

Energy (Technology) in the Future



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Dansk Gas Forenings årsmøde

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INTERNATIONAL GAS UNION

Covers >95 % of World Gas Sales

'Spokesman' of the Gas Industry



www.IGU.org



Non Members



Membership from 67 countries and 22 Associated Members



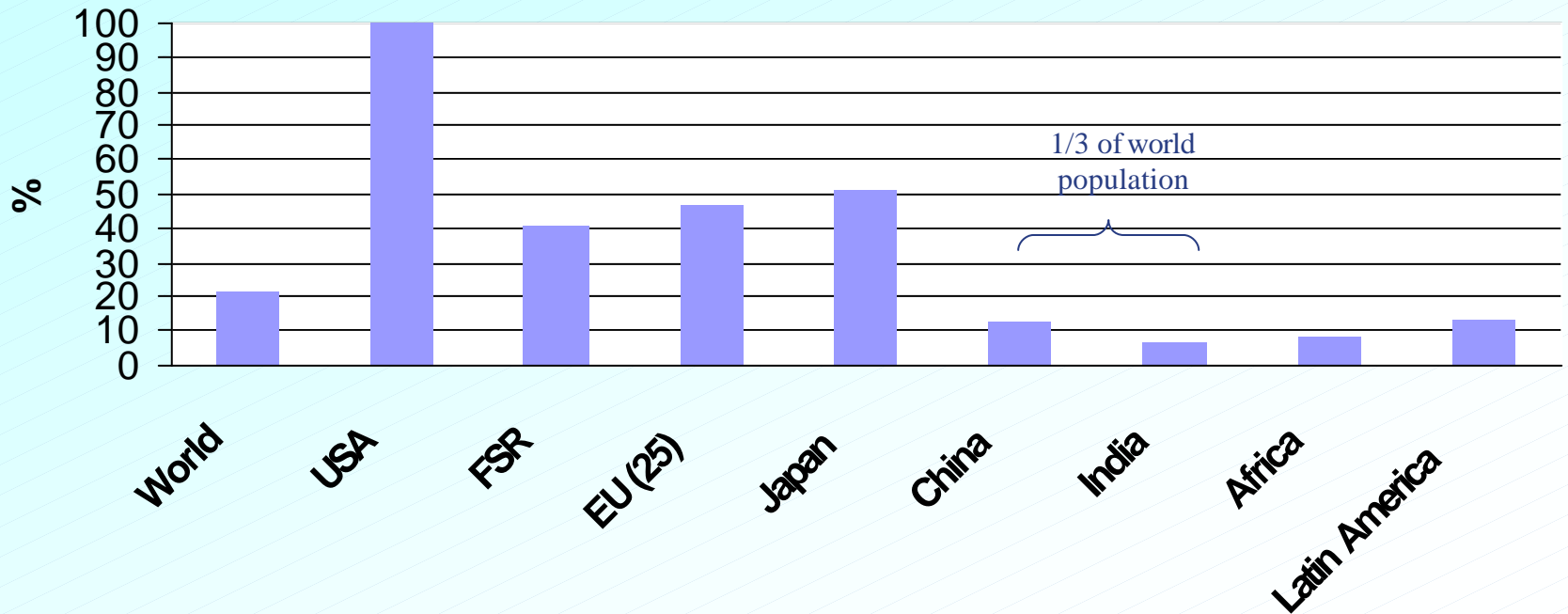
Themes for Today

- **The World needs Energy (technology);**
- **At What Prices?**
- **LNG changes the Global Gas Scene;**
- **Regulation, Liberalization.**



Energy Consumption in Perspective

primary energy consumption per capita
relative to USA



IEA data year 2002



Gas Technology. Or How to Serve the Customer: Gas Distribution in China

There is a Keen Local Interest in Promoting Gas Usage





Gas Technology. or How to Serve the Customer: Delhi CNG Three-Wheeler





Gas Technology: or How to Serve the Customer: Natural Gas Bus in Zigong



Natural Gas Bus in Zigong

There is an abundance of natural gas in this part of Sichuan. All of the local buses in Zigong use natural gas to fuel. The bags of rubber on the top of the bus contain the gas. The sheer weight of the bag forces the gas into the engine. From time to time the buses stop at a station to get a fresh supply of gas. Certain parts of China have natural gas but China doesn't have much in the way of pipelines to distribute the gas to other parts of China.



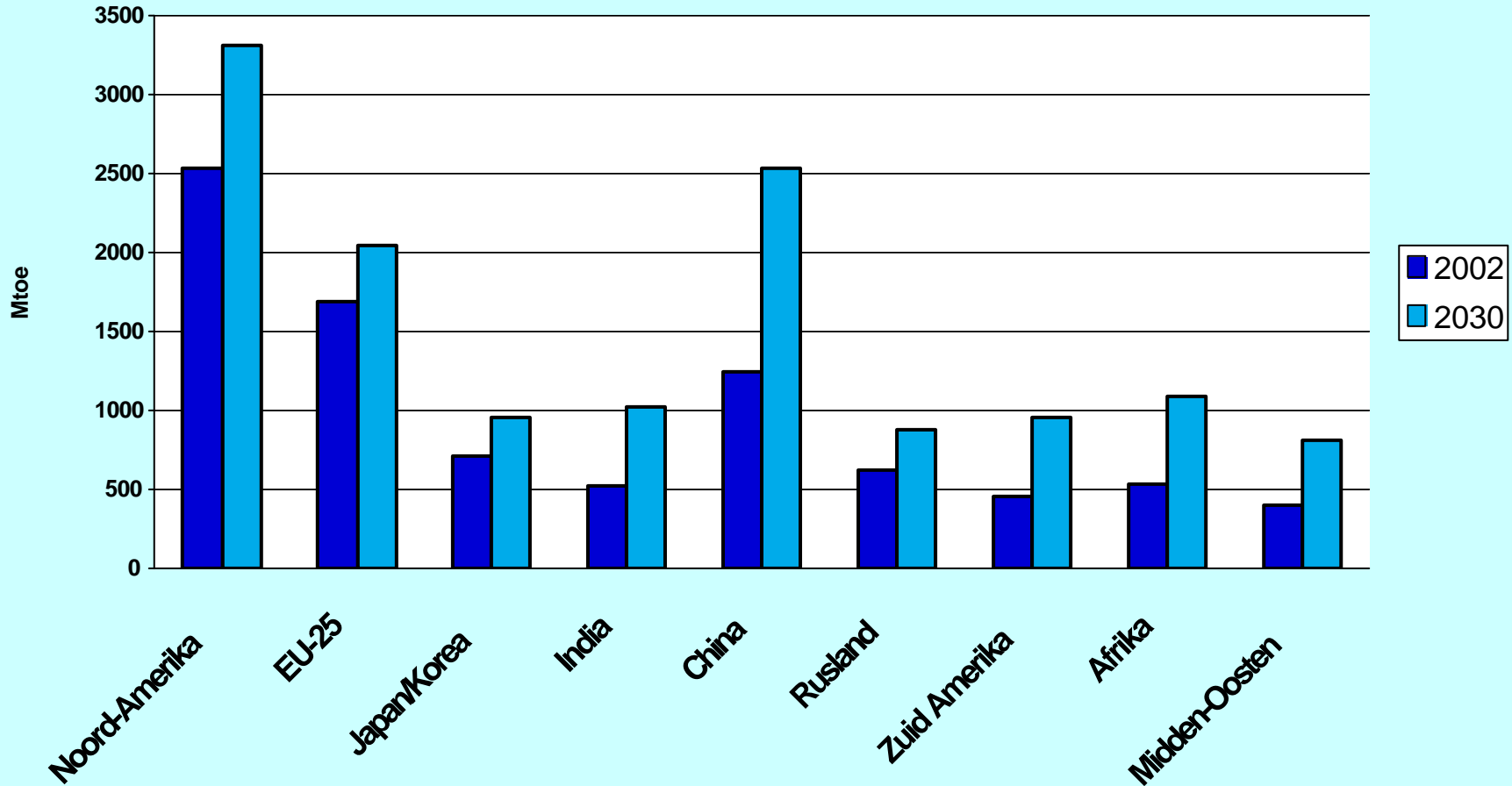
Gas Technology: or How to Serve the Customer: Natural Gas Bus in L.A.



Los Angeles Metropolitan Transportation Authority's CNG-fueled "Metro Liner" buses are powered by the low-emissions Cummins Westport 320-hp L-Gas Plus engine.



Total Energy Demand by Region 2002 and 2030



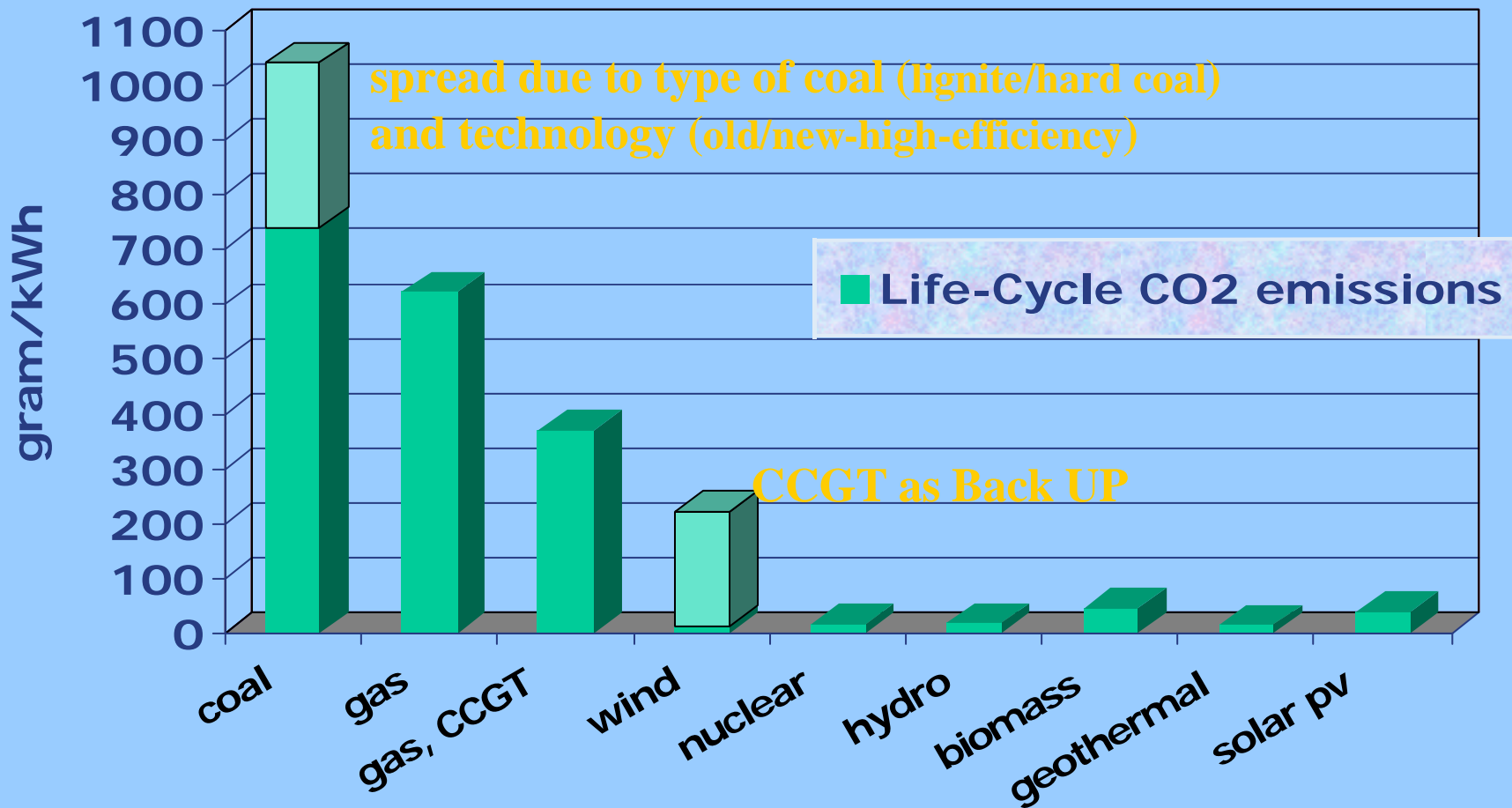


INTER-FUEL COMPETITION





CO₂ Emission from Power Plants



Sources: life-cycle assessment of electricity generation systems and applications for climate change policy analysis, Meier, 2002, published on website Nuclear Energy Institute; own data; IEA



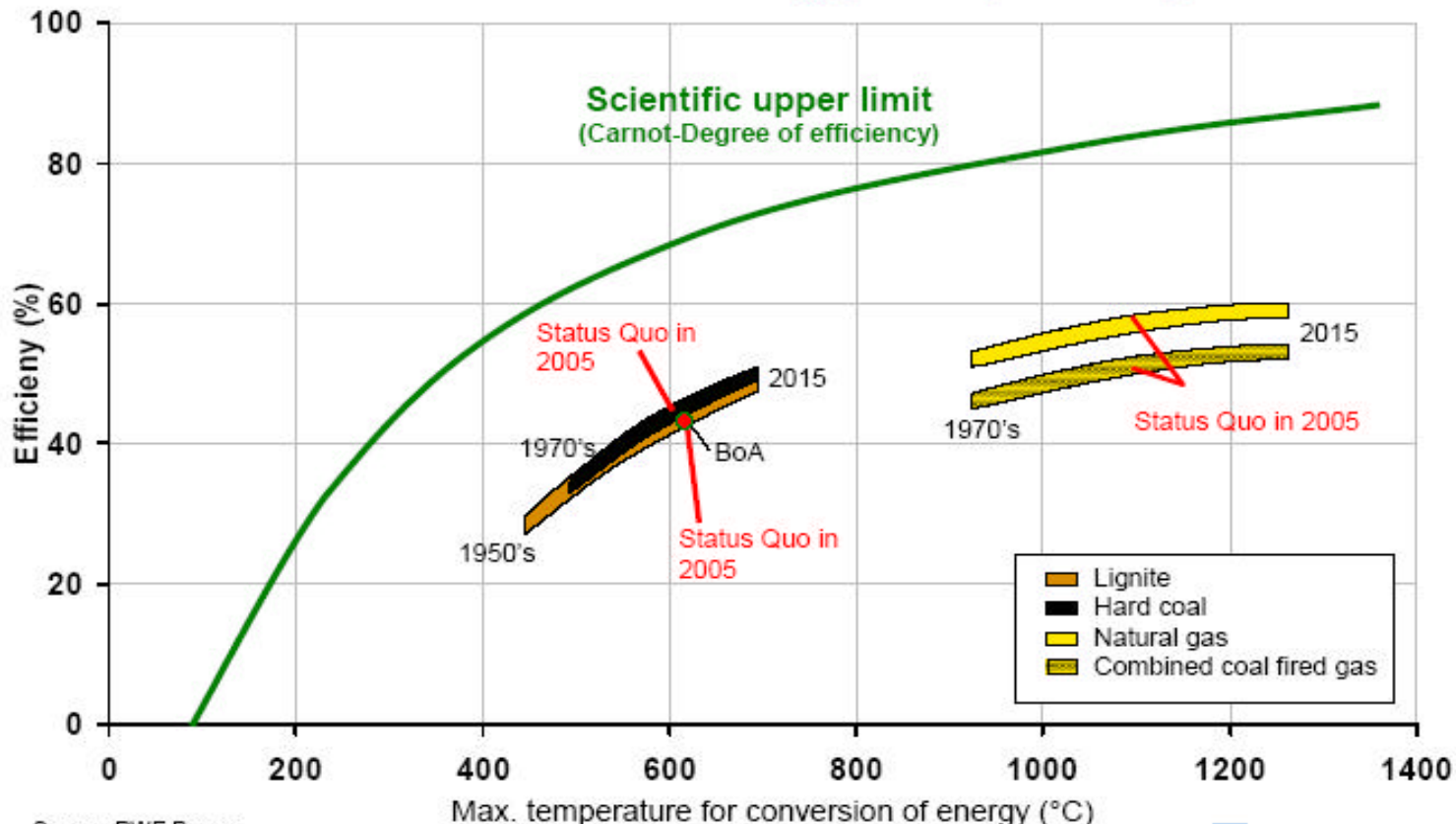
Gas Turbine Technology made possible the breakthrough of Natural Gas in Power Generation

Judisch, RWE, speech at Flame 2005



RWE Trading

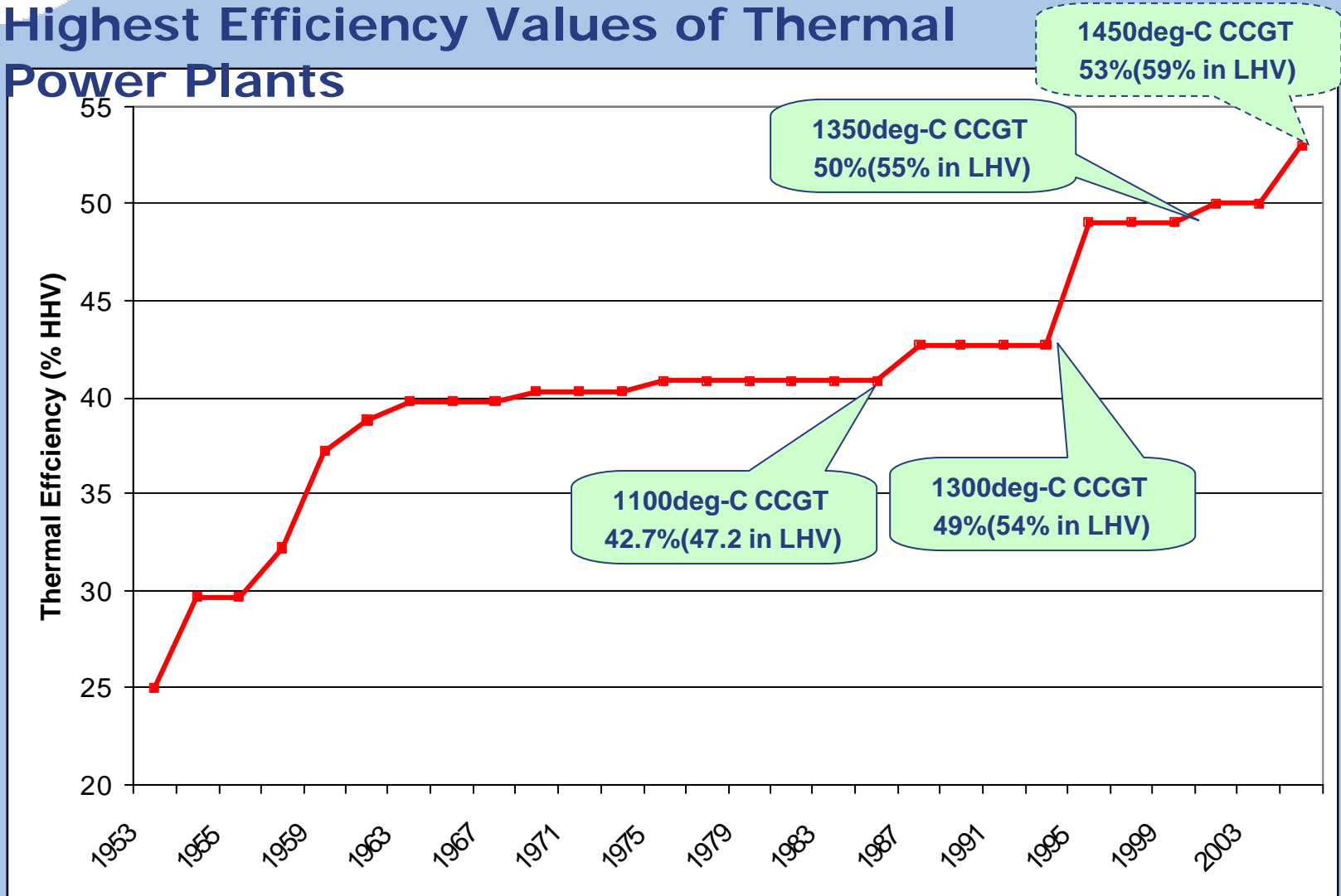
Development in technology – natural gas remains the most efficient type of power plant





Improvement of Thermal Efficiency of Gas Turbines

Highest Efficiency Values of Thermal Power Plants

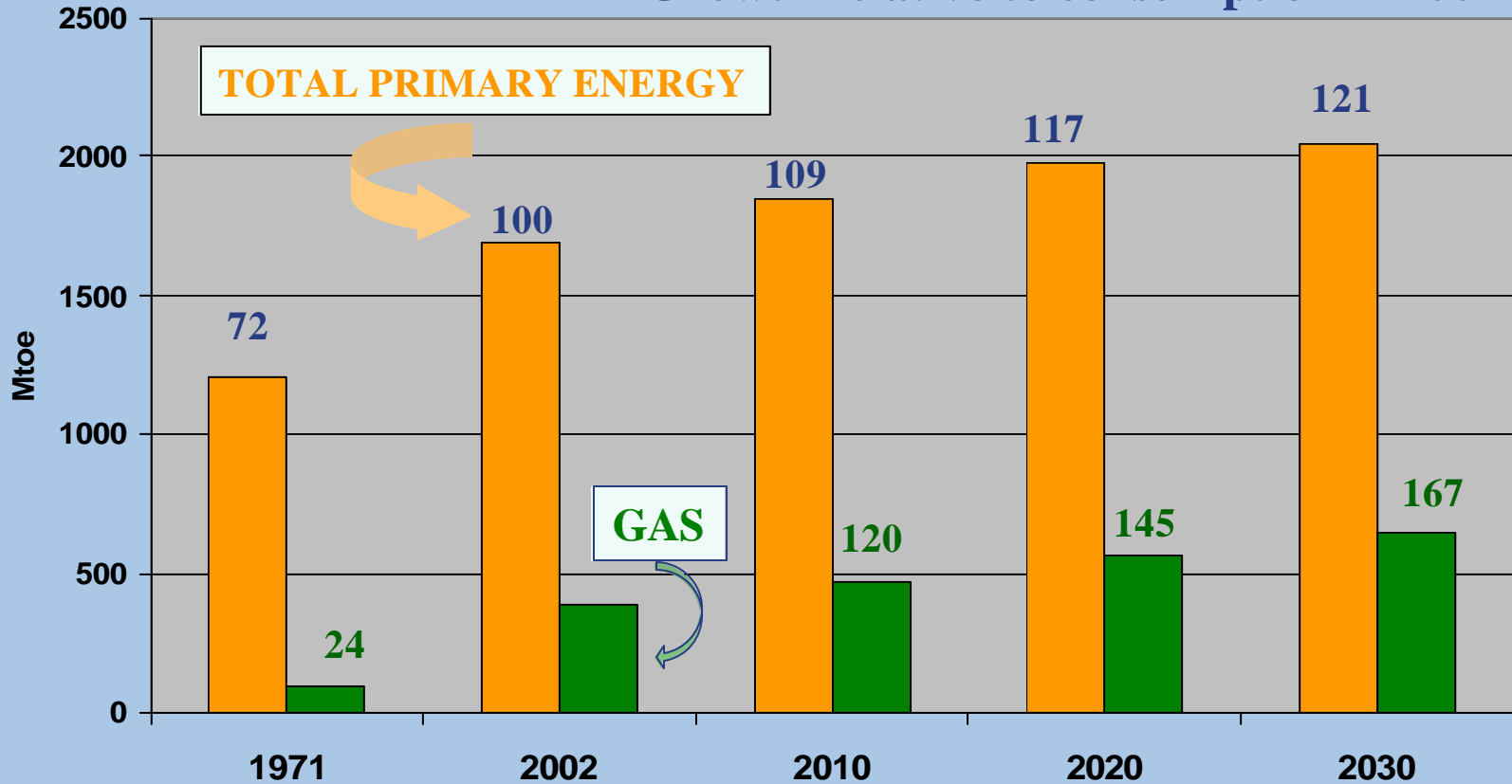




EU Energy Demand Forecast IEA

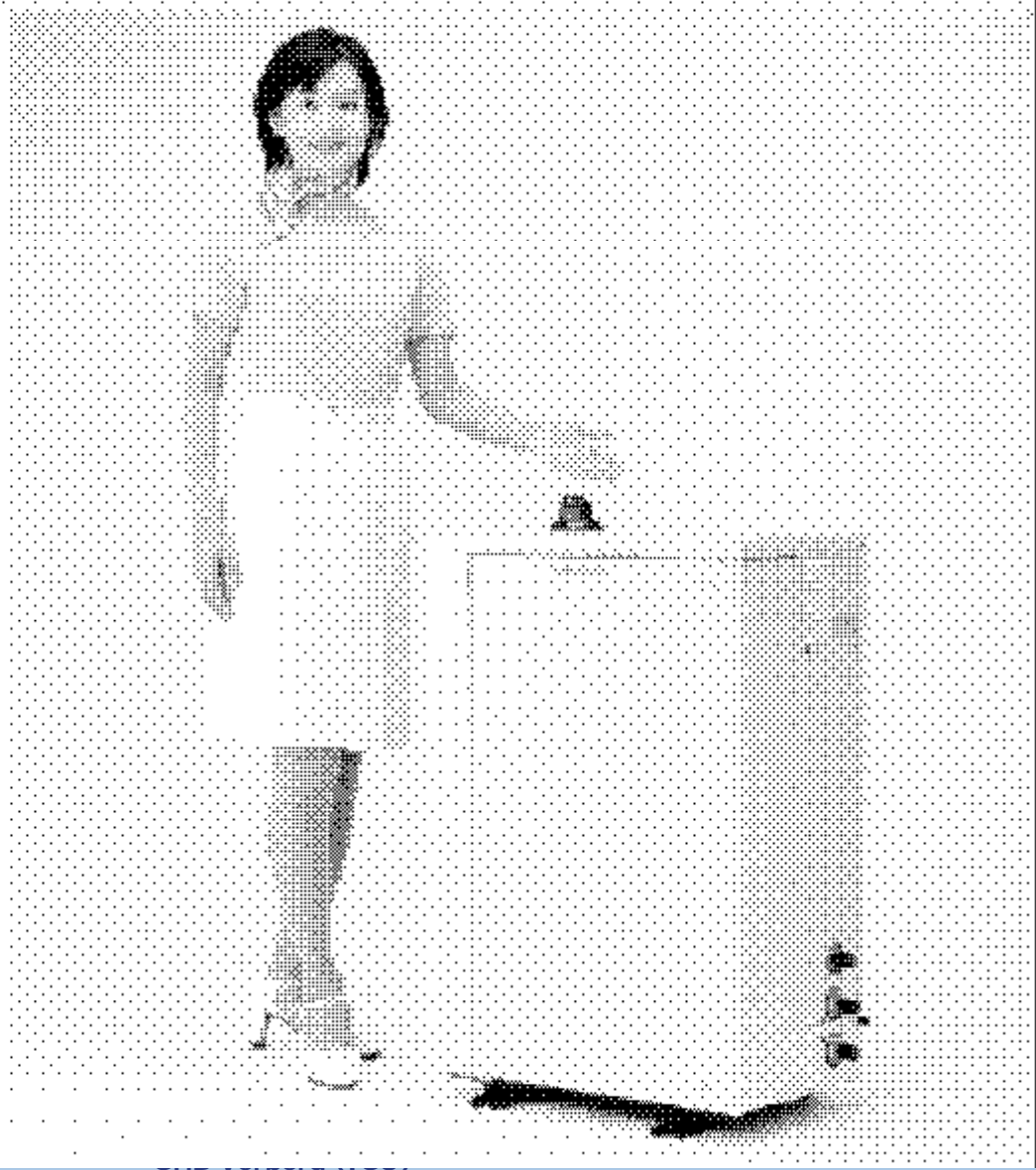
EU (25)

Growth relative to consumption in 2002



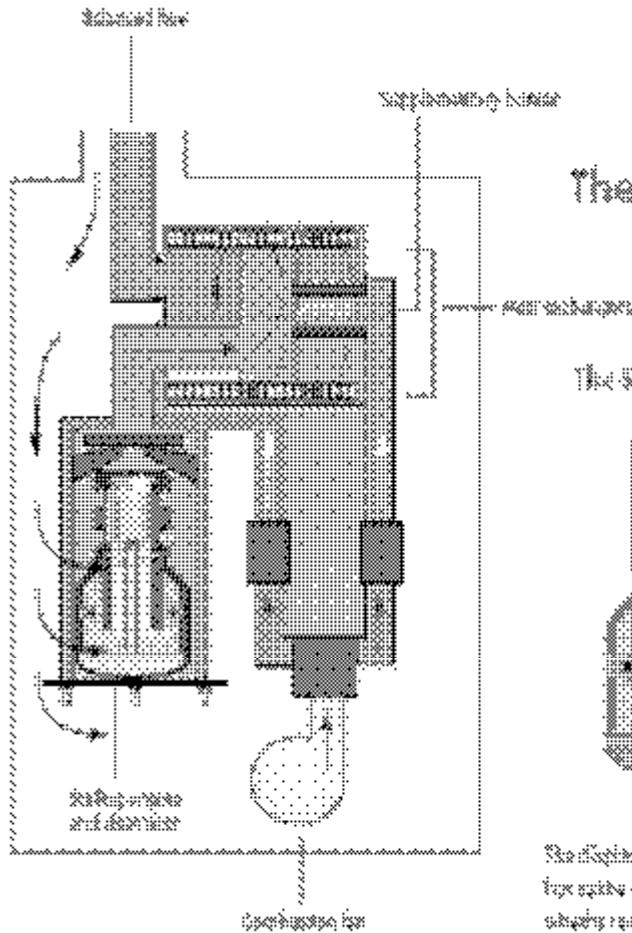


Honda MCHP1.0 Gas Engine Micro CHP unit



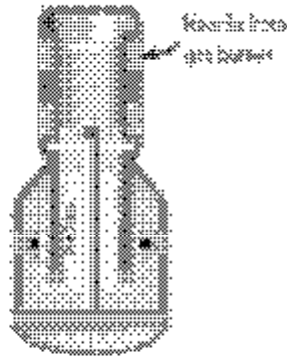


Microgen (UK) 1 kWe Stirling Engine, wall hung unit with build in additional boiler



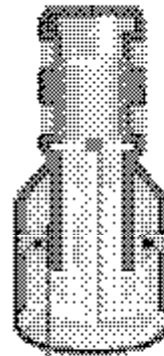
The Microgen system

The Stirling engine



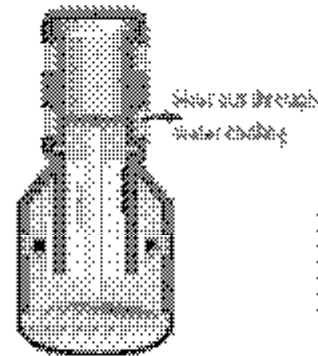
No difference between gas-fired and for water cold end of gas duct as safety depending on construction

Expanding gas

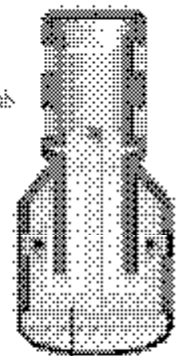


Displacement generates electricity and the heat goes to the engine

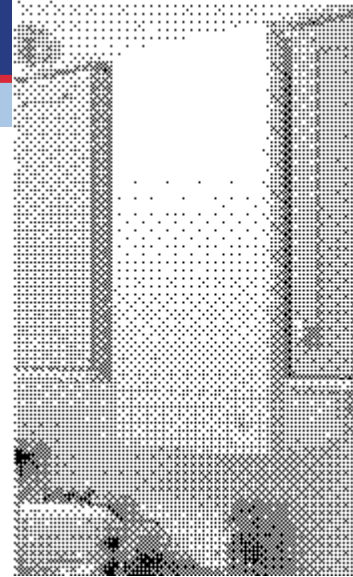
Contracting gas



Water cooling through nickel heat transfer & granite base



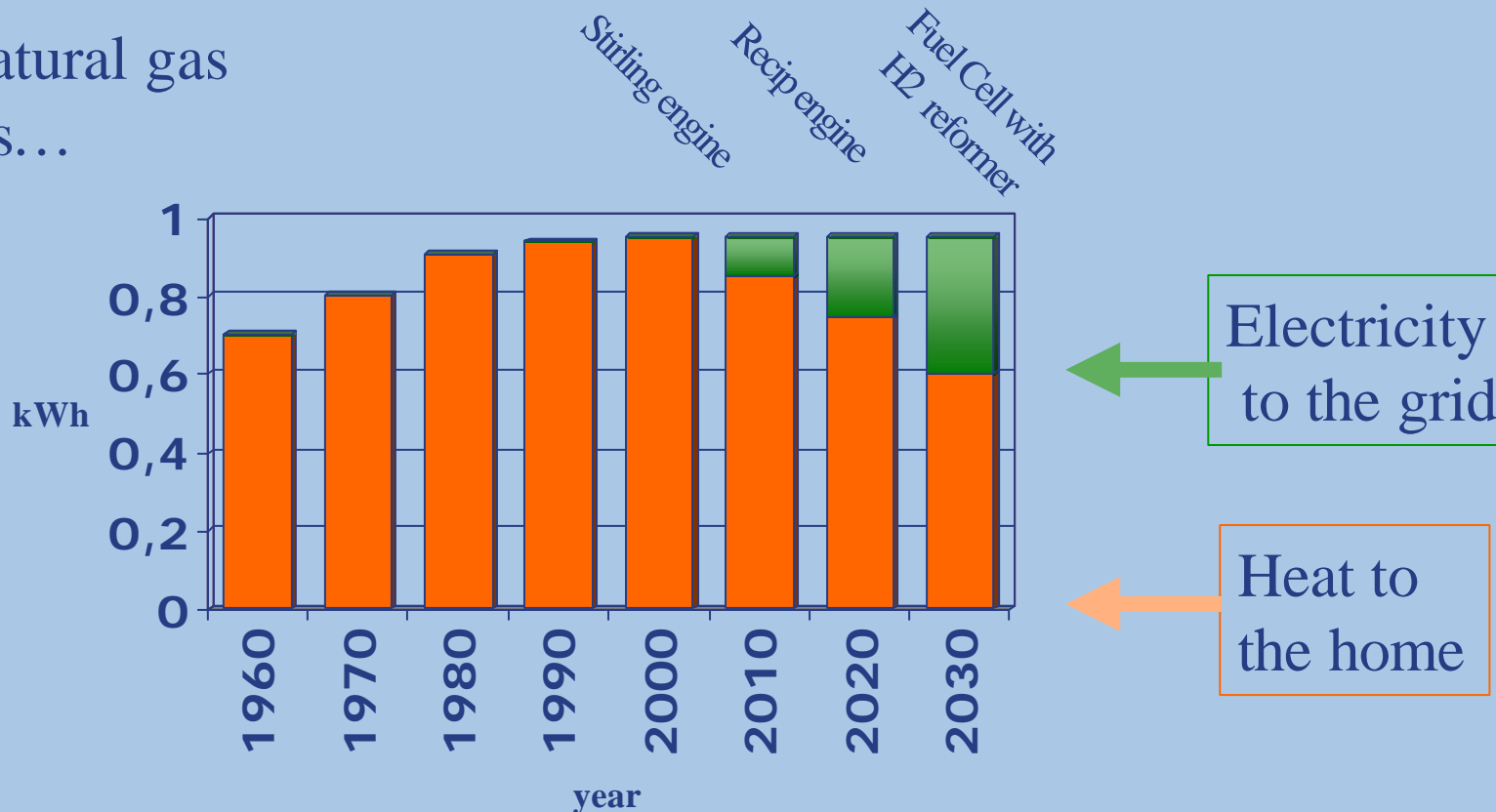
Flex spring keeps piston moving up and down





Residential Heating with Gas

1 kWh natural gas produces...



The Virtual Power Plant

- decentralised energy production and supply;
- higher overall energy efficiency;
- improving reliability and flexibility of energy supply;
- reduced transmission and distribution losses;
- cutting down CO₂-emissions and saving primary energy;
- facilitates integration of renewable energy sources;
- supports the realisation of the hydrogen economy;
- cost reduction opportunities.





Beyond the Engine: Fuel Cell

Vaillant Fuel Cell Heating Appliance

Vaillant and Plug Power have jointly developed a proton exchange membrane (PEM) fuel cell heating appliance. The first of these systems to be installed in Europe went on trial in a home in Germany in December 2001. The product is CE marked and over 20 units are now field installed with 9 operating in the EU funded "Virtual Power Plant" project. Field demonstrations will be extended in 2003/2004 with significant further installations.



Technical Details:

Electrical Output: 1-4.6 kWel grid parallel
Thermal Output: 1.5-7 kWth plus ~ 25-280 kWth peak heater
Electric Efficiency: > 35 %
Total Efficiency: > 80 %
Fuel: Natural gas
Heating System Temp max:
70/55 °C
Exhaust Temperature: max. 75 °C



Gas the Fuel of Choice

- For financial-economic reasons,
- For environmental reasons,
- For space planning reasons (gas fired power station needs a lot less space than a coal fired one)
- For cooling water requirements (gas fired power stations need a lot less cooling water than coal fired ones or nuclear)

Natural Gas will be the fuel of choice!



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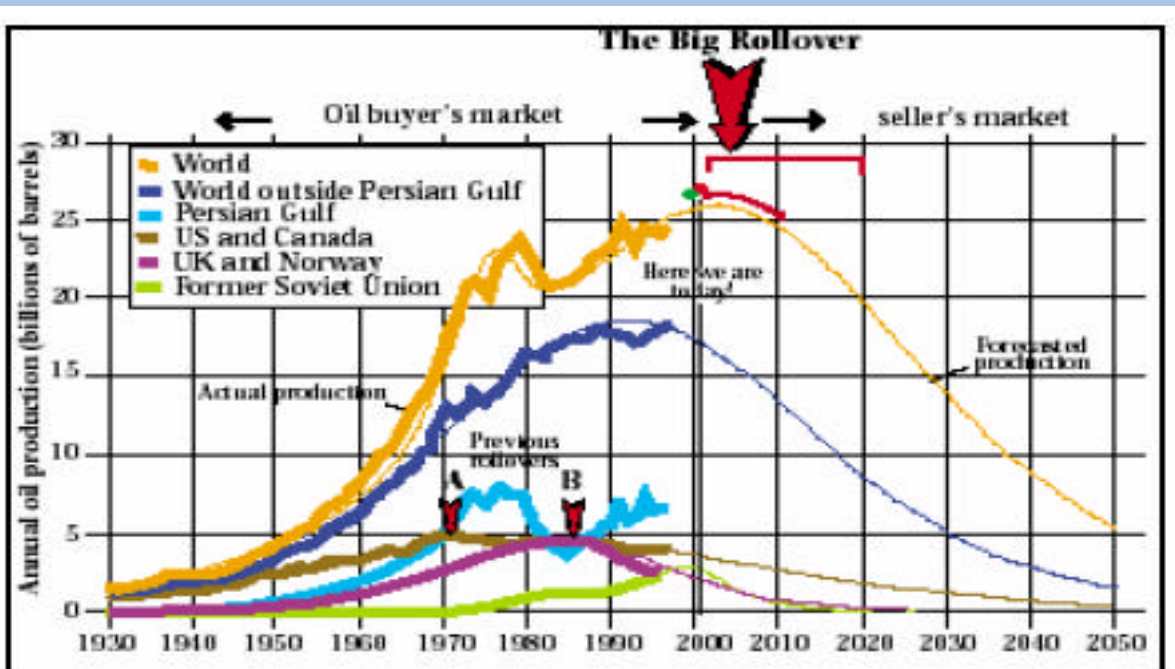
Oil Prices: How High is High?

Oil prices in US\$ of 2004:

- 1864: 92 \$/b, but at that time no oil dependent economy
- 1980: 81 \$/b, economic difficulties
- 2004: 55 \$/b
- 2005: 60+ \$/b
- Expected: restraints in refinery capacity lifted by 2008; (shortages in LNG till 2008/9)



How Much Oil is Left ?



Year of The Big Rollover	Forecaster
2003	Campbell, 1998
2004	Bartlett, 2000
2007	Duncan and Youngquist, 1999
2019	Bartlett, 2000
2020	Edwards, 1997
2010-2020	International Energy Agency, 1998



A New Logo for the IEA??

Wake up!!!

We are here



Peak Oil

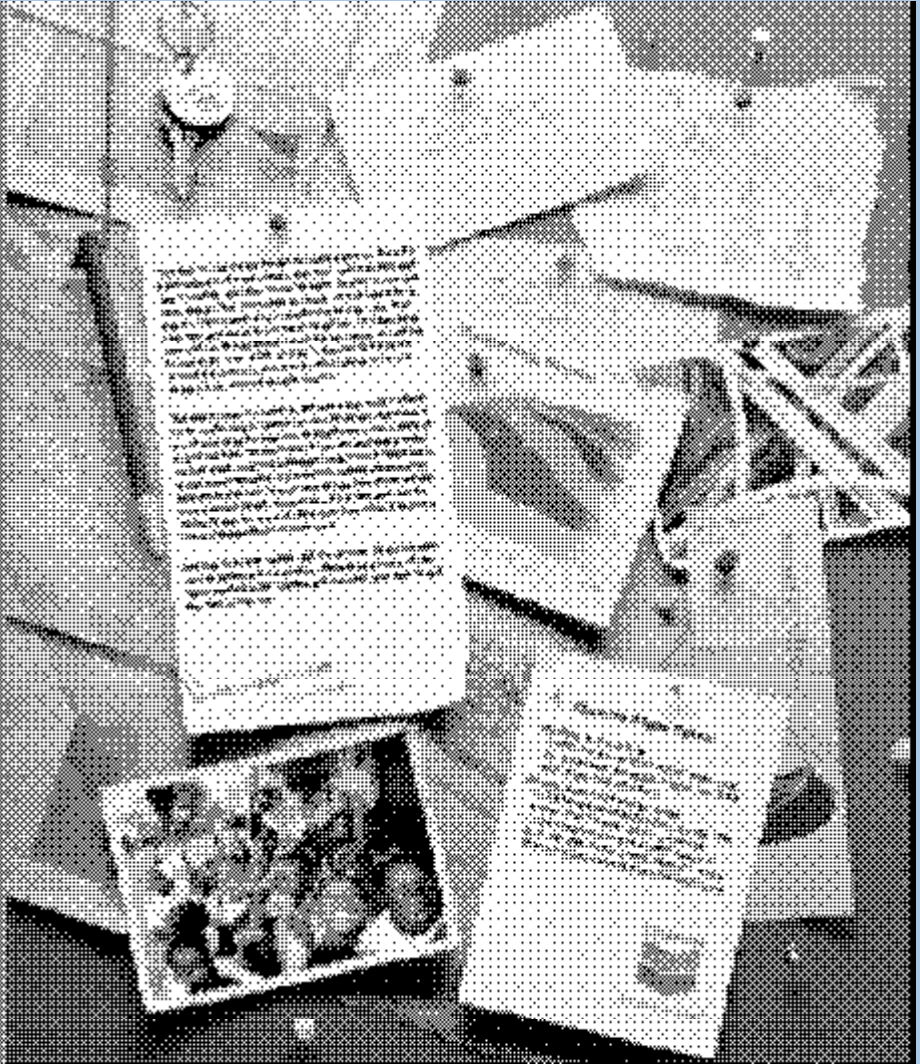
www.oilcrisis.com



chevron. so is this something you should be worried about?

The world consumes two barrels of oil for every barrel discovered.

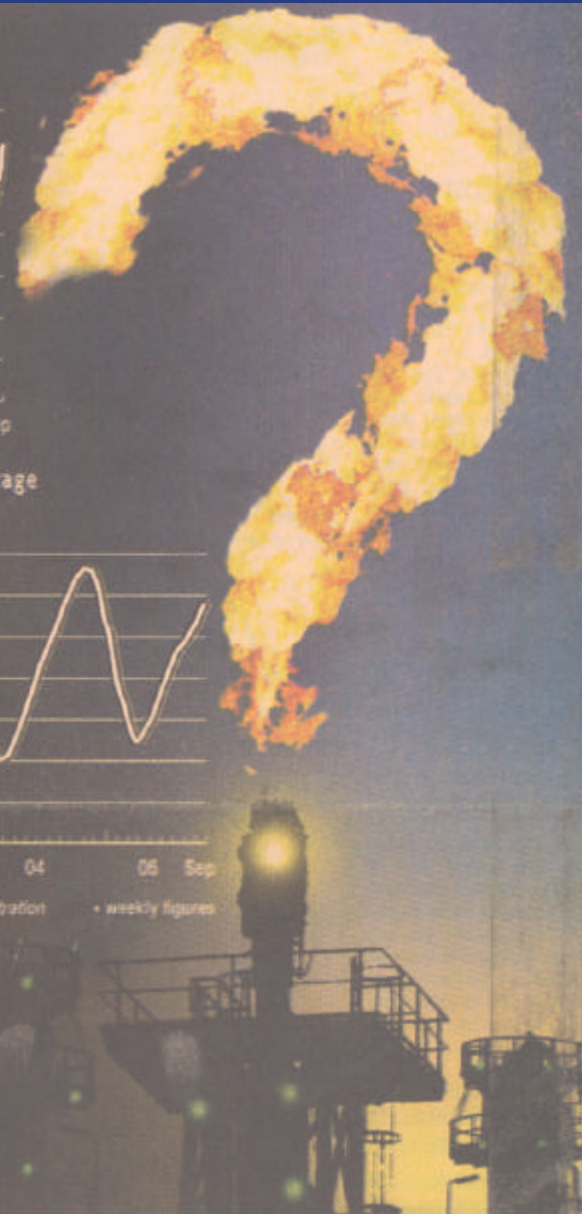
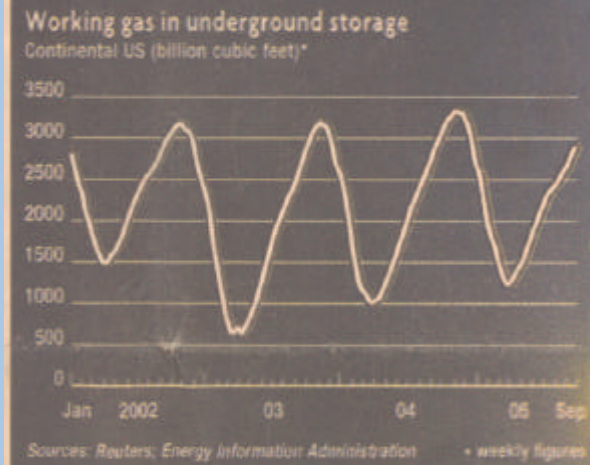
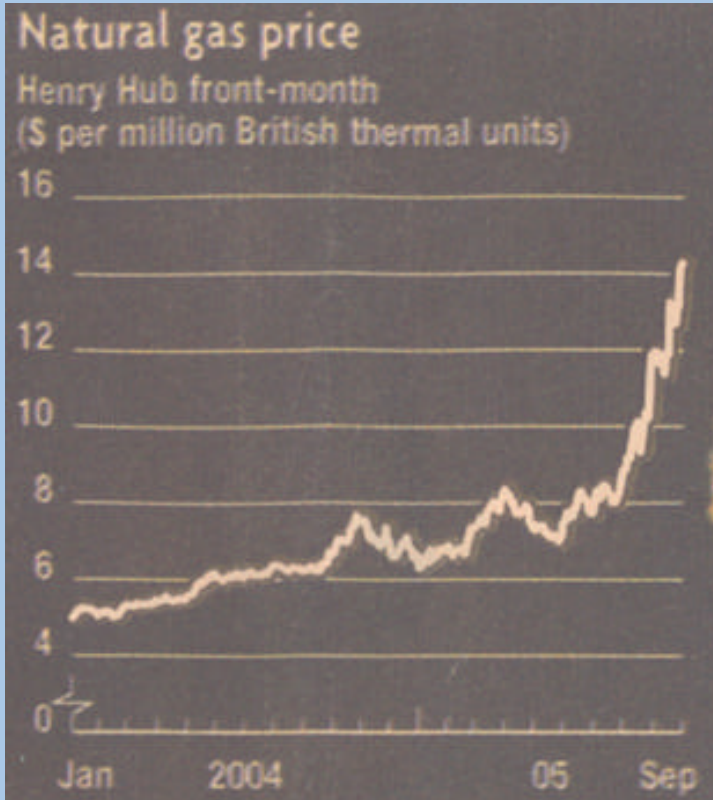
It is the responsibility of you and the oil industry to find more.





Nymex futures until dec 2010: >6\$/mbtu

**High gas prices
squeeze
US manufacturers**
(Financial Times 3 Oct '05)



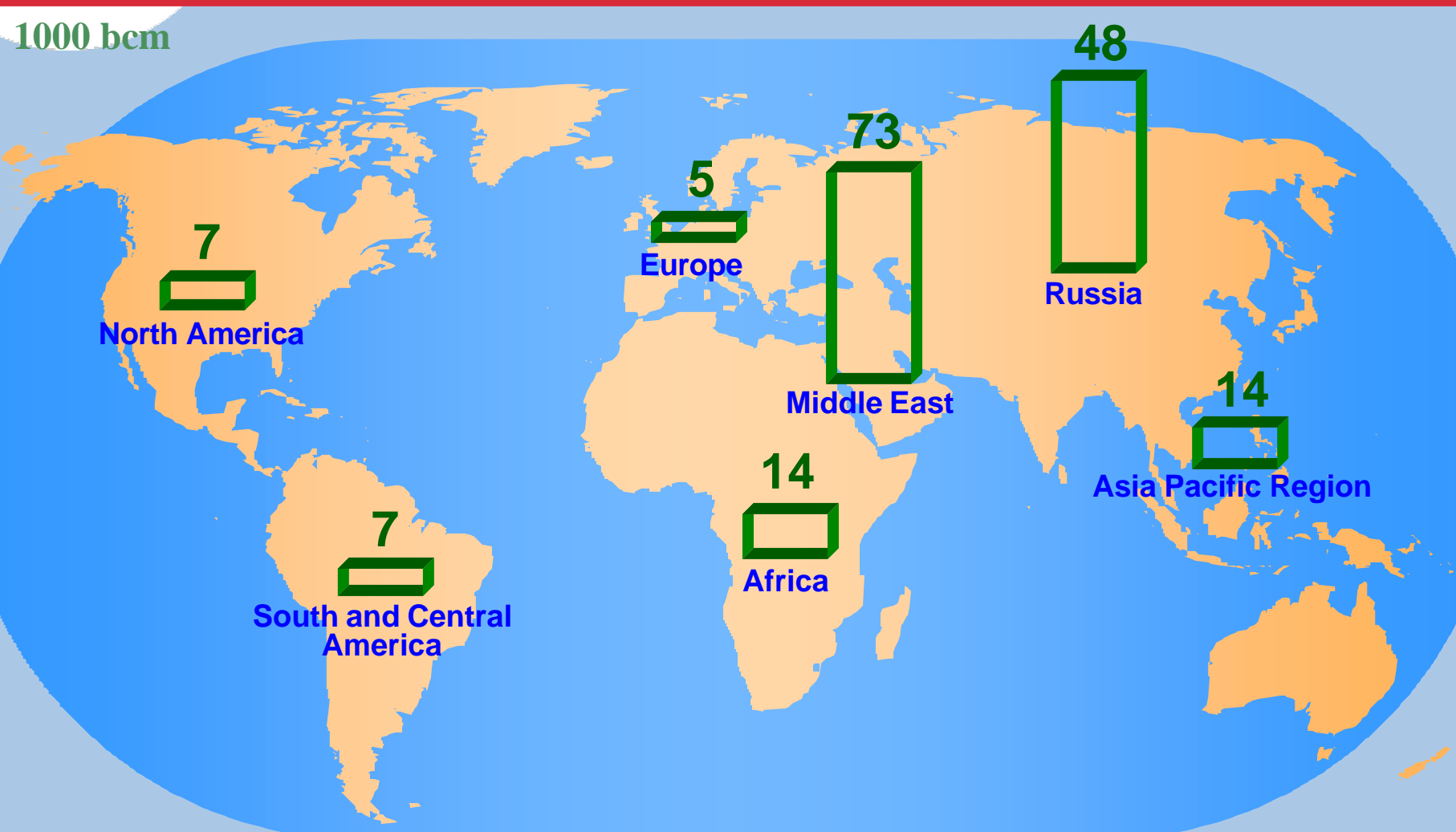


What about Demand Destruction?

- Power Generation will take less Gas, but Coal is not an easy alternative due to the emissions;
- A revival of nuclear seems to be in the carts, but that takes time;
- Closing Chemical Industry and Energy Intensive Industry lowers demand mainly to the extent it is not a relocation of that industry to regions with lower energy/gas prices.



World Gas Reserves Proven 180 Trillion m³ R/P ratio ~66 years





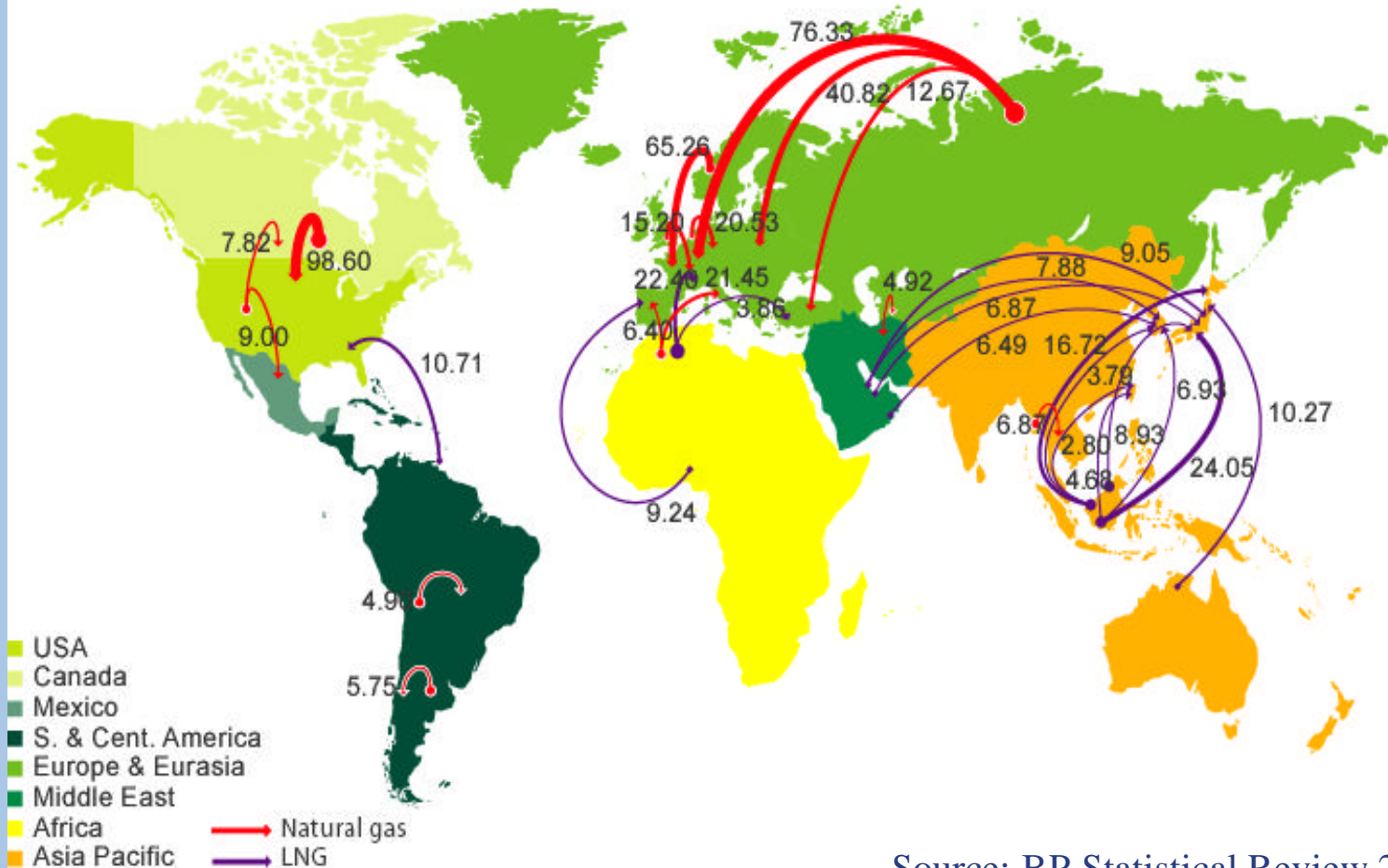
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Major Natural Gas Trade Movements at the Start of the 21st Century

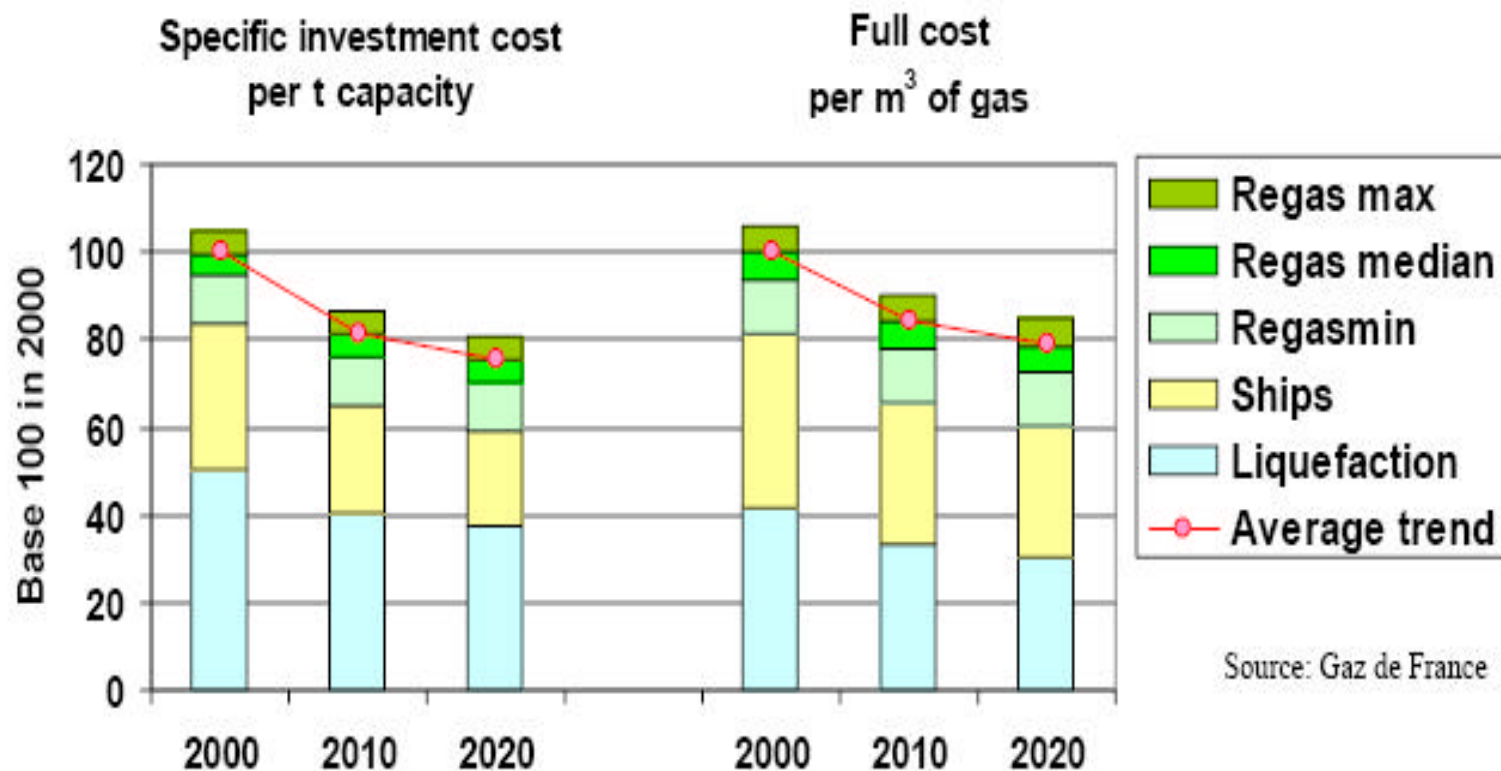
Trade flows worldwide (billion cubic metres)



Source: BP Statistical Review 2004

LNG trumps: decreasing costs

For a 7 400 km LNG chain

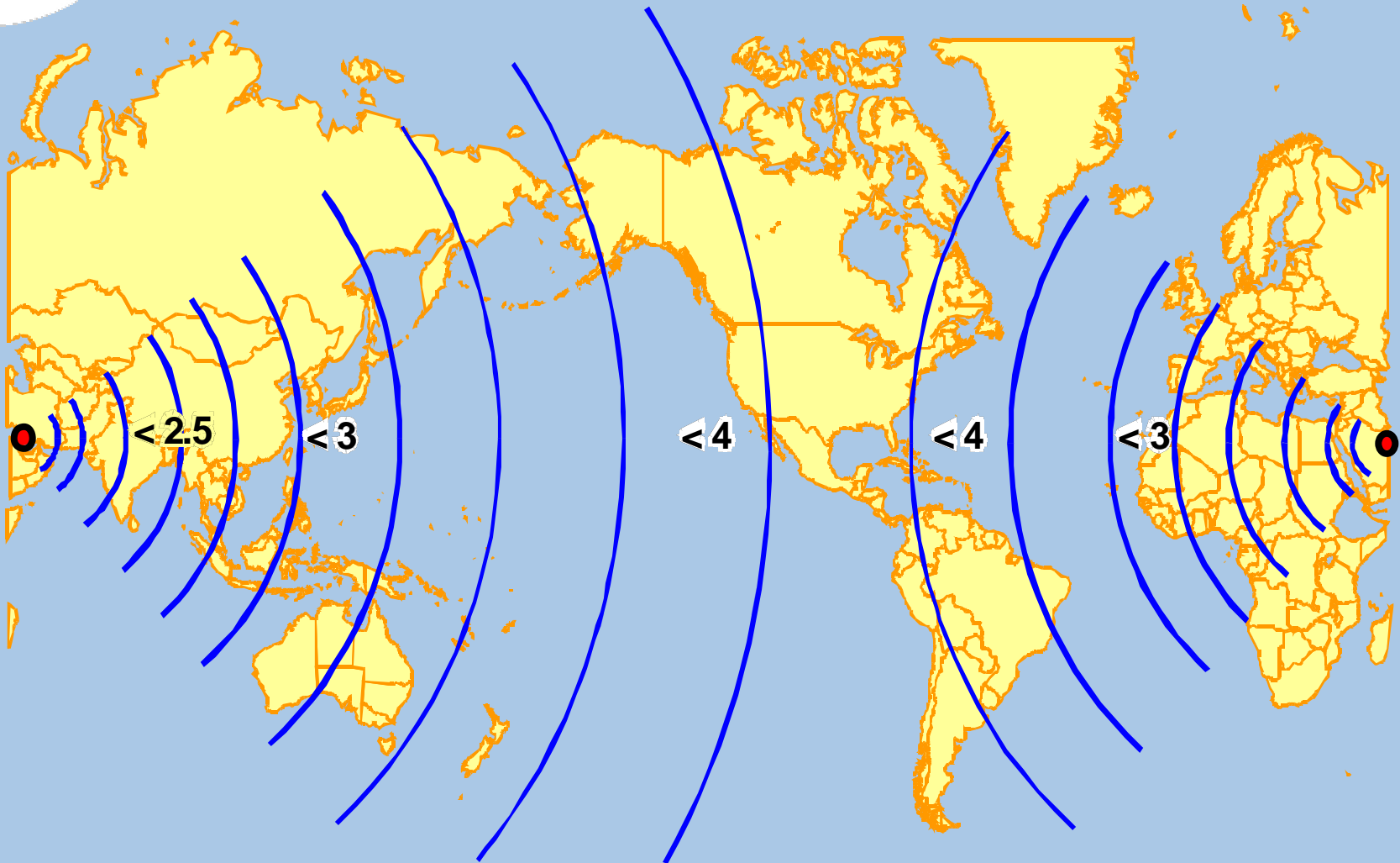


Source: Gaz de France

Source: presentation by GdF at 19th WEC, sept. 2004



Middle East LNG—Setting a New Global Cost Benchmark (\$ per MMBtu)

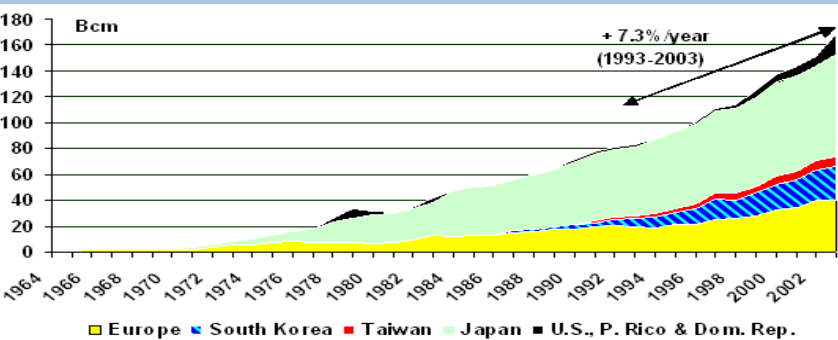
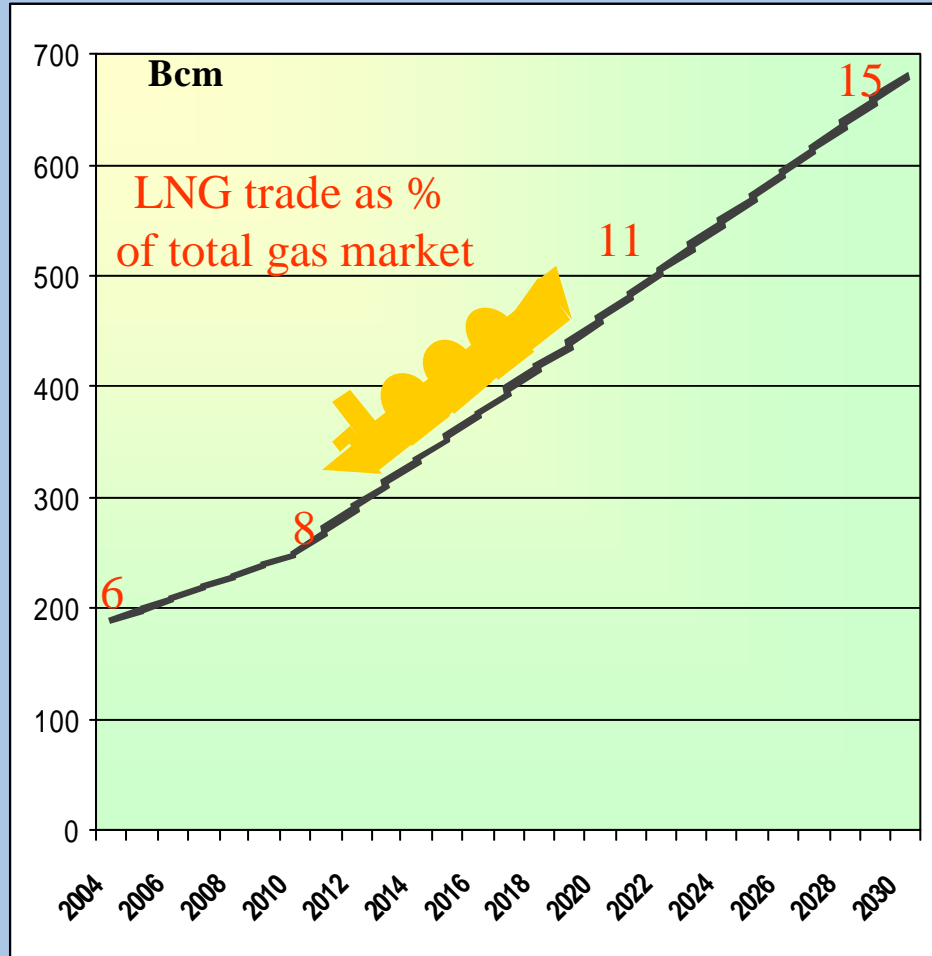


Source: Cambridge Energy Research Associates.
31001-10

GHB Verberg (IGU)
Dansk Gas Forenings årsmøde



LNG Trade History and Perspectives



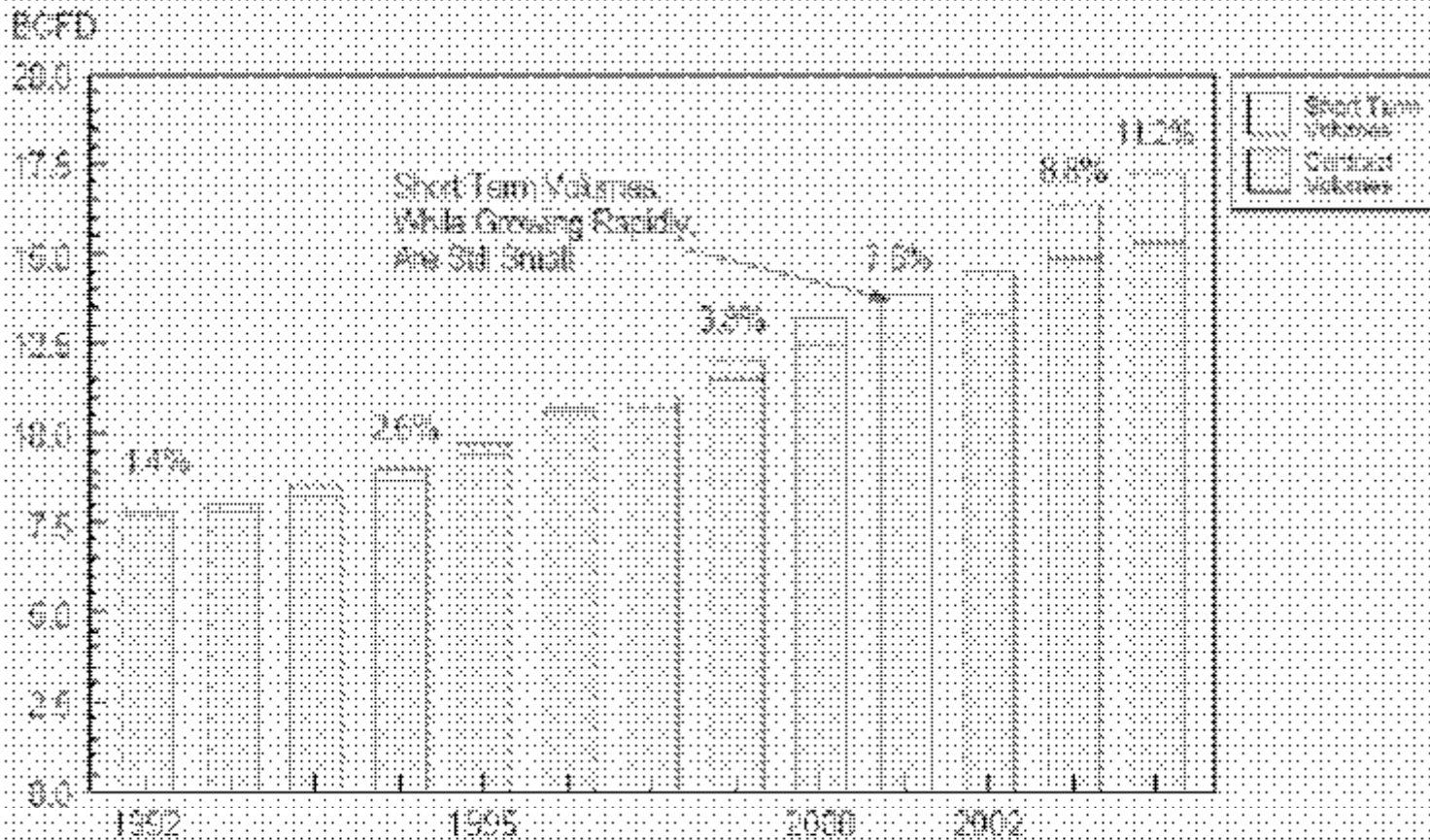
History (CEDIGAZ)

Forecast (IEA weo 2004)



LNG Spot Trade Grows, but remains < 20%

LNG TRADE SHOWING THE GROWING ROLE OF SHORT TERM SALES
BCFD





International LNG Trade: Connecting Markets, Competing Markets!





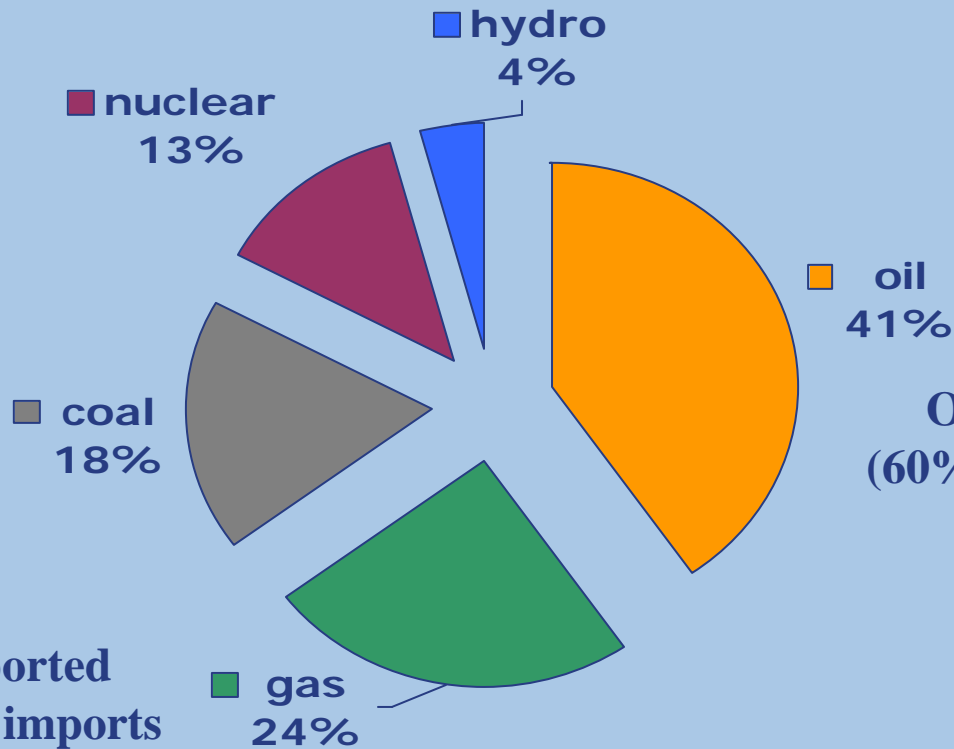
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Primary Energy EU25 (2004)

1719 Mtoe (1910 Bcm gas eq.)



Oil 80% imported
(60% excluding imports
from Norway)

Gas 50% imported
(40% excluding imports
from Norway)

Energy intensity
150 Mtoe/trillion



Gas Imports EU25 (2004)

• Russian Federation	107 BCM
• Norway	75
• Algeria LNG+pipelines	55
• Nigeria LNG	15
• LNG several sources	<u>6</u>
	258

Total Consumption 467

Import dependency will grow!



Regulation: EUROPE

- In the eighties and first part of the nineties supply of gas to Europe was expected to be abundant;
- Security of Supply was (therefore) not considered to be an issue;
- Regulation of the gas sector was very much done along the lines of the regulation of the electricity sector.
- The energy intensive industry lobbied hard and referred to low energy prices in the US with a liberalized, competitive market.

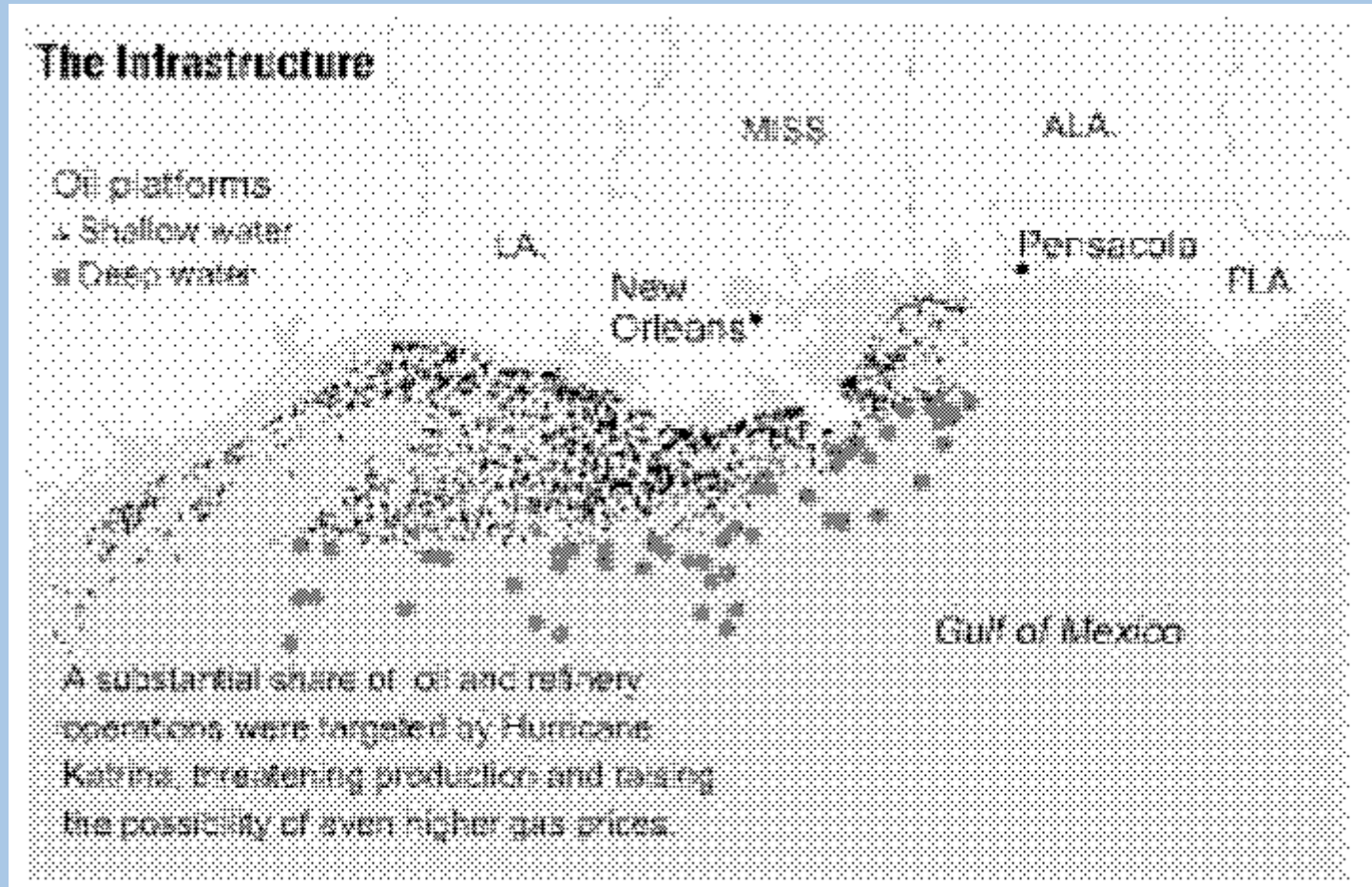


Regulation: EUROPE

- The European gas market changed towards a sellers market during the implementation of regulation/liberalization;
- And it became clear that Europe will become more and more dependent from a small number of countries:
- Security of Supply is (again) on the agenda!

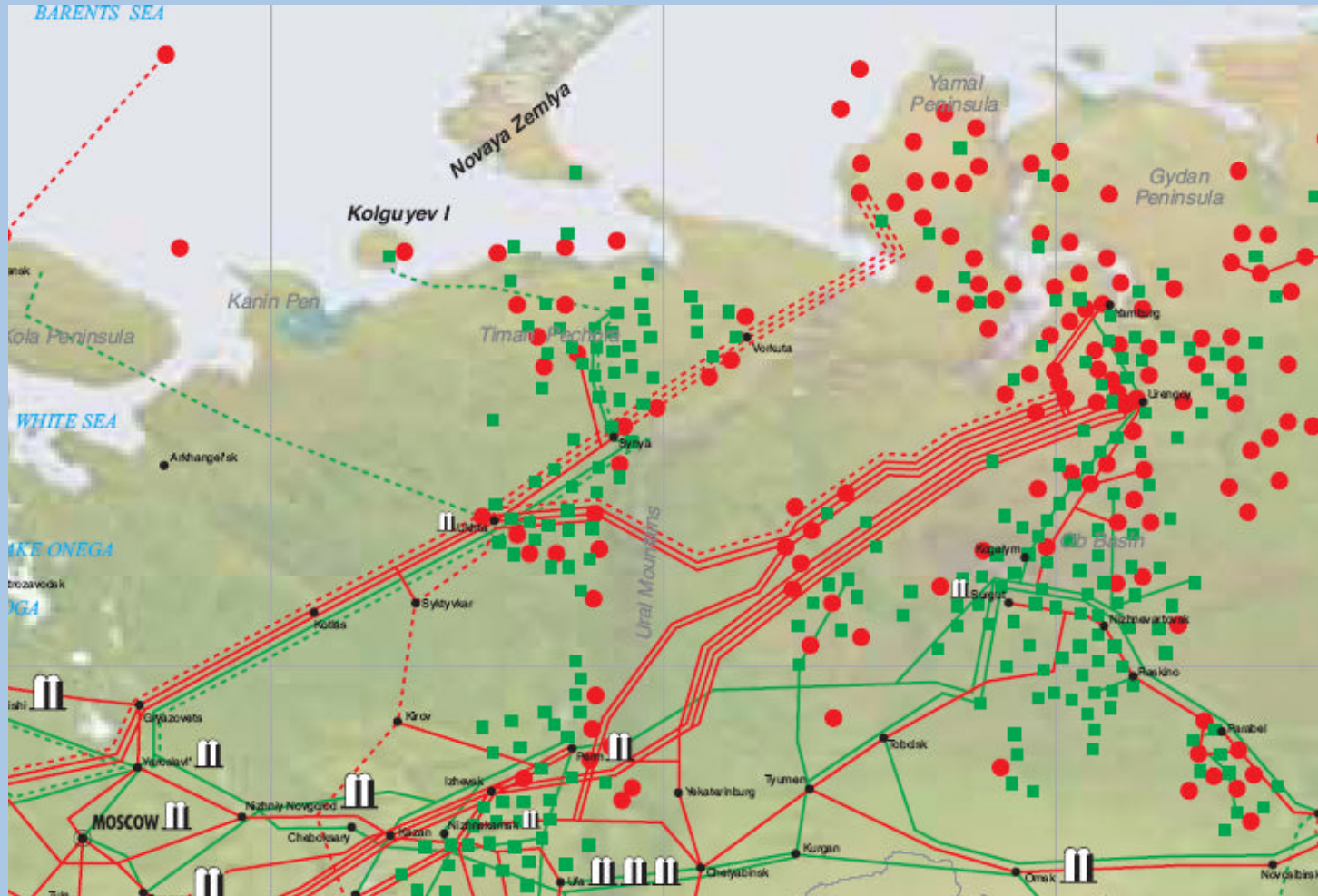


SoS: Key Energy Region (1): Risk : Tornado's





SoS: Key Energy Region (2): Risk : Melting Permafrost





SoS: Key Energy Region (3): Risk : Political Situation?





SOS: Several Key Straits : Risks : Overloading and Terrorism





Replacement of Reserves

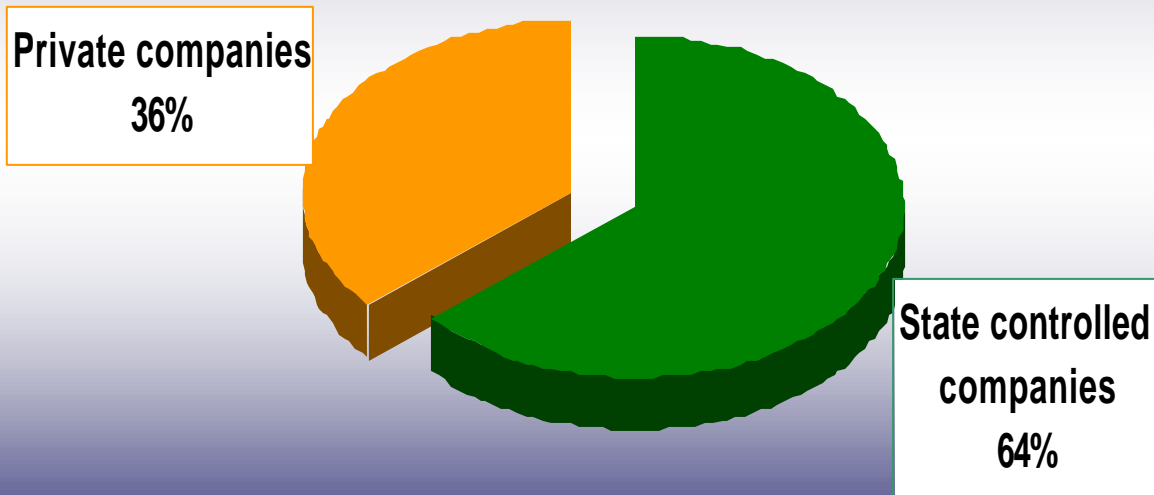
... the industry has replaced only half the reserves it has produced and needs to spend \$ 40 bn a year, rather than the current \$ 14 bn, to ensure it found a new barrel of oil for every barrel consumed.

(Wood Mackenzie in Financial Times, 4 Oct 2005)



SoS: Who Owns the Gas (and Oil) Reserves?

CONTROL OVER PRODUCTION OF REMAINING COMMERCIAL RESERVES NATURAL GAS



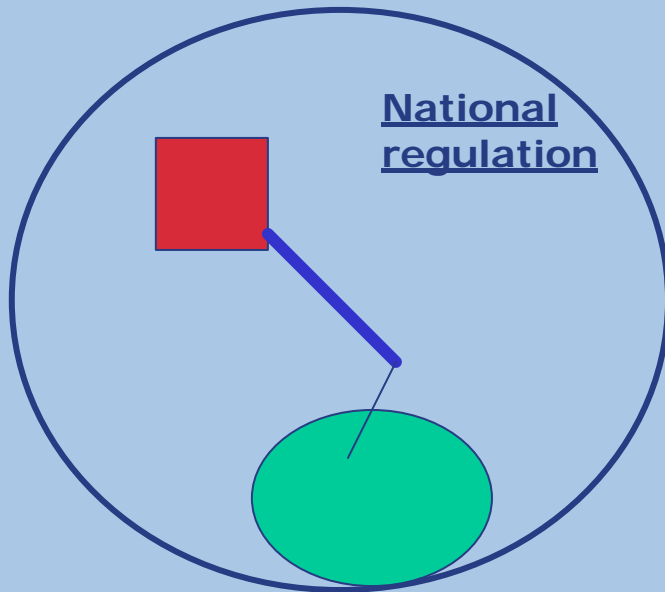


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Regulation: Electricity



Business levels

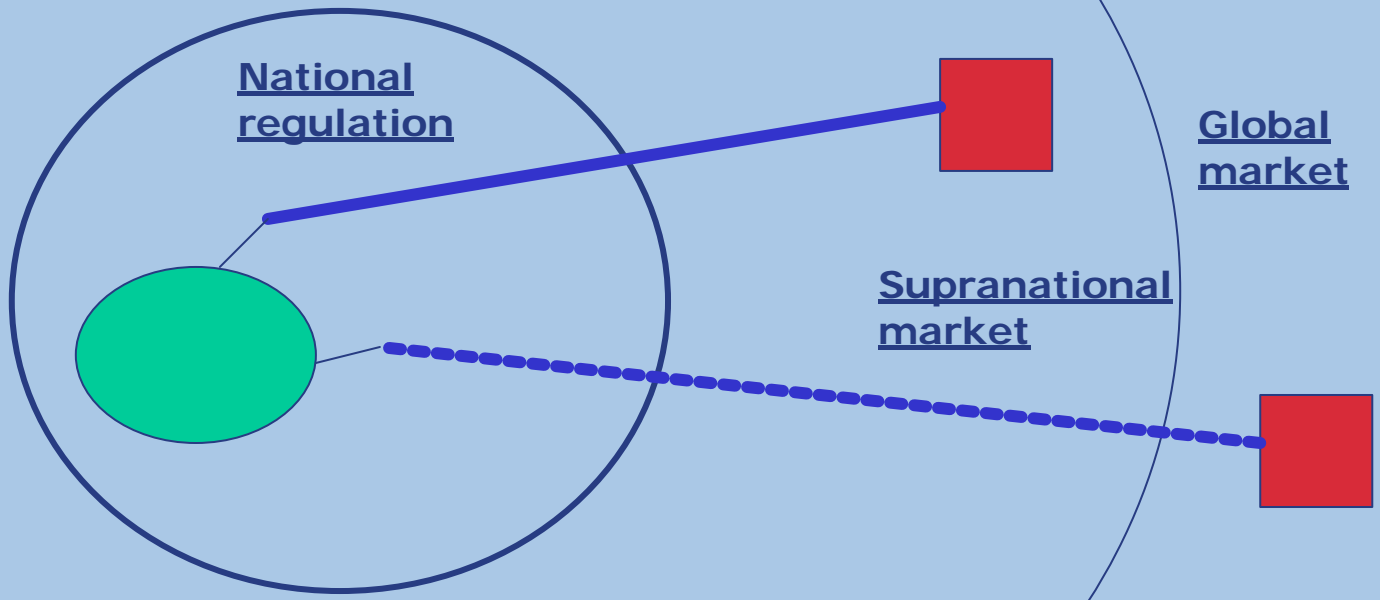
- production
- transmission
- distribution/consumption

Electricity chain:

- Production close to consumption (local, regional, national scale)
- Regulation on a national level (foreseeable effects; consistency)



Regulation: Gas



Business levels

- production
- transmission
- distribution/consumption

Gas chain:

- Production and supply: supranational / global
- Consumption and marketing: national / local

National regulation versus international market dynamics



Regulation: EUROPE

- At the same time LNG is connecting regional markets (North America, Europe, Japan / Pacific Rim and
- “New” gas import regions are making their presence at the world gas market known (India, China and Renewed US)
- This combination implies competition for supplies between gas importing regions:



Regulation: EUROPE

- Competition will presumably not only be on PRICE;
- But also on the conditions at and structure of the competing markets;
- So the type of regulation in an importing region/country will have an effect on its attractiveness for an exporting country;
- To reduce risks exporting countries also want to diversify!



Regulation: EUROPE

- EUROPE's regulatory framework needs to be in line with the requirements of an increasing global competition:
- Long Term Contracts will remain the backbone of the gas industry, they are necessary to realize the huge investments in the total gas chain, also for the LNG-chain.



Regulation: EUROPE

- Investments in gas infrastructure should also be encouraged:
- Competition flourishes better with a slight overcapacity.
- But there must be a sound fin./econ. base for investments: "Open Season", to assess the market demand for new capacity



Regulation: EUROPE

- Regulators in Europe and the EU-Commission are showing signs of understanding that some regulatory changes are necessary:
- In the UK since some time Long Term Contracts to enter the National Grid (up to >10 years) are made possible again;
- Exemptions are granted to certain infrastructure projects, but uncertainty for investors remains



Regulation: EUROPE

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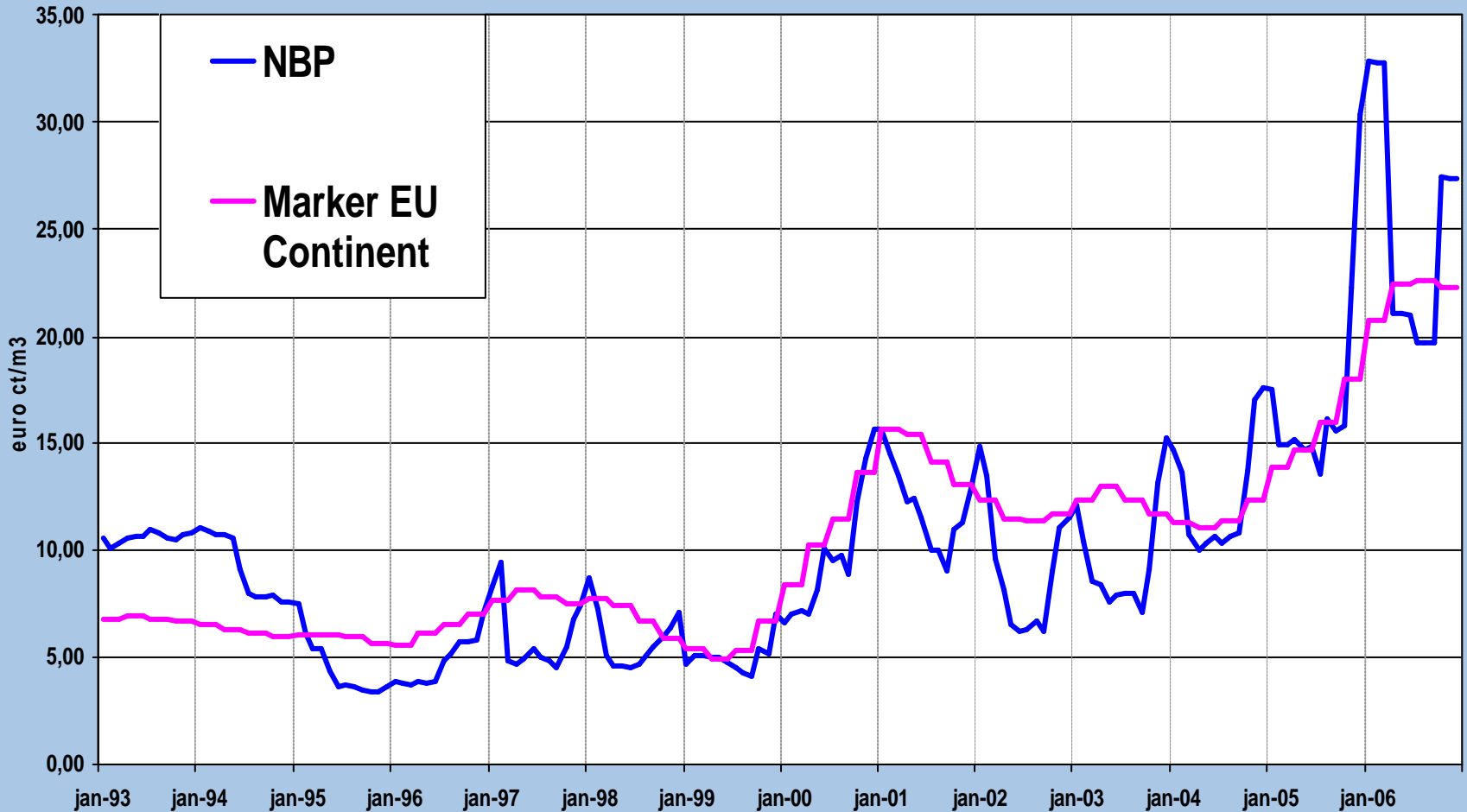
Regulation: EUROPE

- Managing expectations is key for an acceptable result: liberalization is not in itself leading to lower prices, if done well it leads to higher efficiency, but
- Prices of gas in a free market will be determined by the supply / demand balance.
- Strong price volatility is also part and parcel of a liberalized gas market



Gas Prices: UK (spot) versus EU Continent (long term contract)

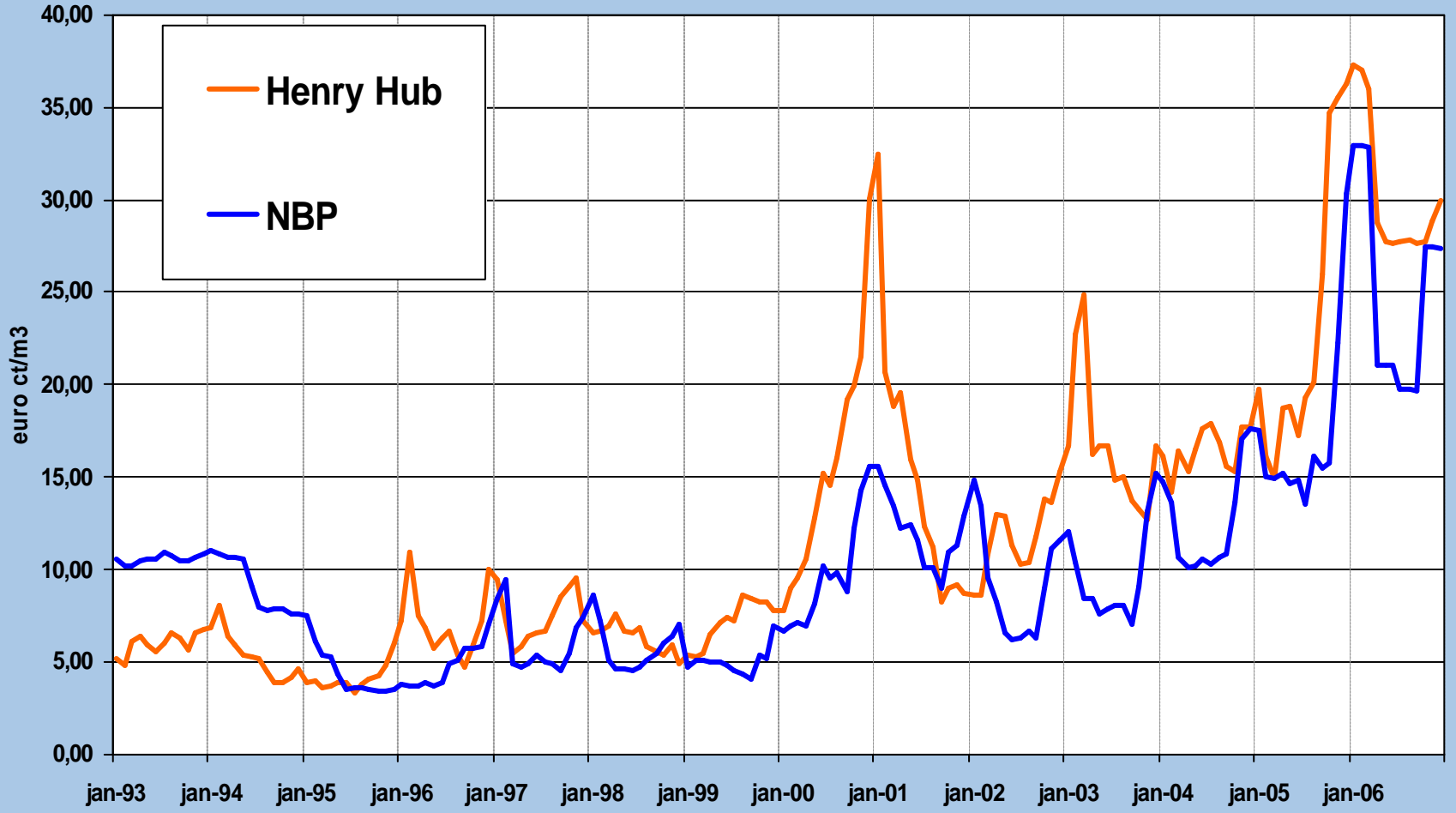
Price is monthly average





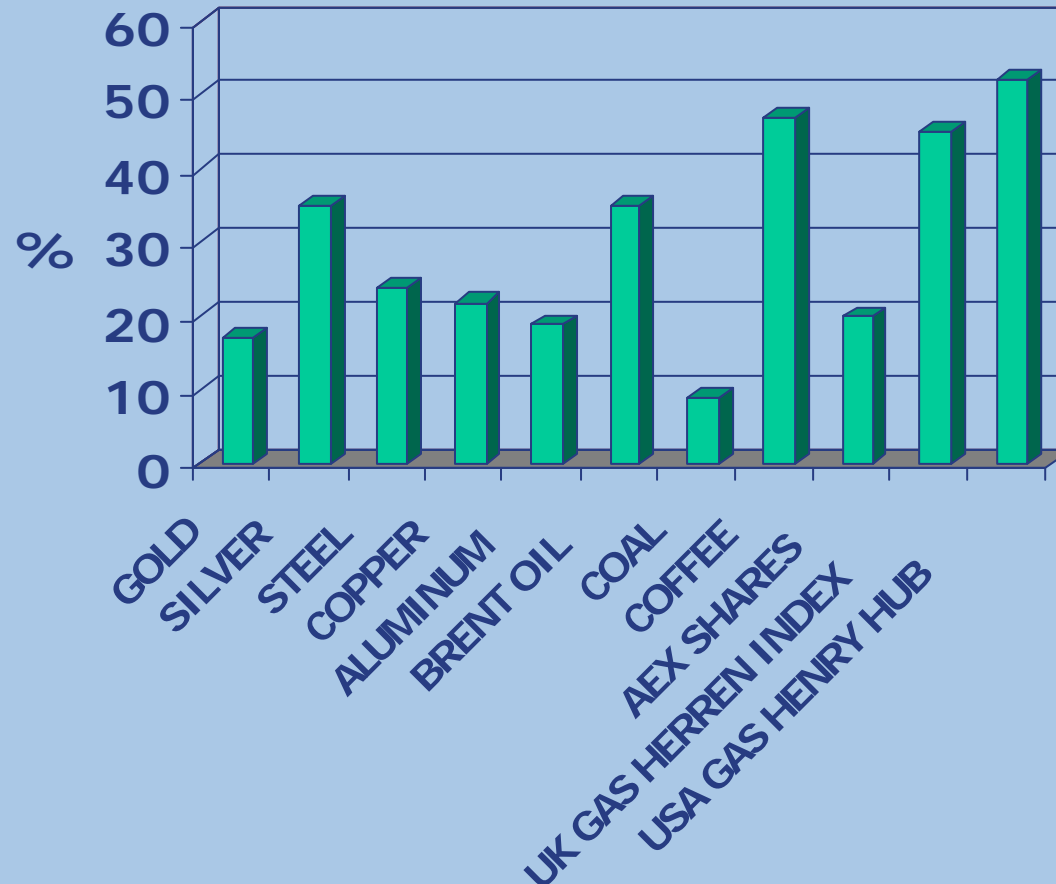
Gas Prices USA - UK

Price is monthly average





Price Volatility of Several Commodities





Some Intermediate Conclusions of Commissioner Kroes regarding the EU Energy Market

- Incumbents remain dominant in gasmarkets
- Not enough liquidity at the wholesale markets
- Not enough cross-border trade (cap. < 10%)
- Not enough consumer switching
- Possible abuse of market power (E.ON?, RWE?, EdF?...)
- Need more powers in order to judge intra-national mergers (Gas Natural-Endesa?, Dong??)
- More than 88% of the gas (contracts?) still oil (product) price-indexed
- High hurdles for new-comers, like lack of access in supply routes.



Sustainability: As a Responsible Industry We Acknowledge:


- The best supply is the saved m3

And if that is not available:

Gas: Powers the People
Preserves the world
Promoted by IGU



**Thank you
for your attention**



See you in Amsterdam!
**23rd World Gas Conference
and Exhibition**
June 5 – 9 2006

