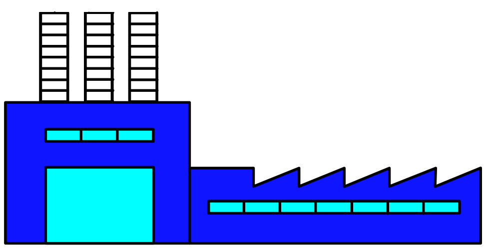
# Cogeneration as an important element of the European Policy for Sustainable Future

## *Twinning project:*
## *Improvement of energy efficiency in Turkey*



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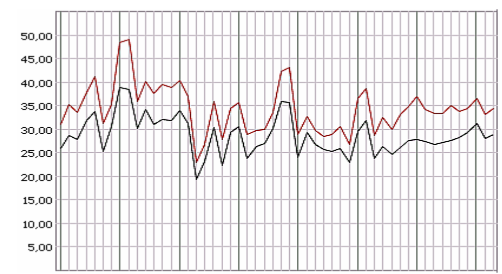
**Ankara**
**21-22 March 2007**

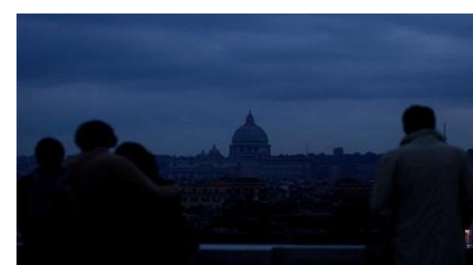
# Energy situation in Europe (EU25)

- Need for massive investment in new capacity
- But new investment risks for large power plants

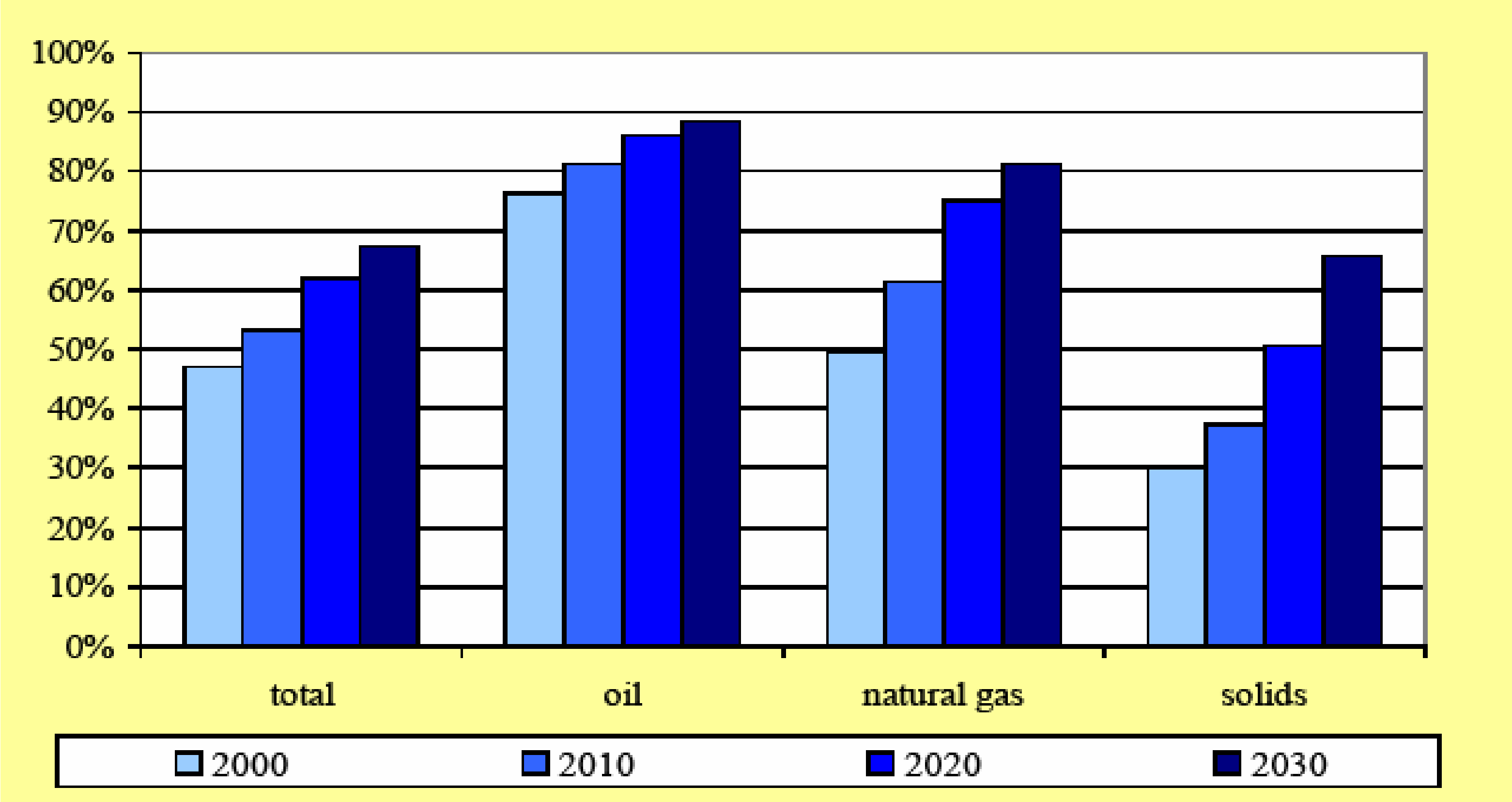
- Electricity price likely to go up
- Price volatility: chances for flexible systems which "surf the markets"




- Power cuts: Security of supply becomes an issue
- Many possibilities to prioritise and support cogeneration

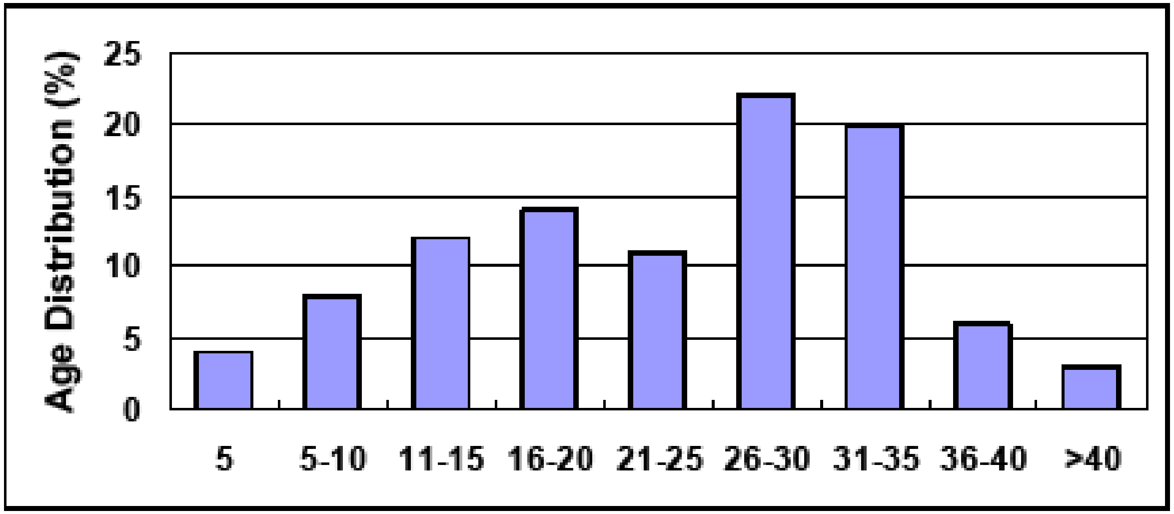


# EU energy import dependency



# Investment needs for energy supply

- Installed capacity in 2003: 696 GW
- Increasing demand and need for replacing 330 GW old power plants
  - *600-700 GW new capacity needed till 2035*
- Investment needed: 500 billion to 1 trillion Euros



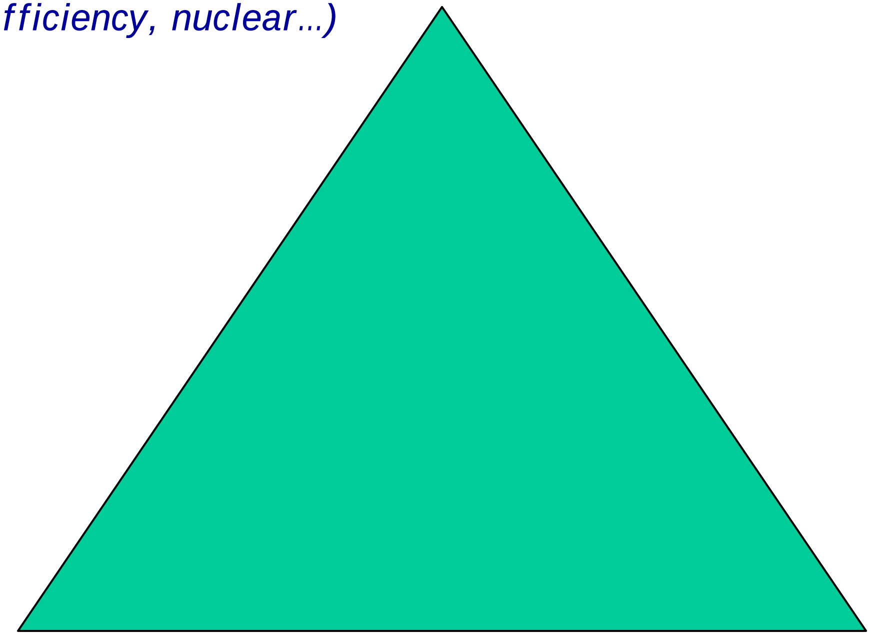

Source: EPPSA

Age distribution of coal power plants in the EU

# Common energy policy goals

- **Competitiveness**

*Internal market, competition, interconnections, European electricity grid, research and innovation (clean coal, carbon sequestration, alternative fuels, energy efficiency, nuclear…)*



- **Supply security**

*International dialogue, European stock management (oil/gas), refining capacity and energy storage, protection against terrorism, energy efficiency*

- **Environment**

*Renewable energy, energy efficiency, nuclear, innovation and research, energy trading*

# Strategic energy review

- **Objective**
  - *A blueprint for an Energy Policy for Europe*
    - Offer a long-term vision of an efficient and integrated energy policy
  - *A common vision*
    - Establish a coherent framework for better coordination of energy actions within Europe
  - *Sustainable energy with a wider perspective*
    - Encompass energy security, environmental protection, and economic competitiveness with social protection
- **Horizon**
  - *2030 (2050 for certain technologies)*

# Energy efficiency action plan

- **Action plan following public consultation**
  - *Focus areas*
    - Dynamic energy performance requirements for energy-using products, buildings and energy services
    - Energy transformation sector
    - Transport sector
    - Financing energy efficiency, economic incentives, pricing
    - Influencing behavioral changes (including education, training and labeling of appliances)
    - Energy efficiency in foreign trade policies, partnerships

# Energy efficiency action plan (EEAP)

- **EEAP adopted in October 2006 with about 70 actions**
  - *National EEAP in 2007 and every 3 years thereafter*
  - *EEAP includes CHP*
    - Improved definitions
    - Requirements
    - Standards
    - Guarantee of origin
  - *Attention for the use of waste heat and for quality district heating*

# Instruments of EU energy policy

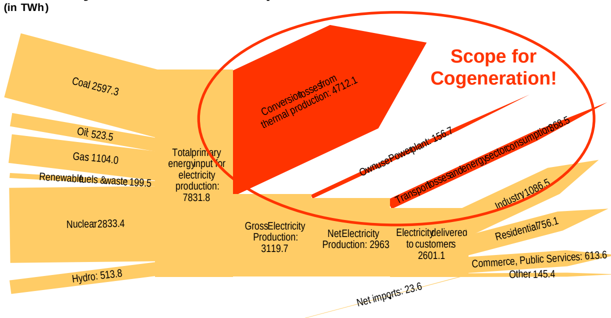
- **Legislative measures: EU Directives**
  - *Electricity from renewables*
  - *Bio-fuels*
  - *Labeling of appliances*
  - *Minimum efficiency requirements of appliances*
  - *Energy performance of buildings*
  - *Cogeneration (CHP)*
  - *Ecodesign (energy using products, including boilers)*
  - *Energy end-use efficiency and energy services*

- **Programmes**
  - *$7^{th}$ RTD Framework Programme*
  - *Intelligent Energy – Europe (including SAVE, ALTENER) in CIP*

# Relevance of cogeneration in Europe

- Cogeneration is the most efficient energy conversion technique
- Europe is world leader in cogeneration, with 75 GWe installed capacity
- Saves around 280 million tonnes $CO_2$ (EU25)
- Reduces energy dependence by 1500 PJ/annum
- Target to increase the share of CHP from 9% in 1994 to 18% in 2010

Electricity Generation in European OECD countries
(in TWh)



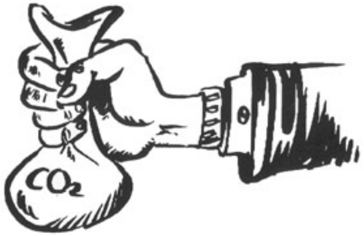

33% total efficiency of the electricity supply system

Source: OECD 1999

# Energy saving potential in Europe

| *Potential savings (Mtoe)* | By 2020 **Implementation of adopted measures** | Beyond 2020 **Implementation of additional measures** |
|---|---|---|
| Buildings: Heating/cooling<br>Electric appliances | 41<br>15 | 70<br>35 |
| Industry | 16 | 30 |
| Transport | 45 | 90 |
| Combined heat & power | **40** | **60** |
| Other energy transformation, etc | 33 | 75 |
| *Total energy savings* | *190* | *360* |

Dutch "clean, clever, competitive" agenda: cogeneration is "single biggest solution to Kyoto"




**Carbon market**

# Reasons to promote Cogeneration

- **Conformity with European energy policy**
  - *Moving from the present 9% to 18% of the electricity generated by CHP will allow the EU to meet half of its $CO_2$ reduction commitments*
- **Reliability**
  - *Proven and reliable technology; cost-effective energy source; long life of at least 20 to 40 years*
- **High thermal efficiency**
  - *Total efficiency between 80 and 90%, 30-40% higher than separate production of heat and electricity*
- **Lower environmental impacts**
  - *Lower fuel consumption leads to reduced impact on the environment ($CO_2$, $SO_2$ and $NO_2$)*

# Reasons to promote Cogeneration

- **Fuel flexibility**
  - *Potential to use a wide variety of fuels, including those with low calorific value and high moisture content*
  - *Natural gas and bio-fuels can largely be used as substitutes for coal and oil*
- **High availability**
  - *High availability levels enabling uninterrupted energy generation, reducing the risk for power and/or heat outages*
  - *Can be better maintained and operated than in-building systems and option for switching to a reserve fuel source*
- **Supply security and market benefits**
  - *Substantial fuel savings and wide range of different fuel use allow to reduce the dependency on foreign energy supplies*
- **Economic benefits**
  - *Facilitates generation plant diversification, competition in generation and liberalization of energy markets*

# Legislative context: the CHP Directive

- **CHP directive seeking to enhance energy efficiency and improved supply security**
- **A framework to promote cogeneration development in Europe**
  - *Support for existing CHP installation*
  - *Creation of level-playing field in the market*
- **The Directive specifies**
  - *Legal basis for cogeneration in Europe*
  - *Definition of “high efficiency cogeneration”*
  - *Analysis of CHP potentials in member States*
  - *Removal of administrative barriers*
  - *Focus support on best schemes*
  - *Guarantee of origin for electricity*
  - *Hard measure – grid access and authorization*
  - *If no progress, then further measures are possible*

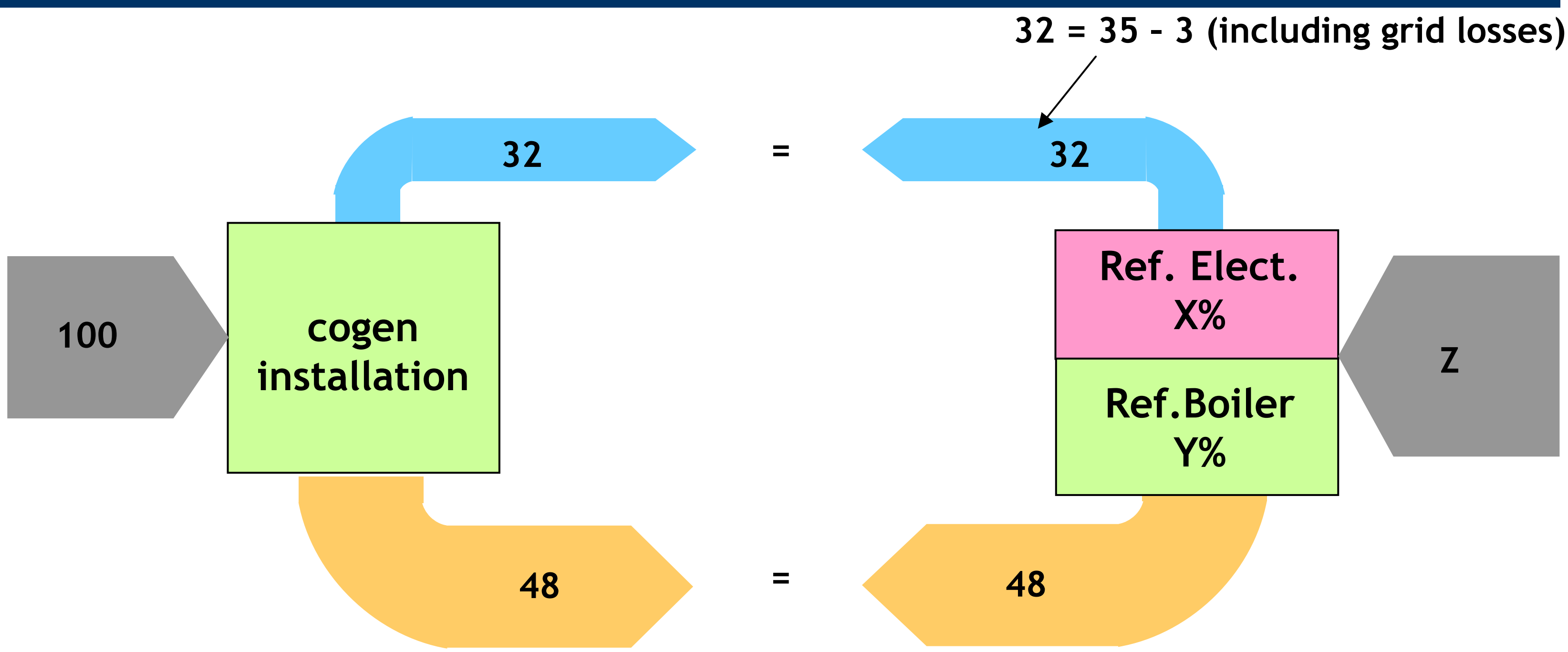
# European cogeneration directive

- **Definition of high efficiency cogeneration**
  - All CHP plants up to 1 MWe, which provide any primary energy savings (PES)
  - Larger plants, which provide PES of at least 10%
  - PES is normally calculated for each individual CHP plant with following formula

$$PES = \left( 1 - \frac{1}{\frac{CHP\,H\eta}{Ref\,H\eta} + \frac{CHP\,E\eta}{Ref\,E\eta}} \right) \times 100\,\%$$

  - Other PES calculation formula possible

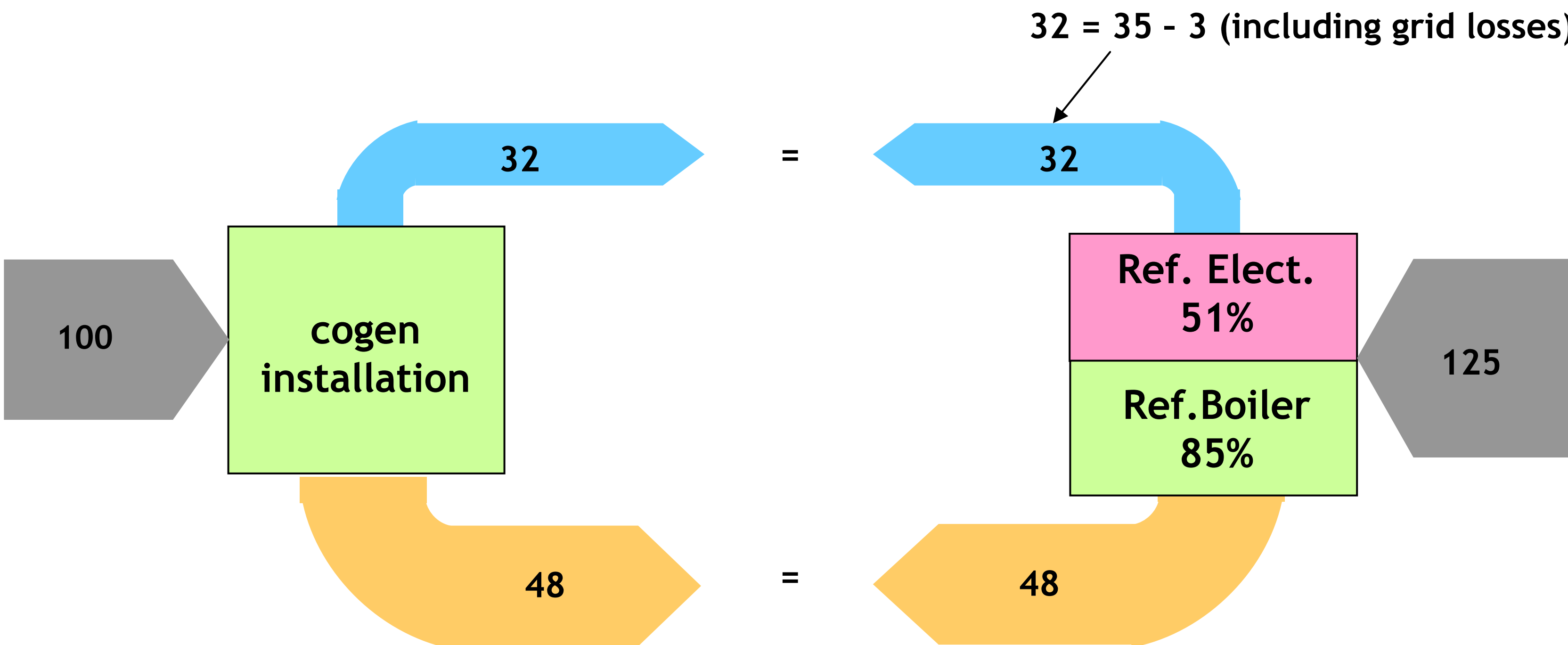
# Primary energy savings




**Savings > 10%**

Comparison of energy consumption for cogeneration and for separate production of electricity and heat

# Primary energy savings



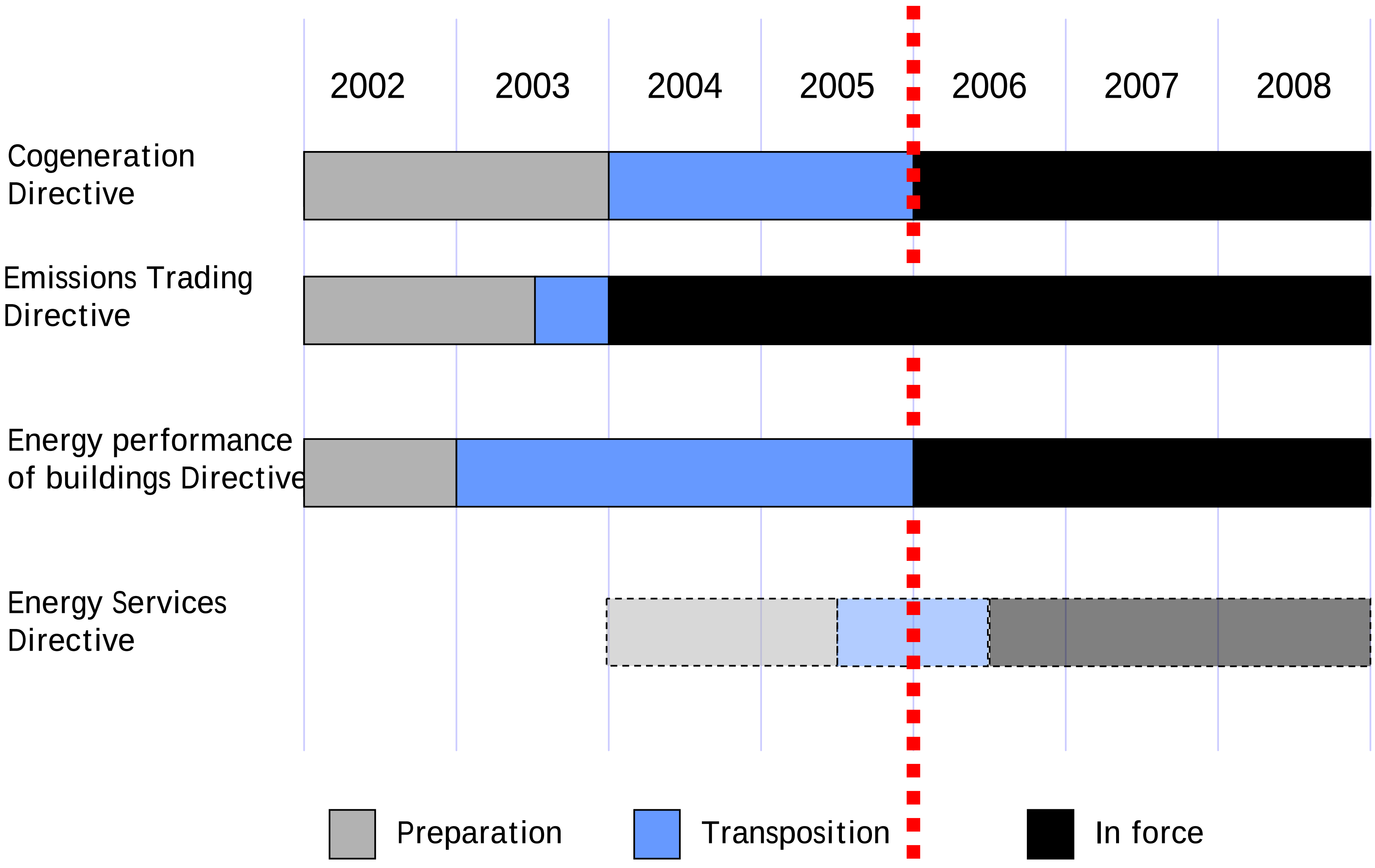

**Savings = 125-100 = 25 = 20%**

Comparison of energy consumption for cogeneration and for separate production of electricity and heat

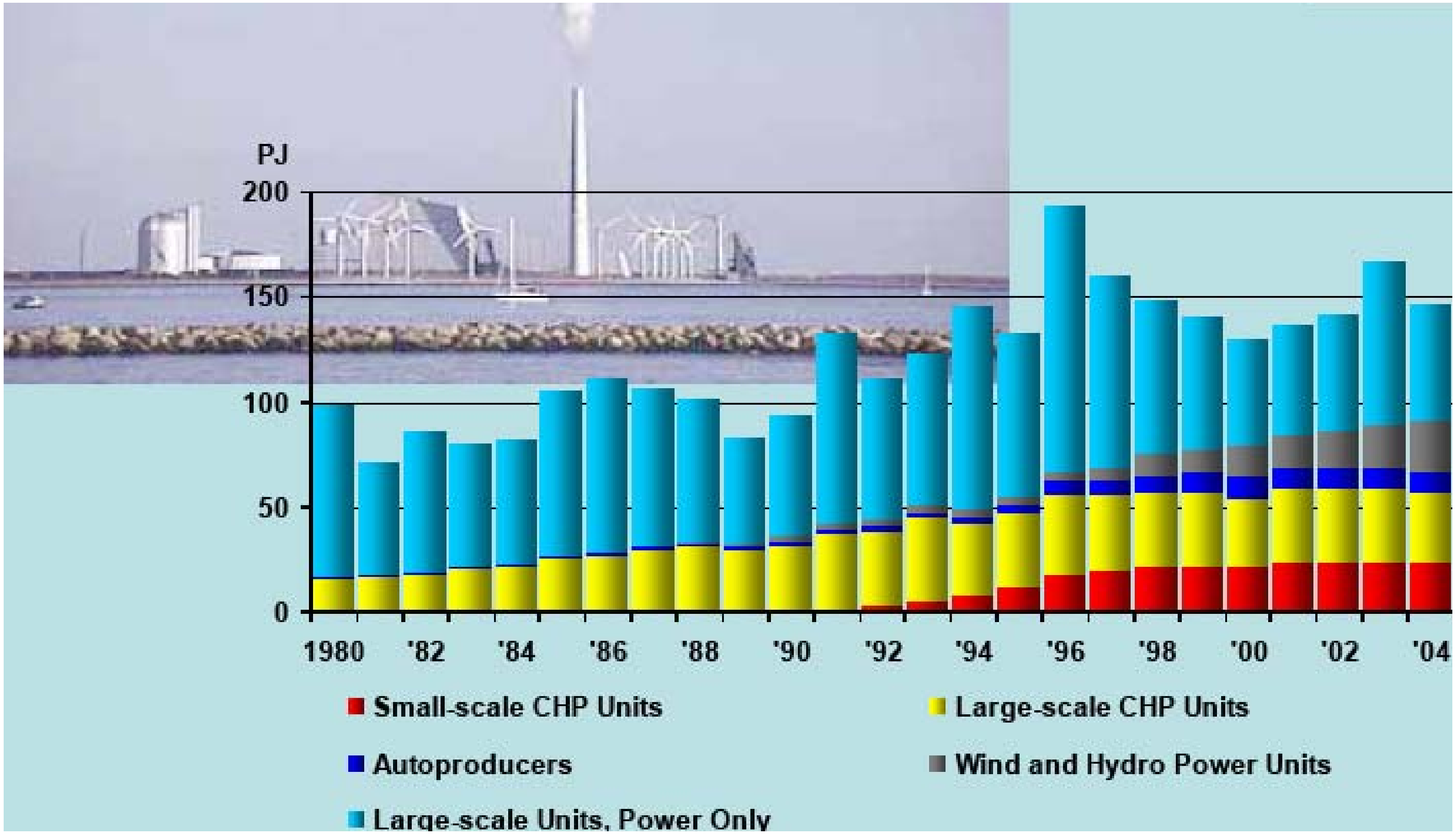
# European regulations favoring cogeneration

- Emissions Trading Directive 2003/87/EC
- Energy Services Directive COM(2003)739
- New Electricity and Gas Directives 2003/54+55/EC
- New Labelling Directive
- CHP Directive 2004/8/EC
- Decision on FP6 1513/2002/EC
- State Aid Guidelines 2001/C 37/03
- Decision on Trans-European Networks COM(2003)742
- Energy Performance of Buildings Directive 2002/91/EC
- Decision on "Intelligent Energy for Europe" (1230/2003/EC)
- Linking Directive COM(2003)403
- Energy Taxation Directive 2003/96/EC
- Renewables Directive 2001/77/EC
- Large Combustion Plants Directive 2001/80/EC
- Directive on Security of Supply and Infrastructure Investment COM(2003)740

# European cogeneration directive



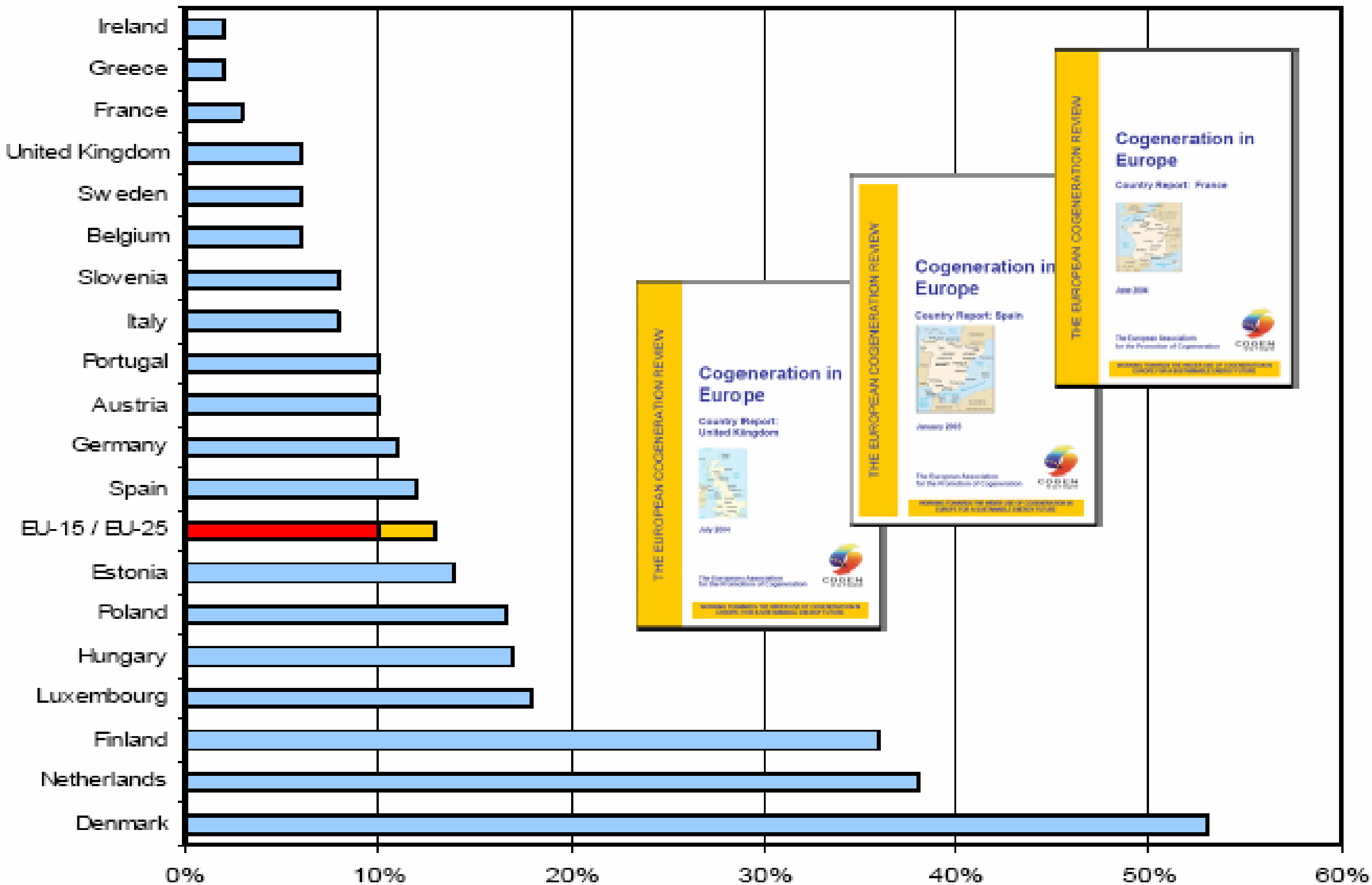
# Electricity supply in Europe



# Status of cogeneration in Europe

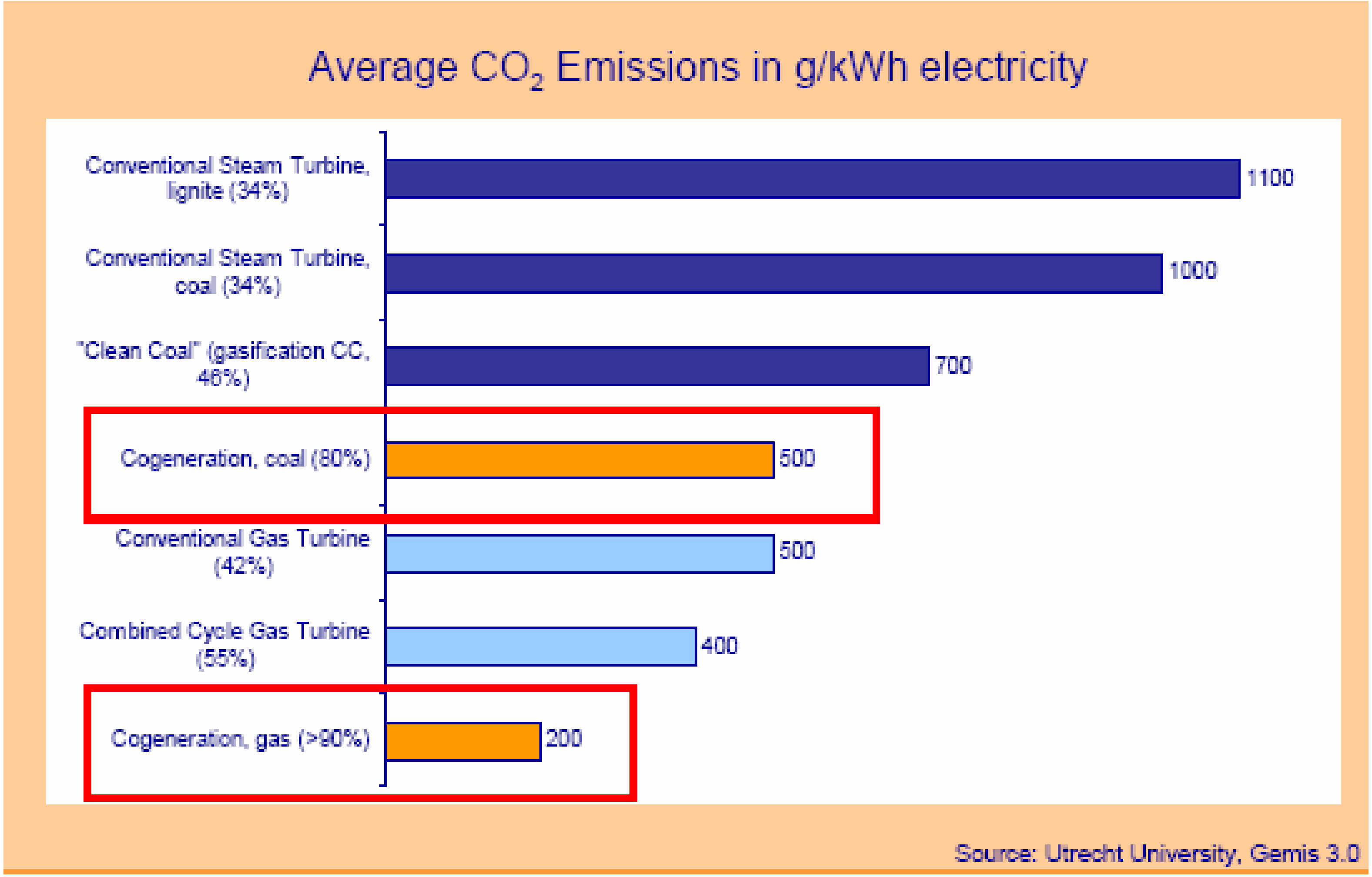
- **Current status**
  - World leader in the use of cogeneration
  - Average of 10% penetration in electricity and heat market in Europe
  - 75 GWe installation capacity
  - Cogeneration used in all sectors of the economy
  - Modern cogeneration is mostly fired with natural gas
  - Cogeneration's competitive advantage eroded with higher gas prices and lower electricity prices
  - Many barriers to cogeneration and distributed generation

# Share of cogenerated electricity in Europe




Source: EUROSTAT 2003 & Others

# Carbon efficiency of power technologies



# Diversity of cogeneration in Europe

- **Natural resources**
  - Countries with natural gas
  - Countries with abundant resources may not prioritise efficiency
- **Energy supply tradition**
  - District energy in cold countries
  - State monopoly traditions
- **Heat requirement**
  - High level of industrialization
  - Warmer countries require less heat (but cooling
- **Environmental policy**
  - Some European governments tend to be greener
  - Outside Europe, environment is a lower priority

# Limited CHP in some EU countries

- **Some possible reasons**
  - *History, planning, government desire, opposition*
  - *No restriction on building condensing power*
  - *Supply-demand dilemma*
  - *System fragmentation (heat, electricity generation, transport and supply), resulting in no total system cost assessment*

# Types of support mechanisms in EU-15

| Country | Capital subsidies | Feed-in tariffs | Certificates/Obligations | Competitive tenders | Fiscal mechanisms | Effectiveness |
|---|---|---|---|---|---|---|
| Austria | × | × | | | | ** |
| Belgium | × | | × | | × | ***** |
| Denmark | × | × | × | | | *** |
| Finland | × | × | | | × | * |
| France | | × | | × | × | * |
| Germany | × | × | | | × | *** |
| Greece | × | × | × | × | | * |
| Ireland | × | | | × | | * |
| Italy | × | | × | | × | *** |
| Netherlands | | × | × | | × | ** |
| Portugal | × | × | × | | | * |
| Spain | × | × | | | × | **** |
| Sweden | × | | × | | × | ** |
| UK | × | | | | × | ** |

# Examples of support mechanisms

- **Belgium - Flanders**
  - *CHP certificates*
  - *Federal investment support*
  - *Ecological premium*
- **Belgium - Wallonia**
  - *Green certificates*
  - *Private sector investment support*
  - *Federal investment support*
- **Spain**
  - *New feed-in regime*
- **UK**
  - *CHPQA/CCL*
  - *Enhanced capital allowances*

# Analysis of support mechanisms

- **Spread-sheet model (source: Delta Energy and Environment)**
- **Two cases considered**
  - *2 MWe gas engine*
  - *18 MWe gas turbine*
- **Technical data and operating data, including**
  - *Levellized electricity costs*
  - *Simple payback period, NPV, IRR…*
- **Standard case**
- **Case per country, including the support system**

# Case 1: 2 MWe gas engine

- Output: 2 MW electricity and 2 MW heat
- Investment = €1.5 million
- Operation = 5500 hours/year
- Fuel used: natural gas
- Electricity used on site
- Primary energy savings = 26%
- Annual net revenue = €190k
- LEC = €c6.4/kWh
- IRR = 11% and PBP = 7.92 years

# Case 1: 2 MWe gas engine

| Belgium | Spain | UK |
|---|---|---|
| Certificates, Investment support and Ecological premium | Feed-in premium | CCL benefits, ECA |
| Investment support = €187k | Investment support = €0 | Investment support = €452k |
| Certifcates = €315k | Feed-in = €232k | Tax+ = €25k |
| Payback (all benefits) = 3.44 years | Payback (all benefits) = 3.57 years | Payback (all benefits) = 4.91 years |
| Payback (no investment support) = 3.93 years | Payback (no investment support) = 3.57 years | Payback (no investment support) = 7.01 years |

# Case 2: 18 MWe gas turbine

- Output: 18 MW electricity and 26 MW heat
- Investment = €17 million
- Operation = 8 000 hours/year
- Fuel used: natural gas
- 85% electricity used on site
- Primary energy savings = 18%
- Annual net revenue = €1.4 million
- LEC = €c6.2/kWh
- IRR = 2.6% and PBP = 12.42 years

# Case 2: 18 MWe gas turbine

| Belgium | Spain | UK |
|---|---|---|
| Certificates, Investment support and Ecological premium | Feed-in premium | CCL benefits, ECA |
| Investment support = €2.1 million | Investment support = €0 | Investment support = €5.1 million |
| Certifcates = €2.9 million | Feed-in = €3.1 million | Tax+ = €455k |
| Payback (all benefits) =1.71 years | Payback (all benefits) = 3.80 years | Payback (all benefits) = 6.52 years |
| Payback (no investment support) = 2.48 years | Payback (no investment support) = 3.80 years | Payback (no investment support) = 9.31 years |

# Cogeneration review of EU countries

- **Cogeneration review of selected EU countries**
  - *Portugal*
  - *Denmark*
  - *Netherlands*
  - *Belgium*
  - *UK*
  - *Hungary*
  - *Italy*

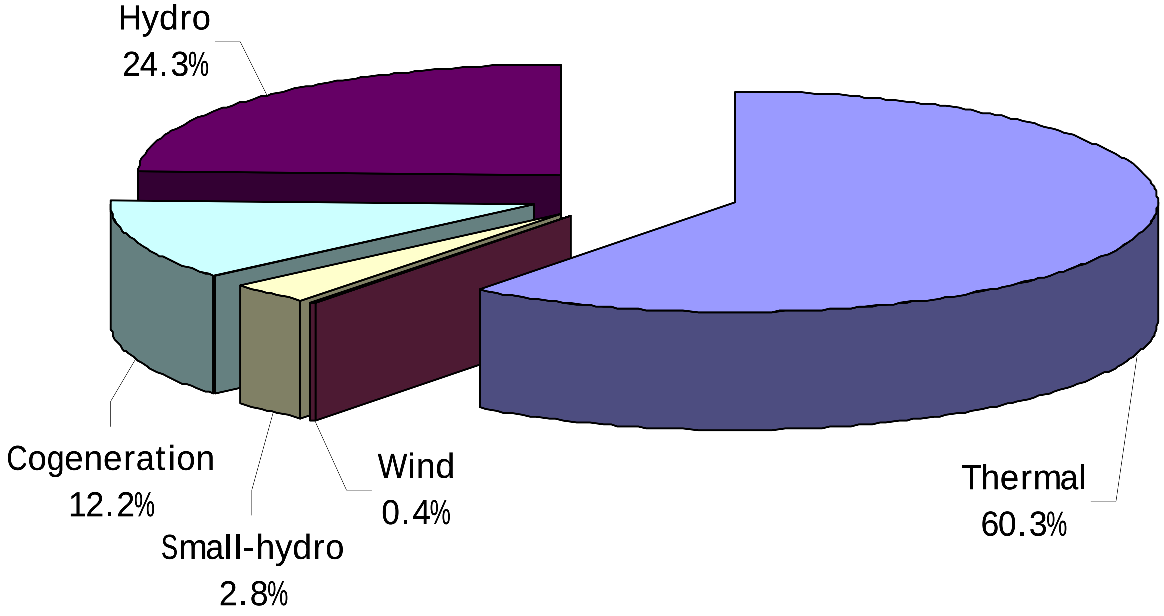
# Cogeneration review: Portugal

| | Installed power 2001 (MW) | Power to be installed until 2010 (MW) |
|---|---|---|
| Cogeneration | 1 200 | 500 |
| **Renewables** | | |
| *Wind* | *101* | *3 752* |
| *Small hydro* | *215* | *400* |
| *Biomass* | *10* | *150* |
| *Biogas* | *1* | *50* |
| *Solid wastes* | *66* | *130* |
| *Waves* | *0* | *50* |
| *Solar photovoltaics* | *1* | *150* |
| *TOTAL* | *394* | *4 682* |

# Cogeneration review: Portugal

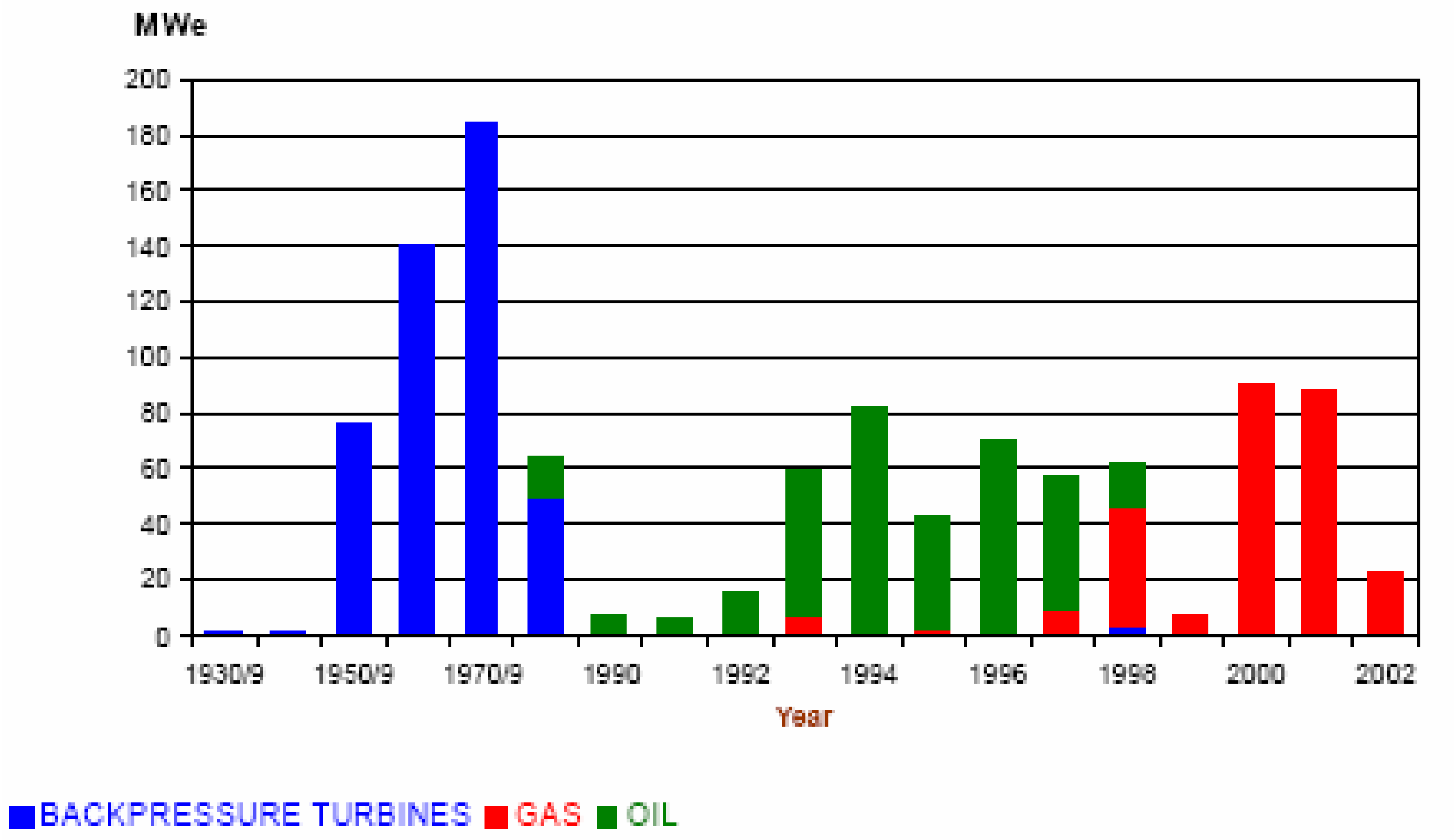


## Electricity production structure (2002)



# Cogeneration review: Portugal

## New cogeneration installed capacity



# Cogeneration review: Portugal

- Portuguese cogeneration law
  - Allows the continuity of existing cogeneration plants
    - New efficiency requirements according to technology used
    - Recognition of all energy and environmental improvements through the different technologies employed
  - Makes the integration of multiple cogeneration plants and associated consumers
    - Rules clarification for licensing
    - Correct evaluation of global efficiency increase
  - Applies different remuneration according to type of fuel
    - Based on the avoided costs concept
    - Extending the environmental benefits to the global produced electricity

# Cogeneration review: Portugal

- Feedback tariffs = avoided costs

COGENERATION:

$$SP_m = [\ FT + VT + ET\ ] \times f_{losses^*}$$

RENEWABLES:

$$SP_m = [\ FT + VT + ET\ ] \times Z \times f_{losses}$$

Monthly payment for electricity supplied to the network

Fixed term

Avoided costs:
-new production investment
-plant availability

Variable term

Avoided costs:
-Fuel
-M&O
-Network investment
-Network M&O

Environmental term

Avoided costs:
-$CO^2$

Technology factor

-Wind according operating hours
-Small Hydro
-Waves
-Solar Photovoltaic
-Others

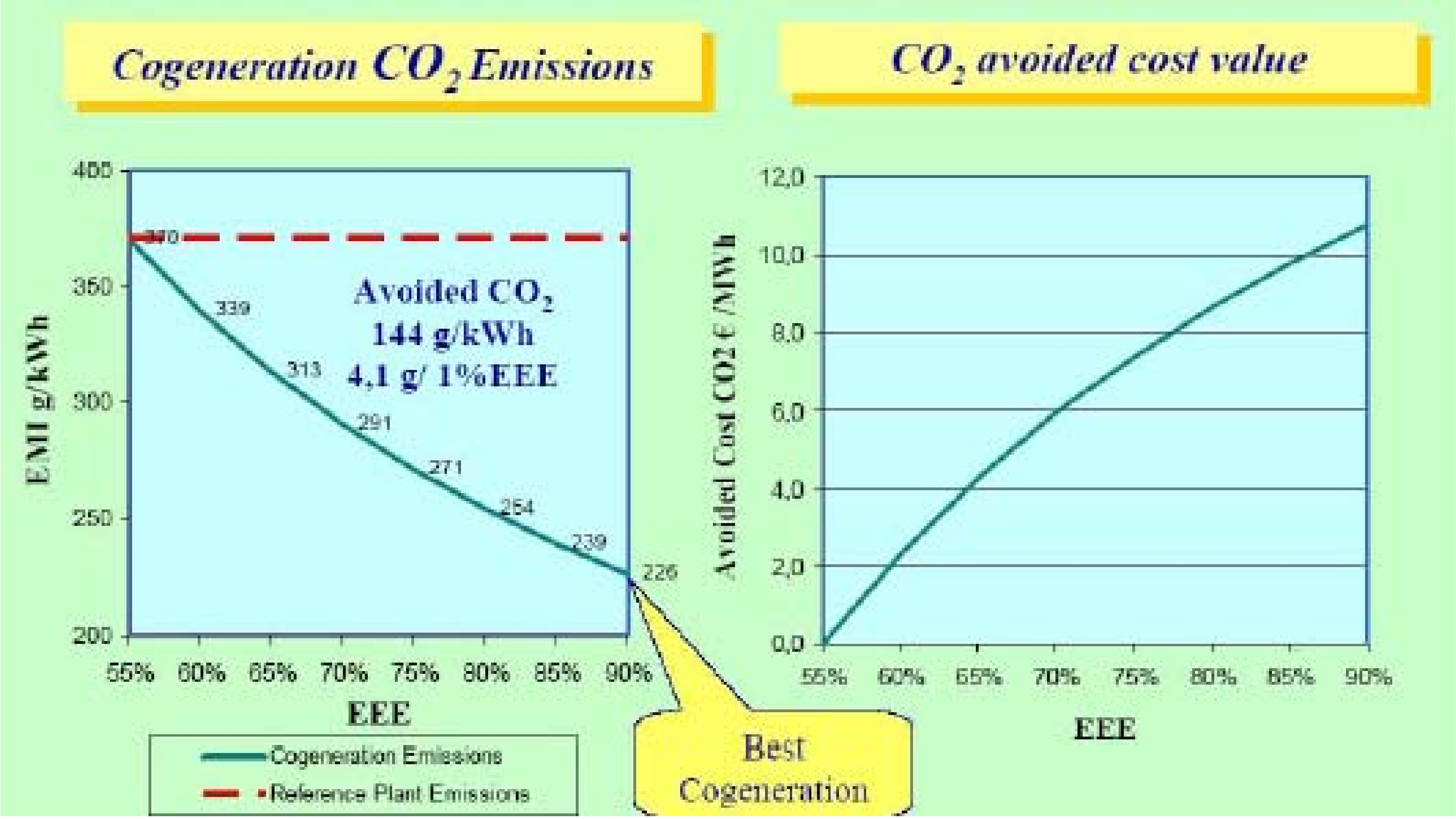
Network losses factor

Avoided costs:
-Transmission
-Distribution

* n.a. for > 10 MW

# Cogeneration review: Portugal

- Calculation of avoided environmental costs

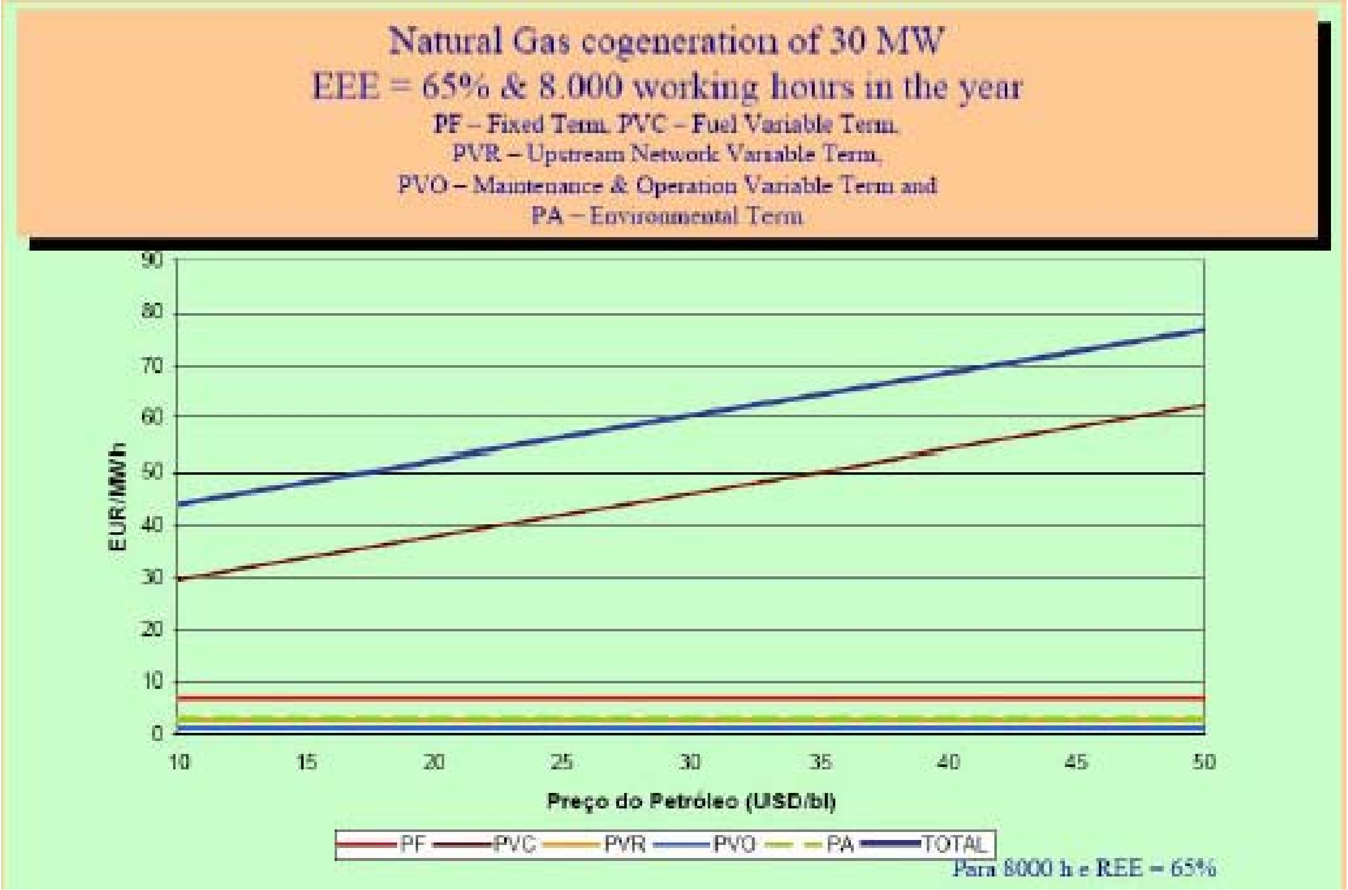


# Cogeneration review: Portugal

- Regulation of feedback tariff
  - Government regulation 57/2002
    - Connection power greater than 10 MW
    - Applied to cogeneration consuming NG, LPG or LF excluding fuel-oil
  - Government regulation 58/2002
    - Connection power lower than 10 MW
    - Applied to cogeneration consuming NG, LPG or LF excluding fuel-oil
  - Government regulation 59/2002
    - Any connection power value
    - Applied to cogeneration using fuel-oil
  - Government regulation 60/2002
    - Any connection power value
    - Applied to cogeneration using fuel-oil

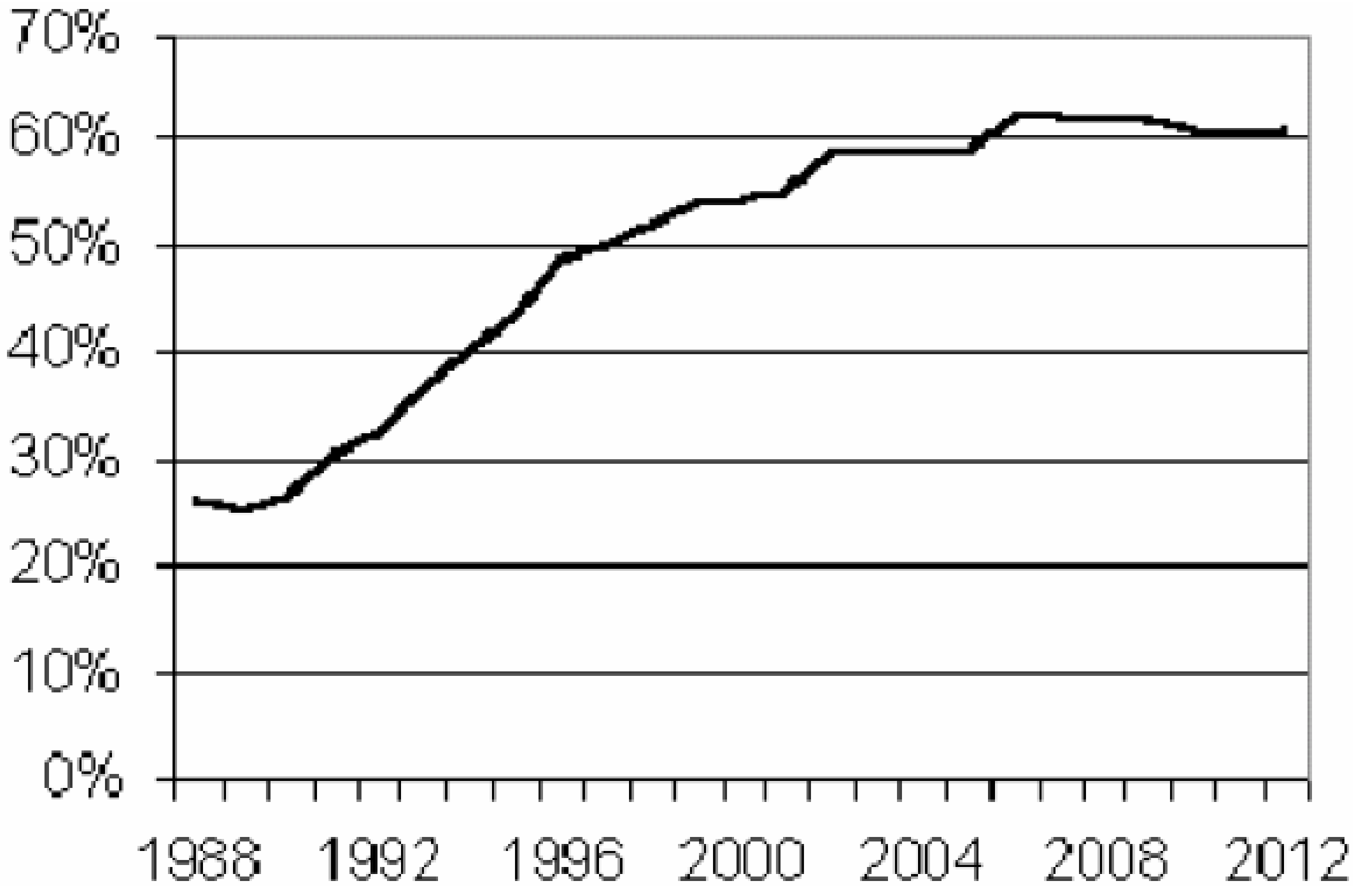
# Cogeneration review: Portugal

- Example of Regulation No. 57

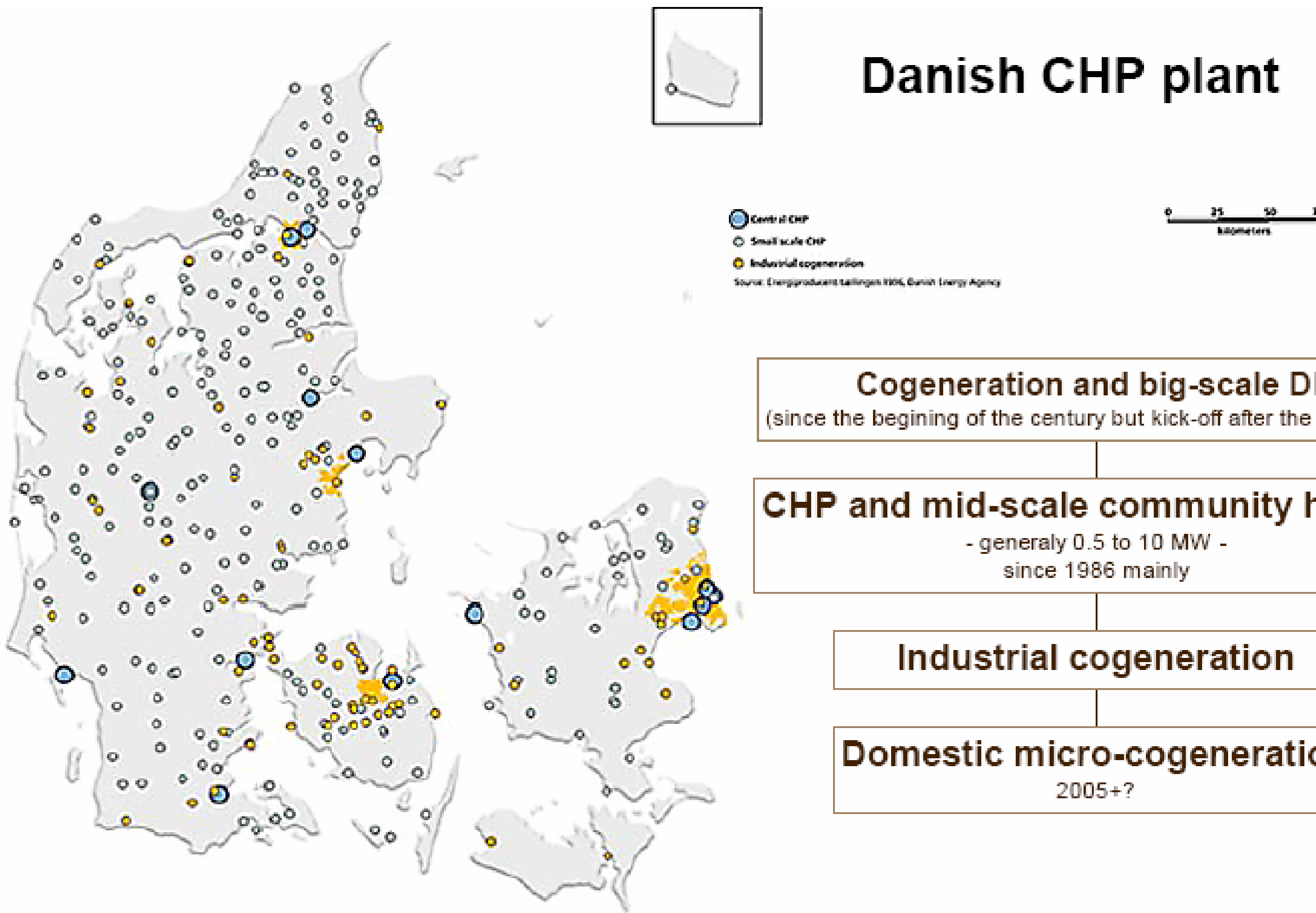


# Cogeneration review: Denmark

- Share of cogeneration in electricity supply



# Cogeneration review: Denmark




**Cogeneration and big-scale DH**
(since the begining of the century but kick-off after the oil schock)

**CHP and mid-scale community heating**
- generaly 0.5 to 10 MW -
since 1986 mainly

**Industrial cogeneration**

**Domestic micro-cogeneration**
2005+?

Pre-accession Assistance Programme
Improvement of Energy Efficiency in Turkey, Twinning Project: TR03-EY-01

# Cogeneration review: Denmark

- Reasons behind cogeneration expansion
  - Broad political consensus
  - Comprehensive legal framework (legislative and economic incentives) ensuring successful implementation of market conditions along with environmentally compatible energy production
  - Agreements with supply companies
  - Security of supply due to oil crisis at the beginning of the 70s
  - Transparent interconnection rules – shallow interconnection costs
  - Natural gas network in 1985 – North sea oil & gas

# Cogeneration review: Denmark

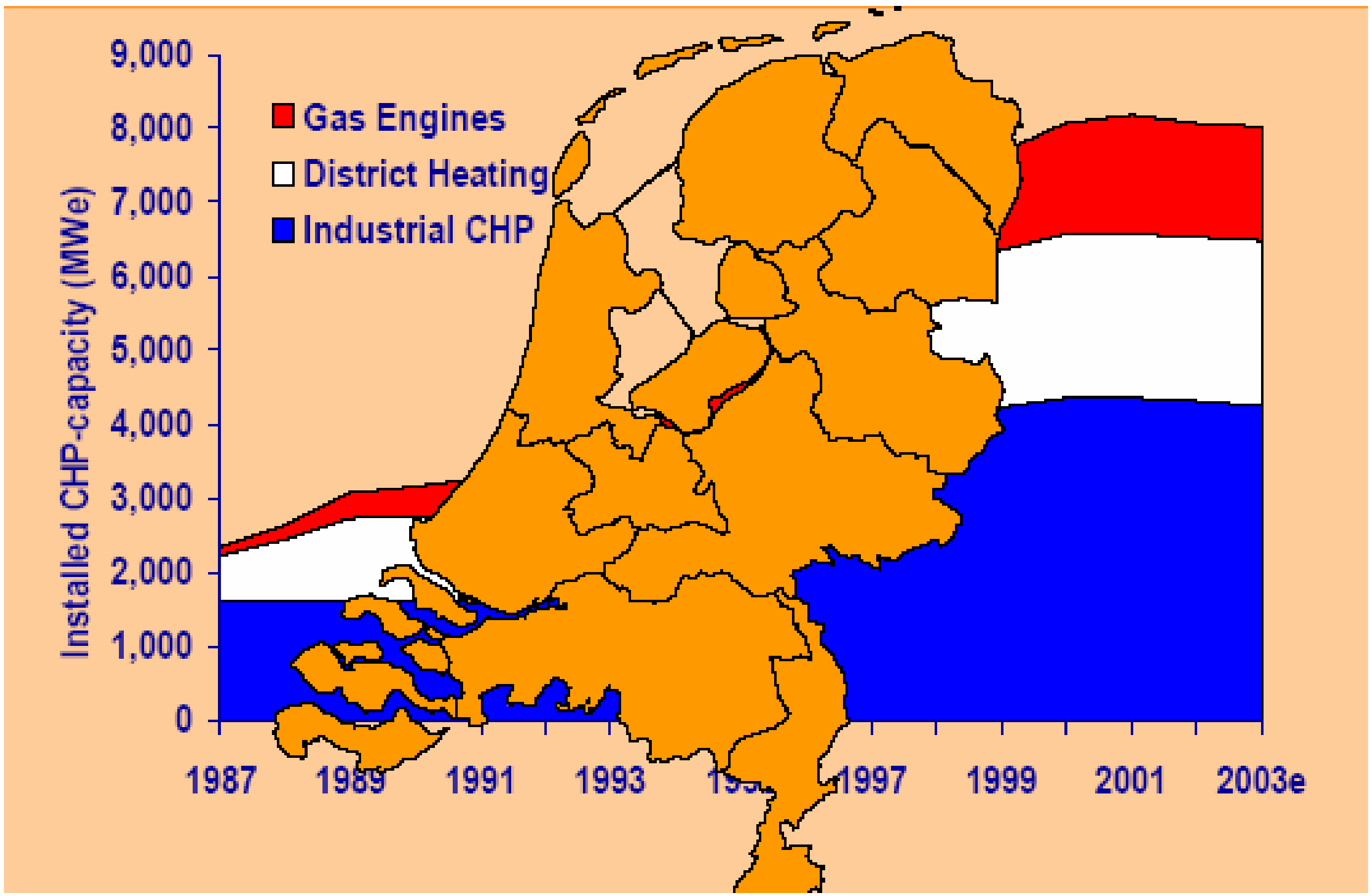
- Political agreement of 1990
  - Based on the first bill on District Heating (1979) and first political agreement on decentralised cogeneration (1986)
  - New heat planning system: Letters of condition to municipalities
  - Conversion of existing plants to combined heat and power supply – 3 phases:
    - 1990-94: large district heating plants from coal/gas to cogeneration (gas)
    - 1994-96: remaining larger coal/gas district heating plants to cogeneration, smaller ones outside gas grid converted to biomass
    - 1996-98: small gas heat-plants to cogeneration

# Cogeneration review: Denmark

- Legal framework and incentives
  - Economic incentives
    - Taxes on fuel and electricity (1970s and 80s)
    - Subsidies for cogenerated electricity (1990s)
  - Administrative measures
    - Direct regulation (conversion to district heating and cogeneration)
    - Transparent interconnection rules including shallow interconnection cost
  - Information, R&D
    - Public campaigns, funds for R&D

# Cogeneration review: Netherlands

- Need for revitalisation

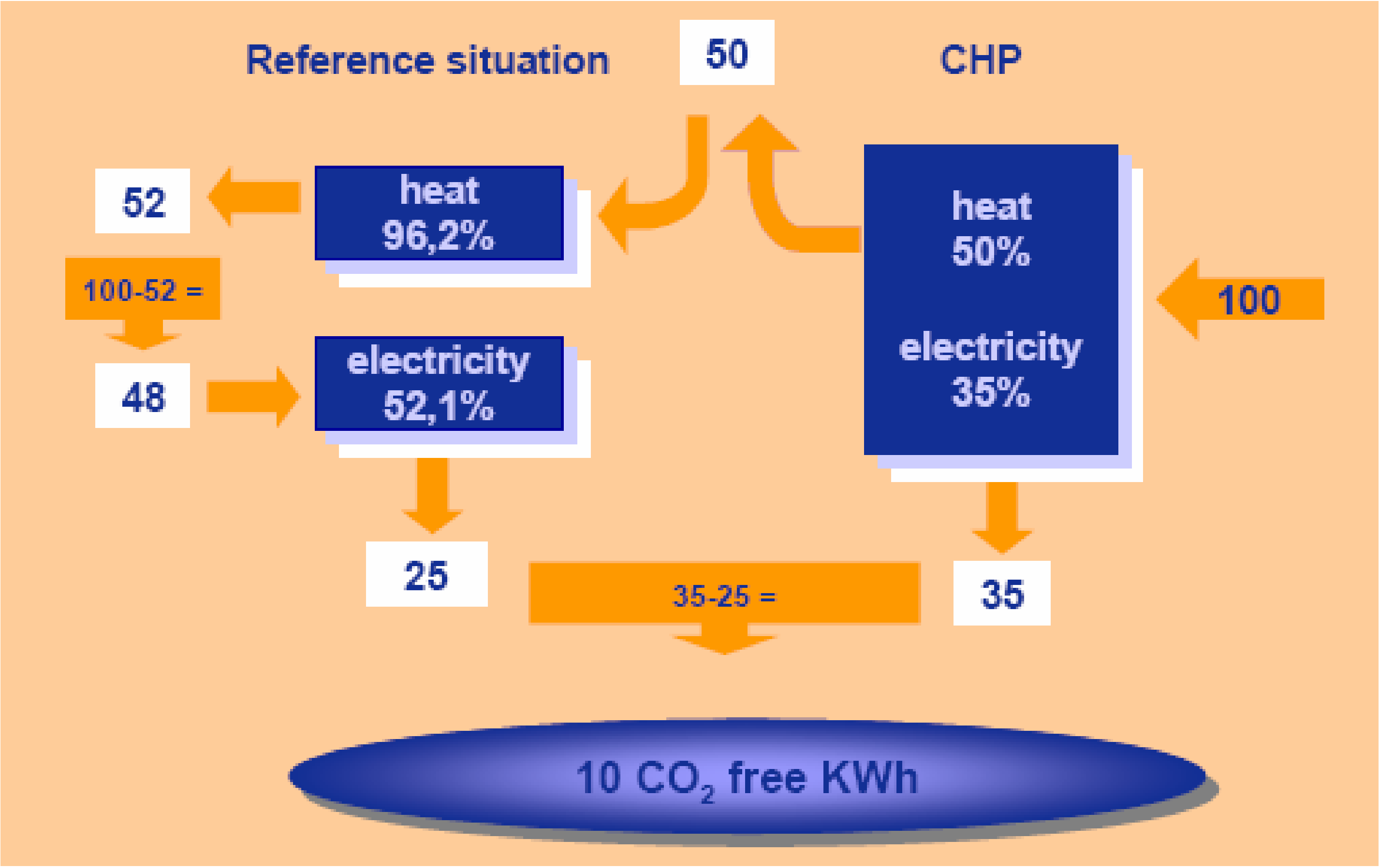


# Cogeneration review: Netherlands

- Good potential for renewed cogeneration policy
  - 40% share of electricity market, falling, not cost effective and in difficulties
  - Dutch cogeneration policy needs reactivation
  - $CO_2$ index (since July 2004) calculated Blue electricity = $CO_2$ free part of cogeneration electricity
  - Cogeneration certificates reward Blue electricity
  - Cogeneration generated 85% of Dutch CO2 free electricity
  - Yet, considerable measurement and procedural issues to settle

# Cogeneration review: Netherlands

- Computing of Blue electricity



# Cogeneration review: Netherlands

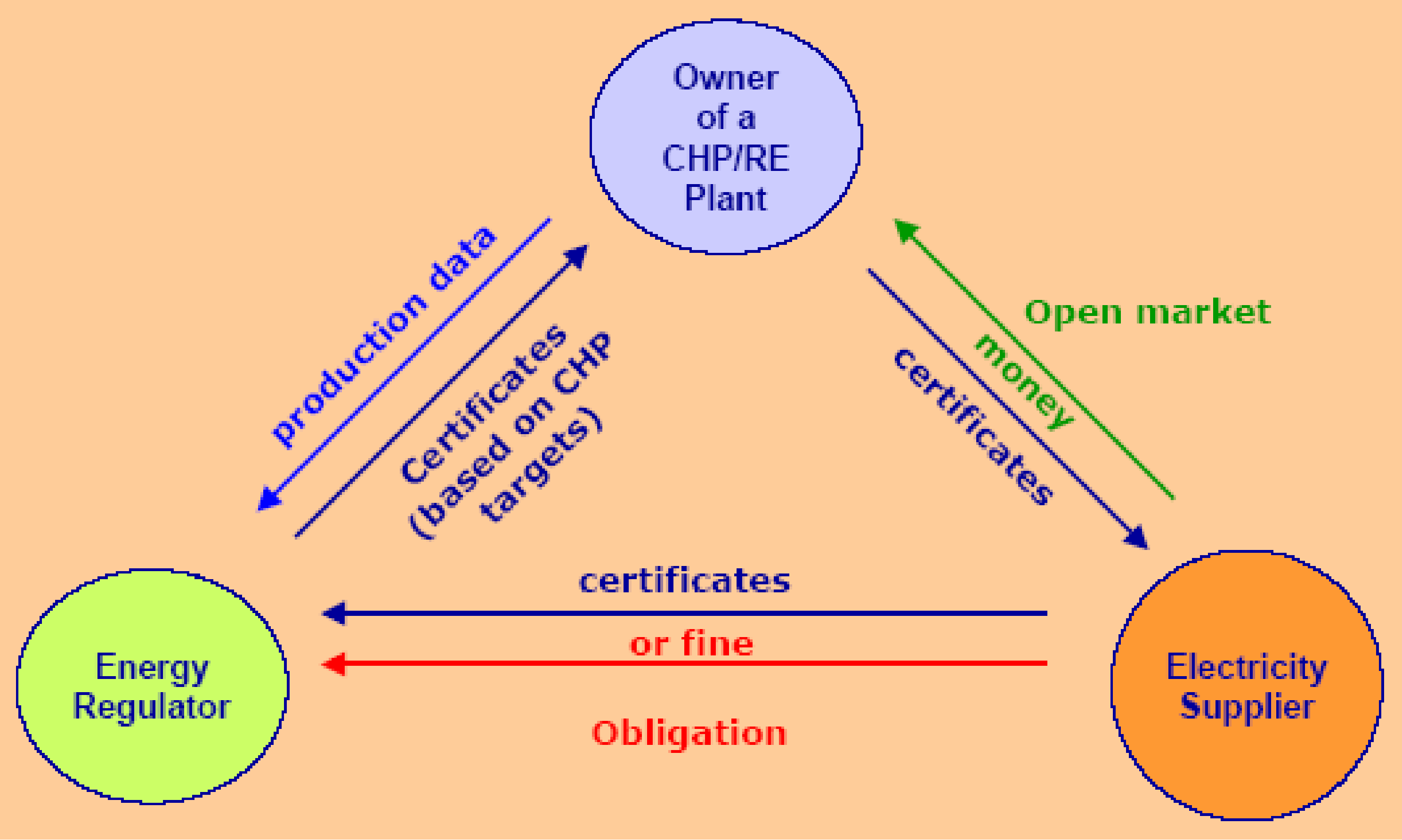
- Promotional policies
  - Long term support for cogeneration from 1985 onwards, plus progressive electricity sector due to structure and incentives
  - Energy investment deduction
  - Exemption from eco-tax for gas used in cogeneration
  - 1st 1000 GWh of cogenerated electricity delivered to the grid rewarded with ¢0.57 euro/kWh
  - Blue certificate scheme
  - Favorable status in NAP but being questioned by the EC

# Cogeneration review: Belgium

- Belgian power sector (2001)
  - Total electricity consumption: 80 423 GWh
  - Fuel mix: 58% nuclear, 40% fossil fuels
- Belgian cogeneration (2001)
  - Annual electricity production: 4 511 GWh (5.65%)
  - Annual heat production: 5 885 GWh (21 186 TJ)
  - Trend: stagnation since 2000

# Cogeneration review: Belgium

- Basics of certificates



# Cogeneration review: Belgium

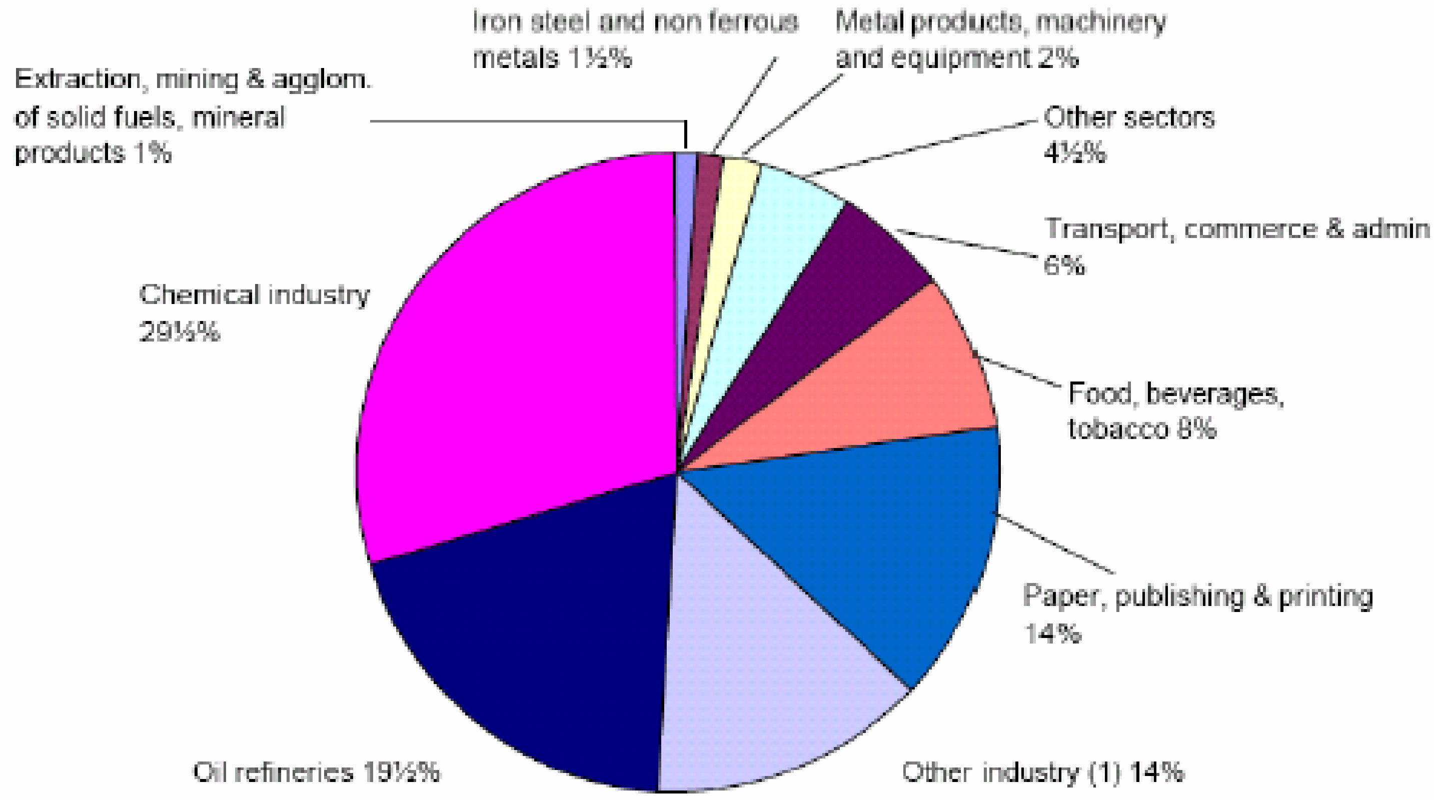
- Green certificate in the Wallonia region (2003)
  - Green certificates apply for
    - High quality cogeneration
    - Renewable energy sources
  - Need for a common basis
    - $CO_2$ emission savings, compared to the best available technology for separate production (reference emissions)
  - One green certificate = 456 kg of avoided $CO_2$ (equal to emissions of 1 MWh from a 55% CCGT)
    - Emission factors for fuels (natural gas: 251 kg/MWh)
    - Reference values
      - Heat: 279 kg $CO_2$/MWh or 340 kg/MWh
      - Electricity: 456 kg $CO_2$/MWh

# Cogeneration review: UK

- Past progress
  - 1980s
    - Technology transformation
    - Demonstration schemes
    - Alternative financing
    - 2000 $MW_e$ installation capacity in 1990
  - 1990s
    - Privatisation/liberalisation of energy markets
    - No significant grants/obligations
    - Capacity more than doubles to 4500 $MW_e$ in 2000

# Cogeneration review: UK

- Cogeneration installed capacity by sector (2003)




*(1) Other industry includes textiles, clothing and footwear, sewage treatment and electricity supply*

# Cogeneration review: UK

- Cogeneration targets
  - First target of 4 $GW_e$ in 1991 in run up to Rio Earth Summit
  - Following good progress, target increased to 5 GWe in 1993 as part of establishing UK Climate Change Strategy
  - New target of 10 $GW_e$ established in 1999 at Bonn Climate Change Conference
- Cogeneration potential
  - 1997 government estimates 10 – 17 $GW_e$ in commerce and industry
  - 1998 government estimates + 2 $GW_e$ for district energy
  - More recent district energy – up to 14 $GW_e$
  - Micro-cogeneration 0.4 to 1 $GW_e$ by 2010

# Cogeneration review: UK

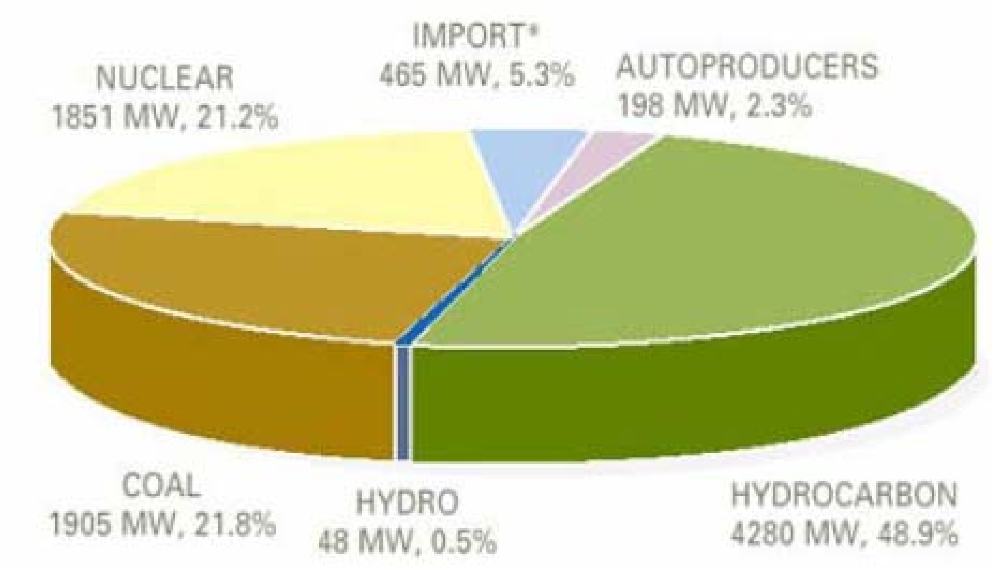
- Impact of New Electricity Trading Arrangements (late 2001)
  - No central despatch, all bilateral trades, penalties for not meeting own contract position, poor price data, poor access to market, unmanageable new imbalance risks, etc.
  - Market destroyed by liberalisation
    - Additions of new cogeneration capacity fell by 95% between 2000 and 2001
    - NETA saw the output of existing cogeneration schemes fall by 17%
    - 1 755 $MW_e$ of consented cogeneration projects did not proceed to development
    - All major developers left the market
    - The capacity of operating cogeneration plants dropped
    - 11 $MW_e$ of less cogeneration plant operating in 2002

# Cogeneration review: UK

- **Effective government measures?**
  - **Climate Change Levy (CCL) exemption**
    - But – *two years to get full exemption*
  - **Climate Change Agreement**
    - But – *80% discounts*
  - **The UK Emissions Trading Scheme**
    - But – *Projects Mechanism introduction postponed*
  - **Business Rates exception for power generation plant and machinery**
    - But – *Originally proposed as an exemption*

# Cogeneration review: Hungary

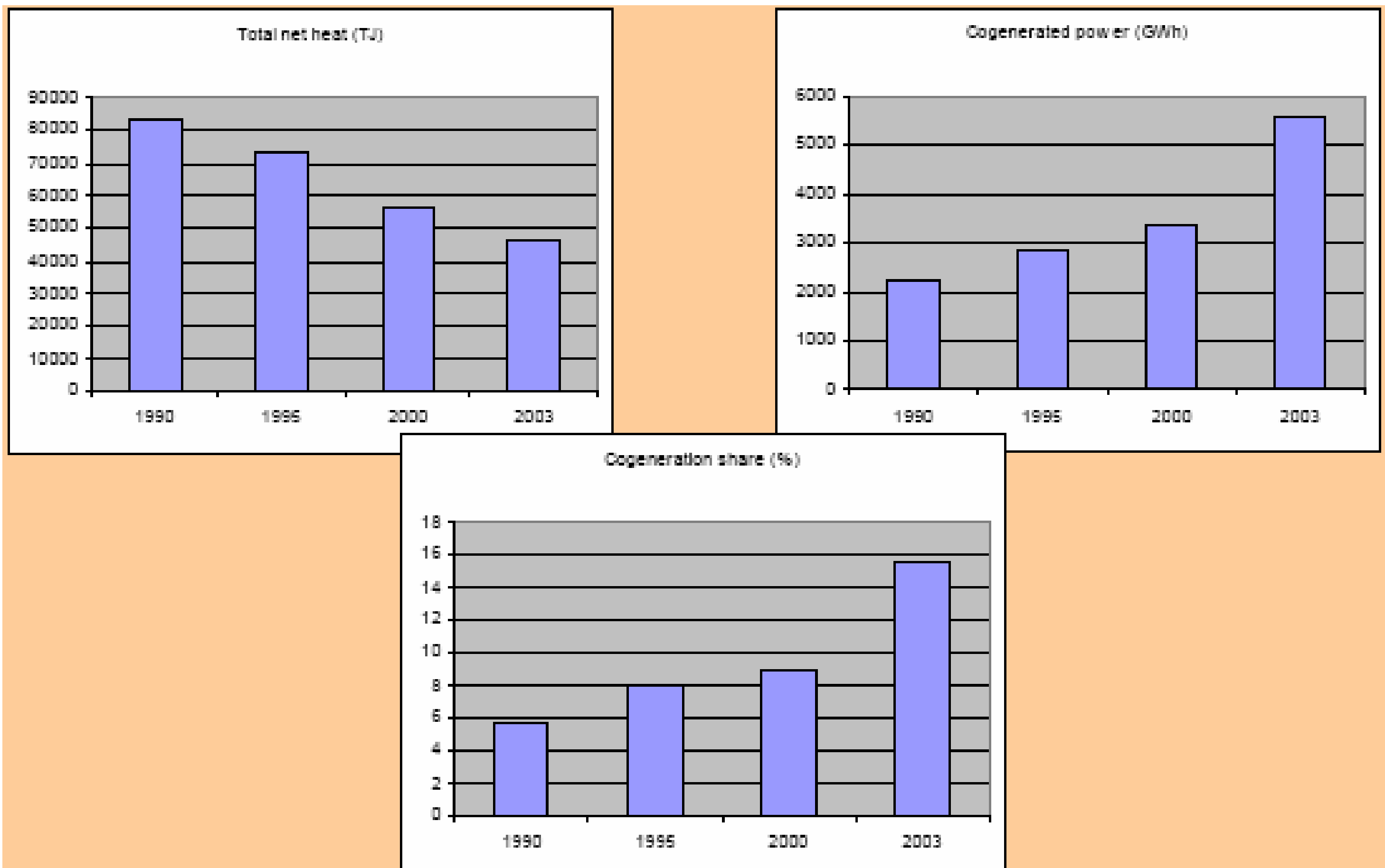
- Installed capacity by fuel




- Types of cogeneration plants
  - Public power supply
  - Urban district heating schemes
  - Industry
  - Small-scale

# Cogeneration review: Hungary

- Share of cogeneration in the energy system



# Cogeneration review: Hungary

- **Cogeneration potentials**
  - **Cogeneration electricity to represent 20-22% of total electricity generation by 2010**
  - **Growth expected to come from brand new installations, and from the expansion and modernization of existing plants**
  - *According to COGEN Europe estimates, cogeneration could cover up to 40% of total electricity demand in Hungary*
    - *Extensive distribution network for natural gas (87% of towns connected by end 2001)*
    - *High number of district heating systems*
    - *Need for new generation capacity in the next few years*
    - *Successful restructuring of the energy sector*

# Cogeneration review: Hungary

- Cogeneration outlook
  - National district heating policy
    - Uncertainties about regulatory framework
    - Official heat pricing does not allow basic investments to be made
    - Social barriers against heat market liberalisation
  - Development of the power sector
    - Government plans to stop polluting power plants from 2005
    - Shut down of 1 070 MW of installed capacity by 2006 expected
    - Old coal- and oil-fired water boilers to be replaced by natural gas fired combined cycle cogeneration plants
    - Opening of the natural gas market will have decisive influence

# Cogeneration review: Italy

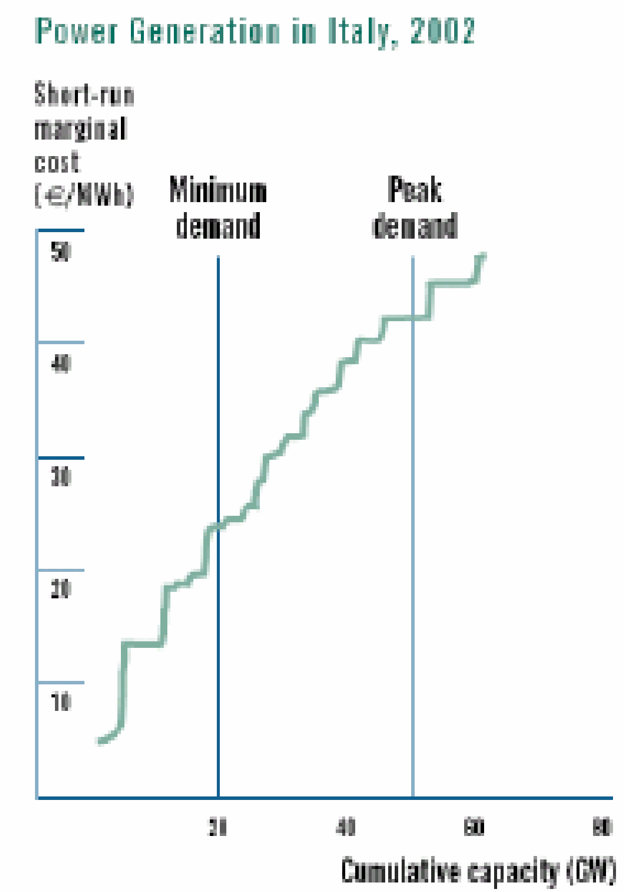
- **Cogeneration potential**
  - Very high cogeneration potential, reaching that of the Netherlands, i.e. 40% of the national production
  - Scheme ≤10 MWe capacity: 16 000 MWe
  - Annual production of 65 000 GWh
  - 28 000 jobs
  - $CO_2$ reduction: 32.5 Mt

# Cogeneration review: Italy

- Old regulatory framework
  - Cogeneration growth from 1994 to 1997
  - Strict criteria for recognition of cogeneration
  - Bureaucratic hurdles during authorisation and permitting
    - Same process for a 30 MWe plant and a 20 KWe engine
    - Under 300 MWt, construction permit granted by local authorities who set emission standards
    - Regions obtained more competences: Regulatory patchwork and lack of administrative capacity

# Cogeneration review: Italy

- Planned cogeneration policy
  - Dispatch priority in the power exchange
  - Possibility to obtain energy efficiency certificates
  - Tax relief (very important for civil users)



# Policy & Regulatory aspects

- **Conclusions**
  - Doubling electricity from cogeneration is possible, but only in the best-case scenario
  - Climate change and the Kyoto Protocol are key drivers
  - Liberalisation can support cogeneration, but only if regulated
  - The European Commission has an important policy role to play
  - Market factors need to be implemented (e.g. certificates, definition of cogeneration)

# Lessons learnt

- Experiences of the countries
  - Despite European regulatory framework, national policies make the difference
  - Hungary: planned transition to a high-efficiency, low-carbon energy system
  - Belgium and Netherlands: Quota and certificate systems work well but need to be simple and robust
  - Portugal: Fair and stable feedback tariffs that reflect the energy efficiency, environmental and security of supply benefits of cogeneration
  - UK: Liberalization is not bad, but markets must not be designed to penalize cogeneration
  - The system has to reward the efficiency of cogeneration

# Principles of a fair regulatory regime

- **Principles**
  1. There must be a fully independent and properly resourced regulator of the system
  2. Electricity system pricing should be fully cost reflective with no cross subsidization
  3. Power generation and supply companies should have no ownership or management interest in the network
  4. All generators of electricity should have fair and non-discriminatory access to the grid
  5. Use of T&D networks should be priced according to the services they provide and not in such a way as to incentivise distribution companies to avoid DE interconnection

# Principles of a fair regulatory regime

- **Principles**
  5. Use of T&D networks should be priced according to the services they provide and not in such a way as to incentivize distribution companies to avoid cogeneration interconnection
  6. Utilities should be required to engage in cost benefit analysis which can enable cogeneration to be developed in areas where its local benefits outweigh the costs of constructing or upgrading new distribution facilities
  7. Any benefits which cogenerators provide to the system should be fully and fairly reflected in system pricing

# General conclusions

- Cogeneration lowers primary energy consumption in the supply chain, reduces transmission and distribution losses, improving balance of trade and foreign exchange savings
- High share of cogeneration can be achieved with the right policies
- Fix feed-in tariff (or fixed bonuses) and transparent grid-interconnection rules give the “best” and quickest development
- Cogeneration requires less total investments in the electricity supply sector compared to traditional central electricity supply
- Easy financing through a dedicated funding mechanism should be available
- ESCO concept could improve cogeneration development