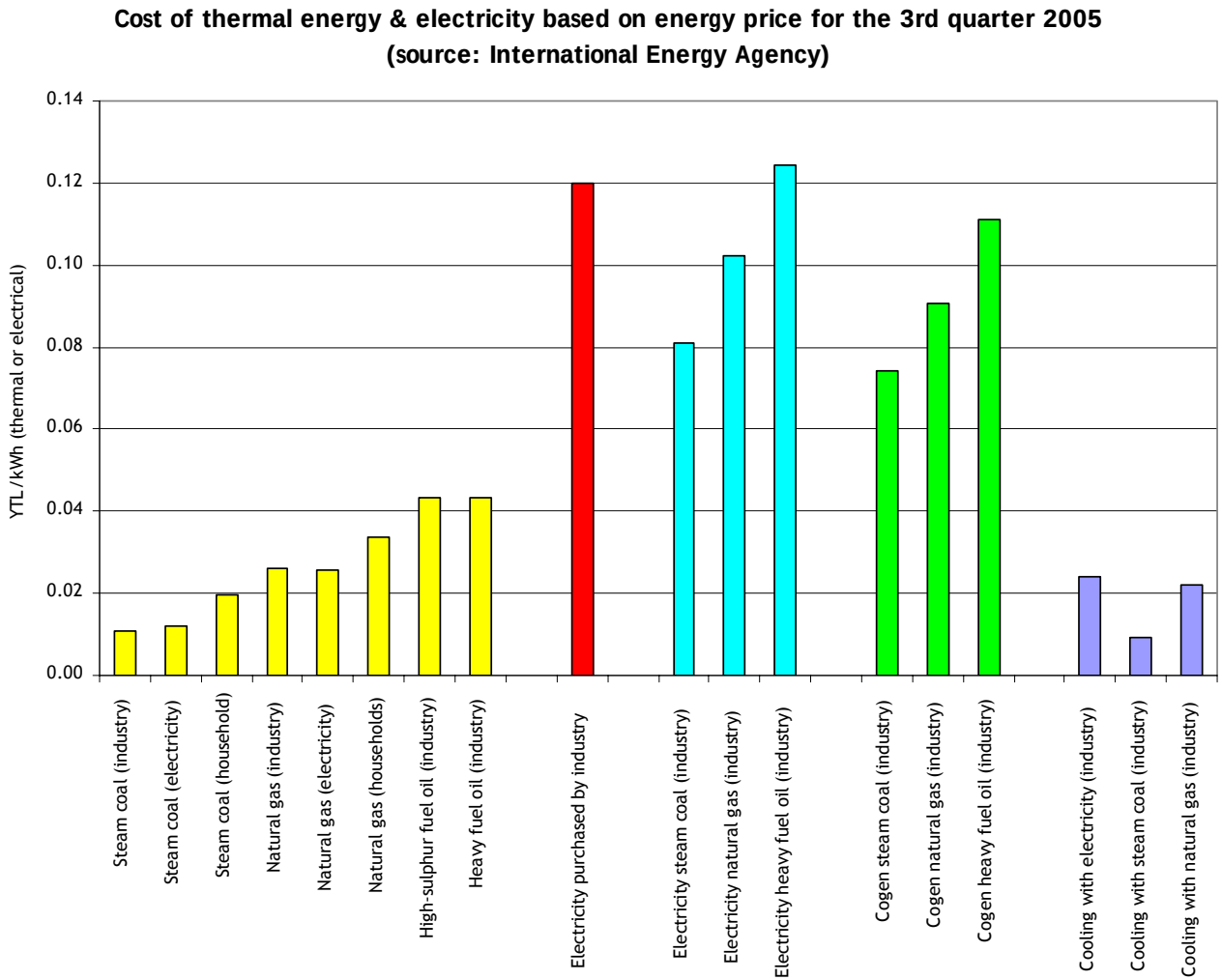


Source: Turkish Cogen Association

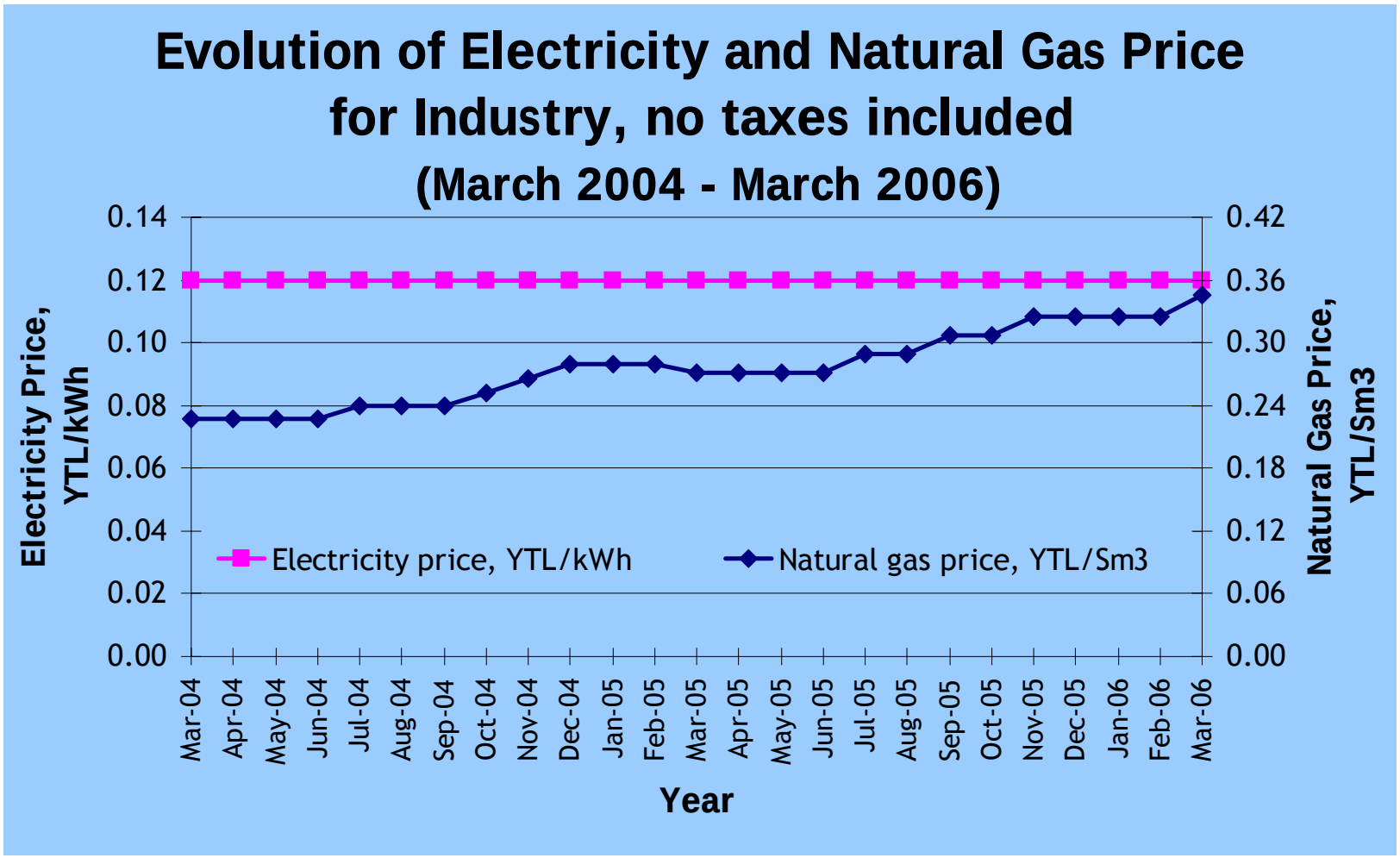
Global environmental impacts



Cost of thermal energy and electricity

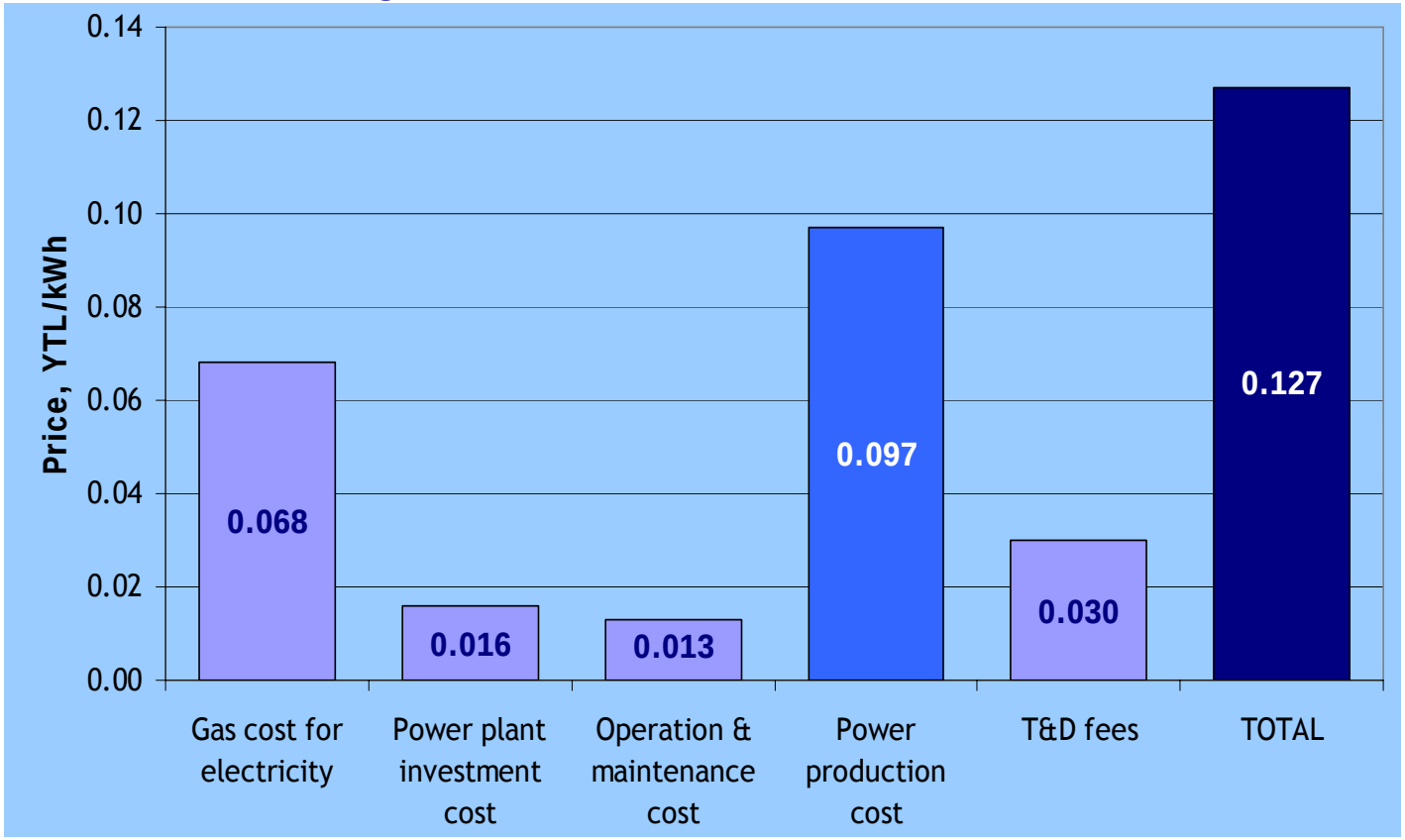


Evolution of energy price



Analysis of private power generation

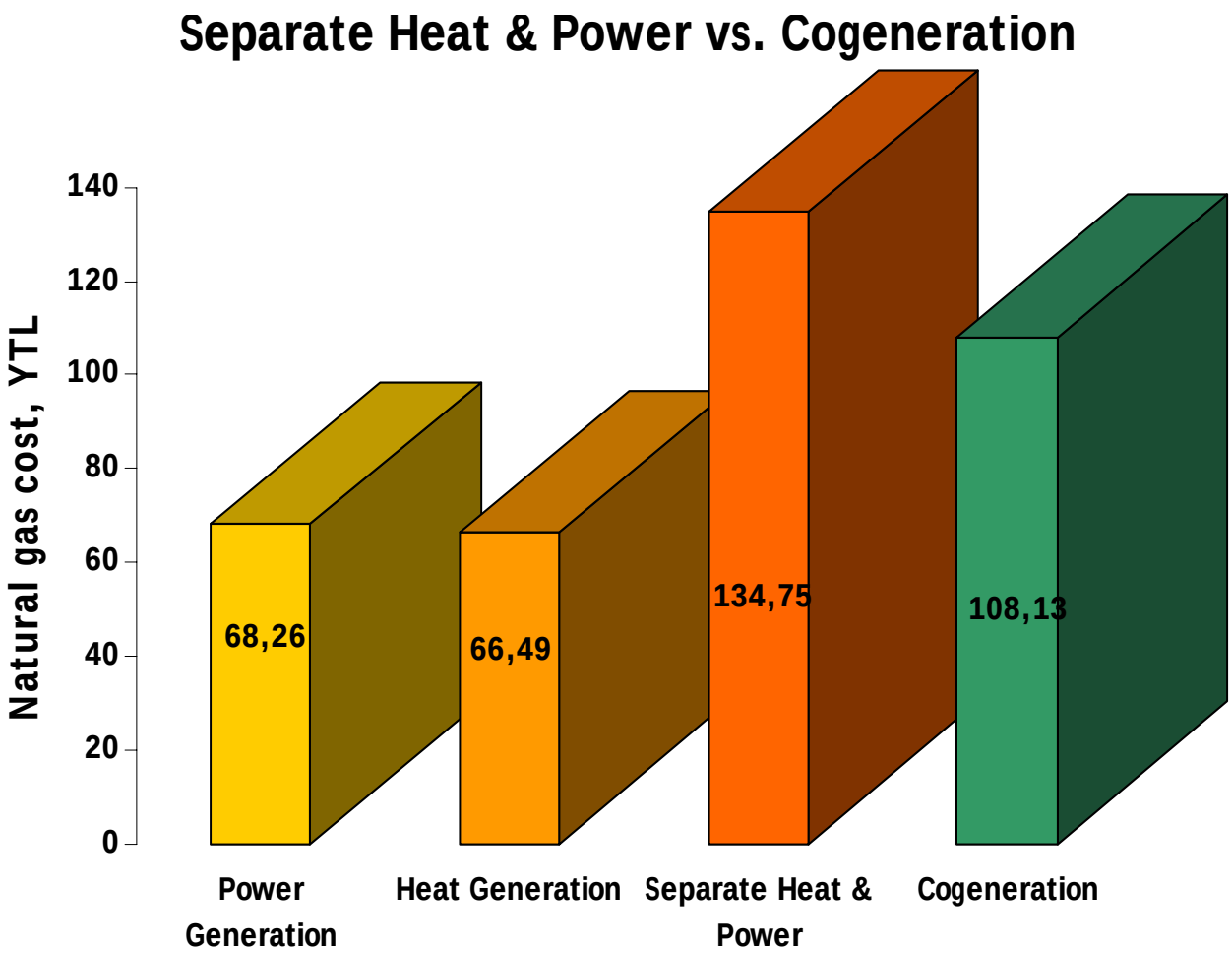
- Assumptions
  - Efficiency of combined cycle power plant: 48%
  - Price of natural gas: 0.346 YTL/m^3 (price of March 2006, not including tax)



Power generation versus cogeneration

- Gas powered cogeneration (using gas turbine & recovery boiler)
  - Electricity generation: 1 000 kWh
  - Natural gas needed to generate 1 000 kWh: 3 300 kWh_{th}
  - Heat recovery (75% efficiency): 1 725 kWh_{th}
  - Cost of natural gas for cogeneration: 108.13 YTL
- Only power generation (using combined cycle: η = 48%)
  - Electricity generation: 1 000 kWh
  - Natural gas needed to generate 1 000 kWh: 2 083 kWh_{th}
  - Cost of natural gas for power generation: 68.26 YTL
- Only heat generation (using a boiler with 85% efficiency)
  - Heat generation: 1 725 kWh_{th}
  - Natural gas needed to generate 1 725 kWh_{th}: 2 029 kWh_{th}
  - Cost of natural gas for heat generation: 66.49 YTL

Power generation versus cogeneration



Potential saving of fuel and fuel cost: about 25%

Barriers to cogeneration development

- Reasons for the slow down in the growth of cogeneration
  - Political and legal uncertainties
  - Installations mainly designed to maximize power generation
  - High increase in natural gas price while the price of electricity remains unchanged
  - Overall surplus electricity generation capacity (up to 2008)
  - Reluctance of TEDAŞ (Turkish Electricity Distribution Company) in permitting connections to the grid
  - Very high transmission and distribution fees
  - High interest rates, hindering the financing of cogeneration investments

Draft Energy Efficiency Law

- Proposal to amend the Electricity Market Law
  - Give license to various residential, commercial and institutional buildings which opt for cogeneration plants
    - That exceed their efficiency above a proposed value
    - To meet their own energy demands
  - Not required to establish a limited company to set up the cogeneration plant
  - Types of buildings include (in Draft EE Law as of July 06)
    - Universities
    - Housing developments
    - Hotels and holiday villages
    - Hospitals
    - Old age homes
    - Shopping centres, etc.

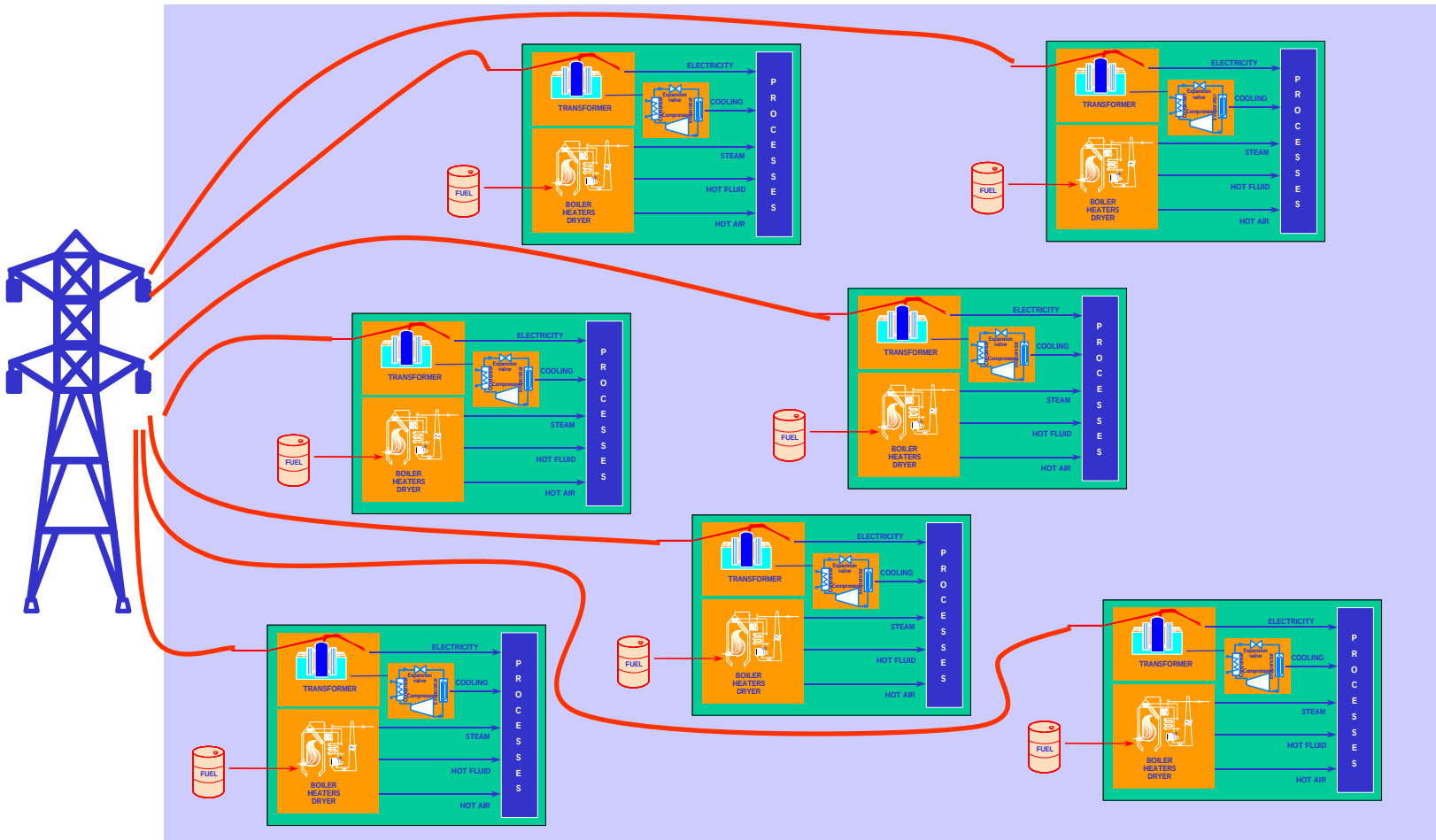
Turkish Cogeneration Directive?

- Issues to be addressed
  - Defining a realistic target to promote high efficiency cogeneration facilities
    - On the basis of surveys of techno-economic potential in commercial and industrial sectors
    - Focus on district energy network to achieve economy of scale and flattening the demand curve
  - Setting efficiency criteria
    - Thermal and electrical efficiency
    - Total cogeneration efficiency, including losses in the district energy network
  - Guarantee of origin for electricity from cogeneration facility
    - Fuel source, place of use of thermal energy
    - Quantity of electricity covered by the guarantee

Turkish Cogeneration Directive?

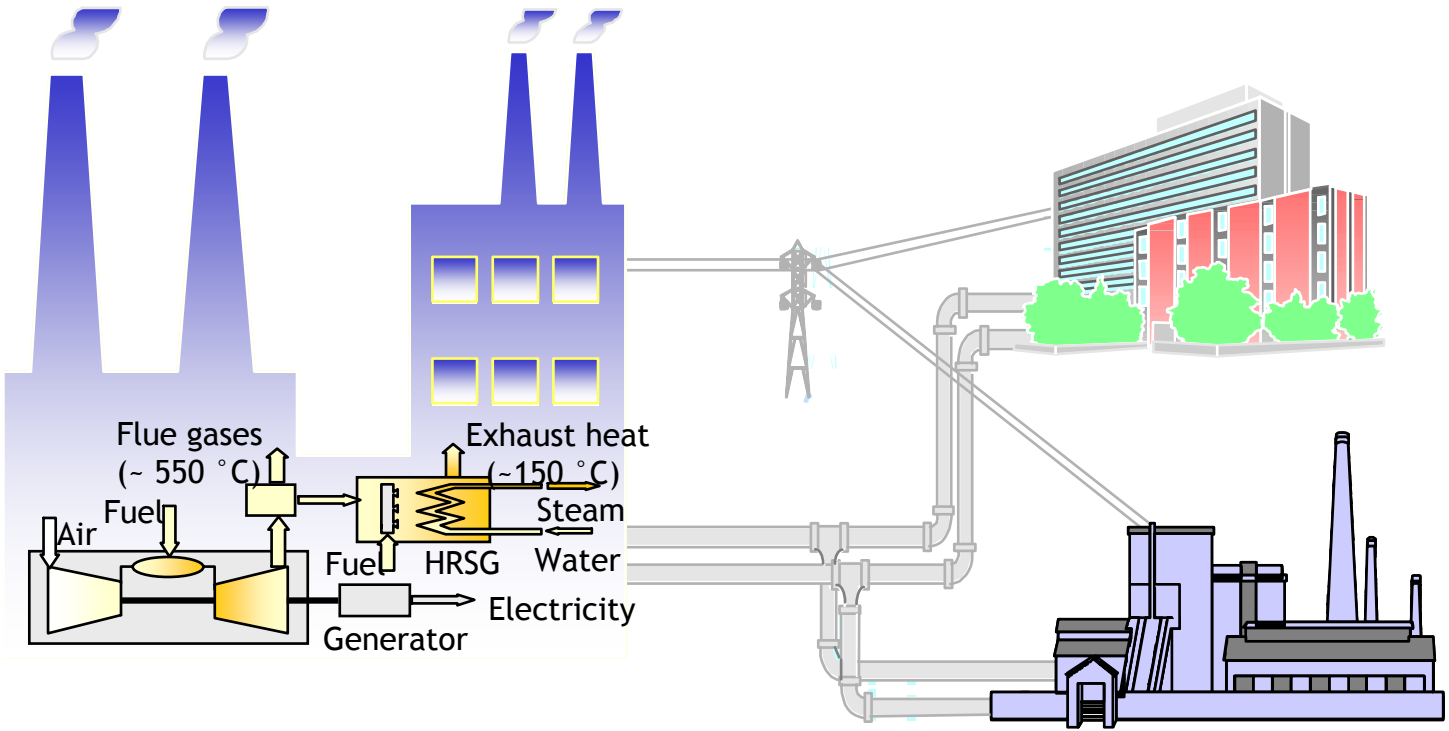
- Policy, legal and promotional issues
  - Institutional and legal aspects
    - Better legal arrangements and less non-regulatory obstacles
    - Impartial and non-discriminatory rules and regulations
  - Energy pricing
    - Support to small/medium high-efficiency cogeneration plants
    - Introduce the concept of **net metering** (cogenerators to guarantee electricity supply during utility peak periods)
    - Favourable tariff for stand-by or back-up electricity supply
  - Supporting role
    - Promote cogeneration through municipalities, industrial zone developers, companies involved in gas network contracting and expansion, energy services companies, etc.
    - Allocate sovereign risks and guarantee utility payment obligations in order to boost investor confidence

Energy supply in individual buildings



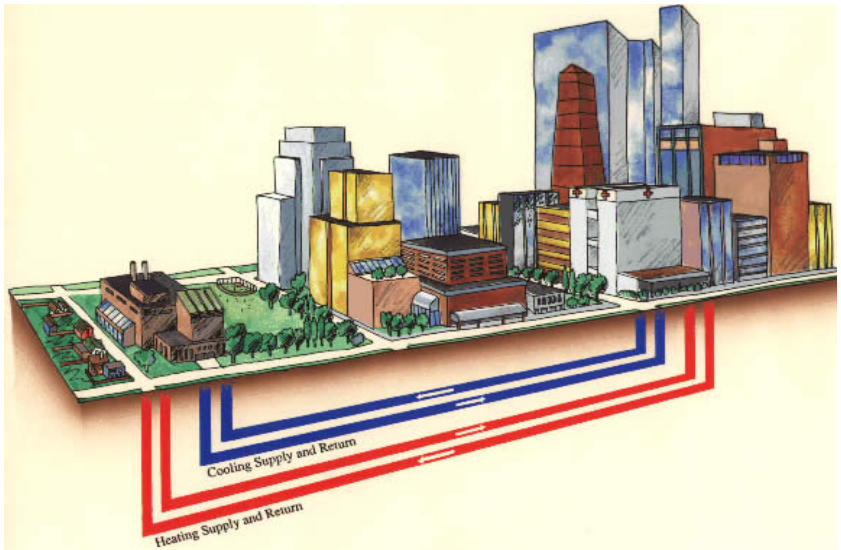
Cogeneration & energy network

- Installation of smaller gas turbines near the end-users
  - Heat recovered from gas turbines for the district heating network
  - Advantages: Higher overall efficiency, lower transmission and distribution losses, less fuel use and least environmental impacts



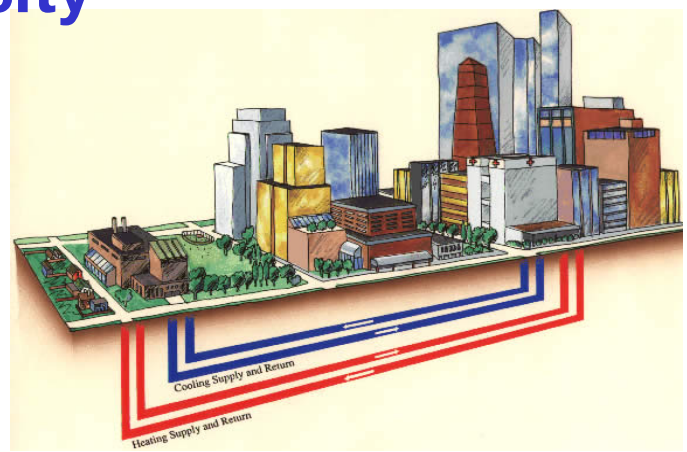
Cogeneration & energy network

- **Larger cogeneration system – economy of scale**
- **System expansion to users for whom individual facility cannot be justified**
- **Improvement in the overall system efficiency**
- **Increased reliability and availability of utility services**

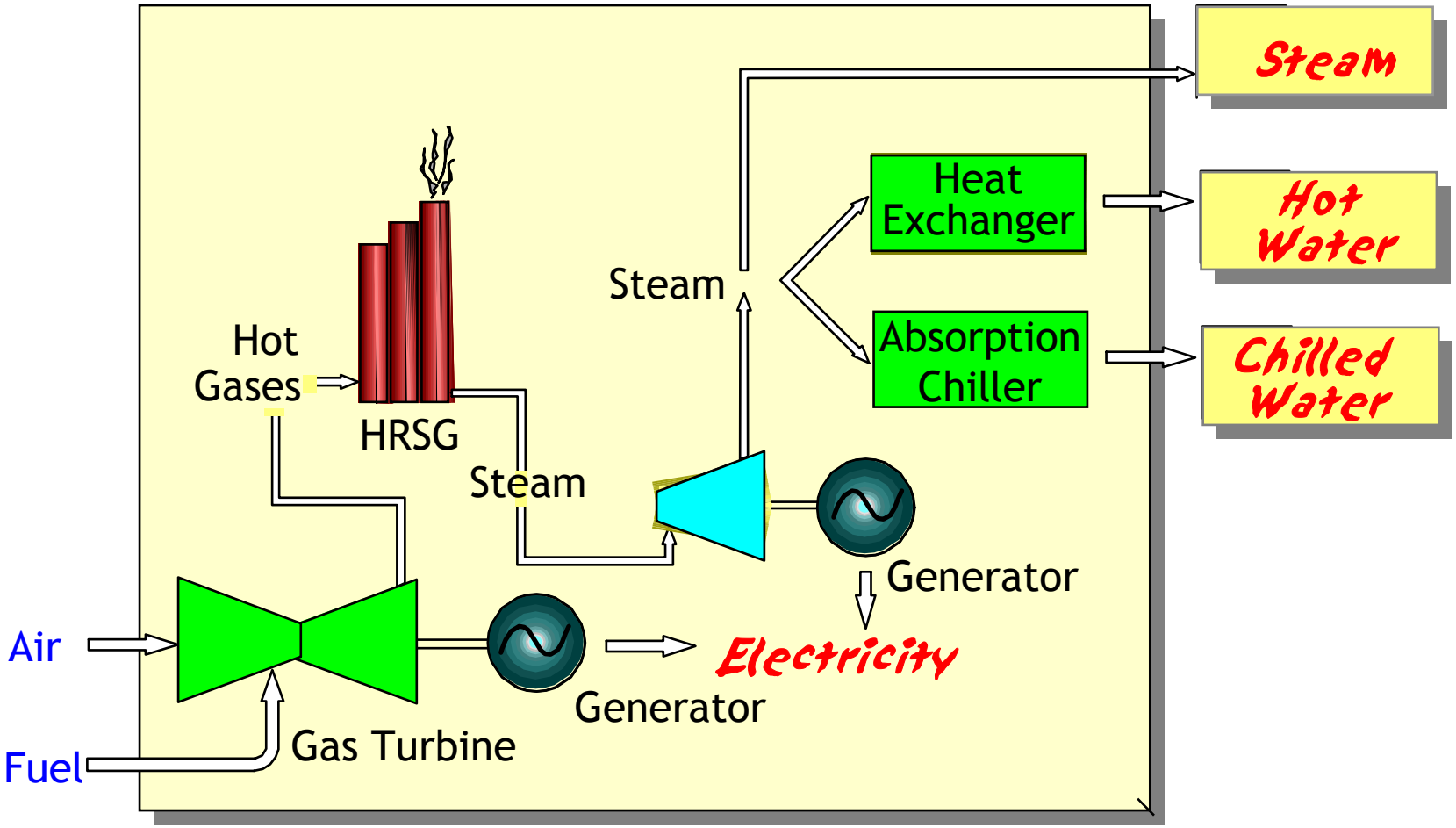


Cogeneration & energy network

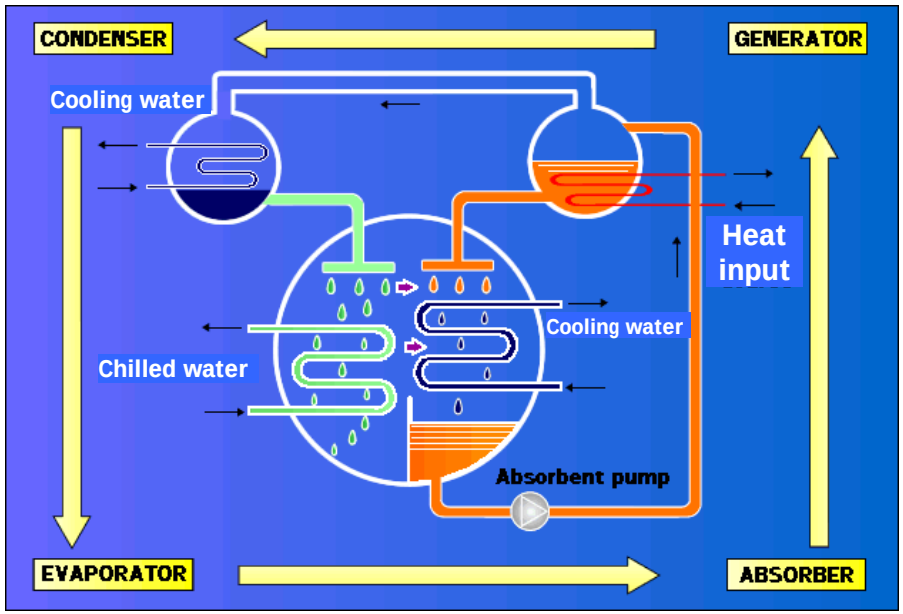
- **Pooling of maintenance personnel and reduction in manpower cost**
- **Saving of mechanical room space in the user buildings**
- **Purchase of fuel at more competitive rate**
- **Better negotiation with the Power Utility for the purchase/sale of electricity**



Scope for trigeneration



Vapour absorption cooling



KLCC district energy supply (Malaysia)

District cooling for over 600 000 m² of floor space in the KLCC North West Development area.