
Electrabel
SUEZ

Investment in power generation

EPRG 14/12/2007

Capacity needs in Europe

- Aging plant park: Last building boom in the 80s
  - Still plenty of coal/lignite plants with fairly low efficiencies
  - Phase out of nuclear
    - laws in Germany and Belgium
    - Old plants in new member states
- Demand development
  - Growth in southern Europe
- Delays in infrastructure investments (Interconnectors)
- Delays in building
  - Scarcity of sites
  - Delays in components
  - Scarcity of Engienering

Outline

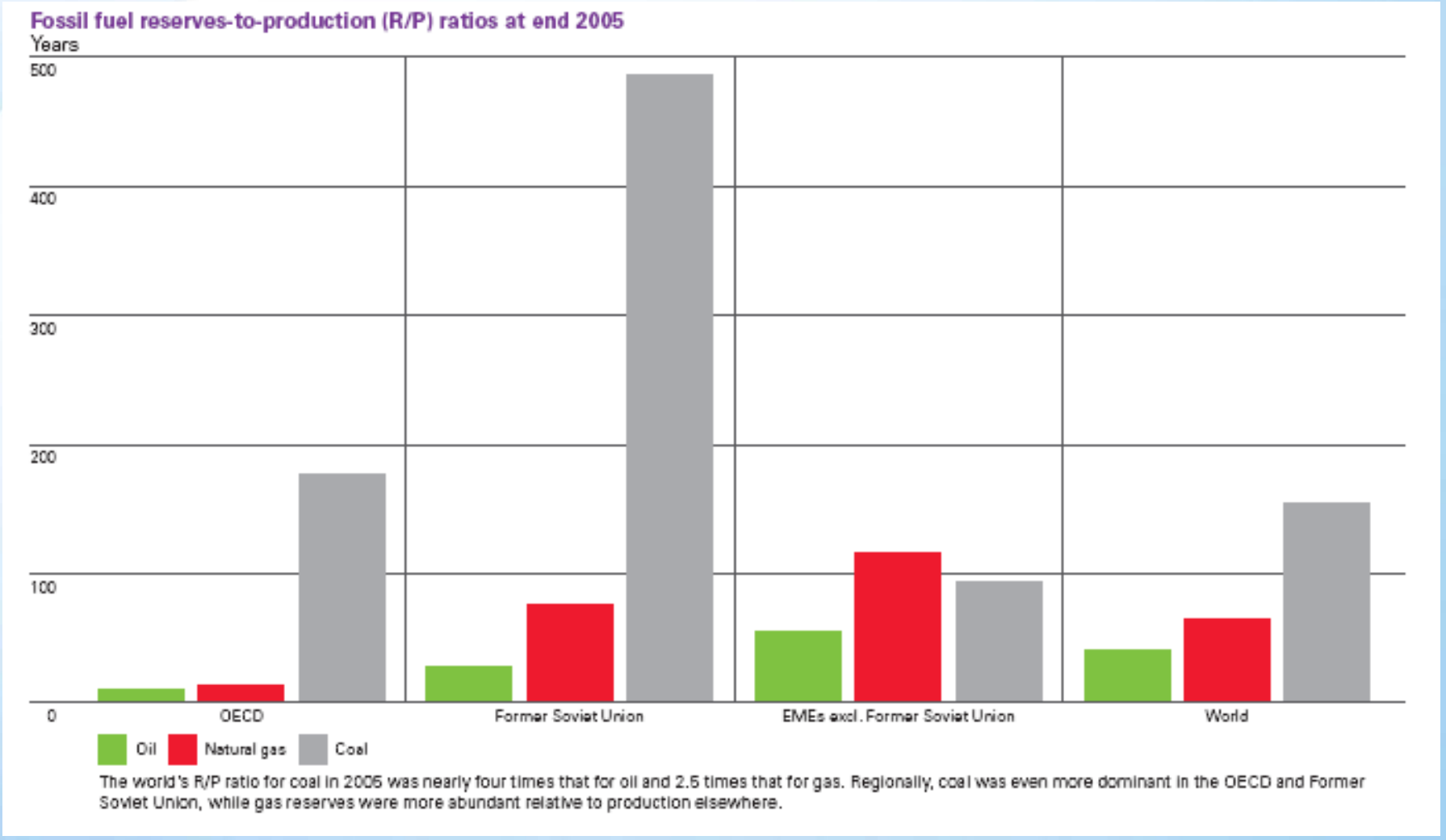
- Long term
  - Traditional uncertainties
  - Regulatory uncertainties
  - Investment choice
    - Portfolio theory argument
    - Location constraints
- Short term implications in the long run
  - Increased price volatility due to peak demand
    - Capacity shortages
    - Reactions by regulators as consequence of shortage of capacity

Traditional competition: Coal vs Gas

- High levels of reserve
- Reserves are not concentrated but spread all over the world
- Fairly cheap
- The world fastest growing fuel (BP review)
- CO2 intensive

- Fairly clean
- High degrees of efficiency (CCGT)
- High levels of flexibility (GT)
- Reserves are concentrated
  - Import Dependency
  - Potentially expensive

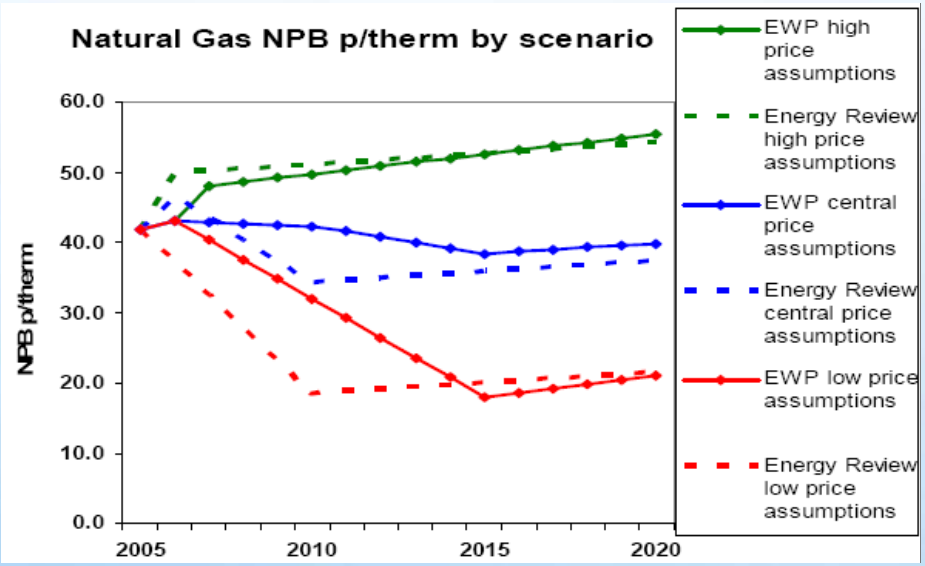
Reserve to production ratios: BP 2006

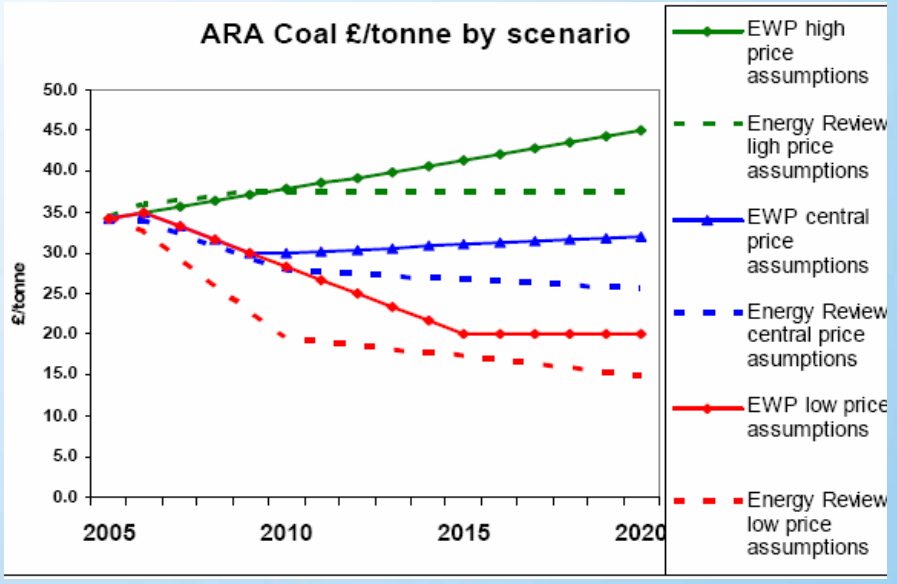


The world's R/P ratio for coal in 2005 was nearly four times that for oil and 2.5 times that for gas. Regionally, coal was even more dominant in the OECD and Former Soviet Union, while gas reserves were more abundant relative to production elsewhere.

Traditional uncertainties:Fuel prices

- Scenarios for future fuel prices
- Spreads decide between gas and coal
  - In an expensive world all fossil fuels are expensive
- Absolute levels decide between fossil and Hydro/Nuclear





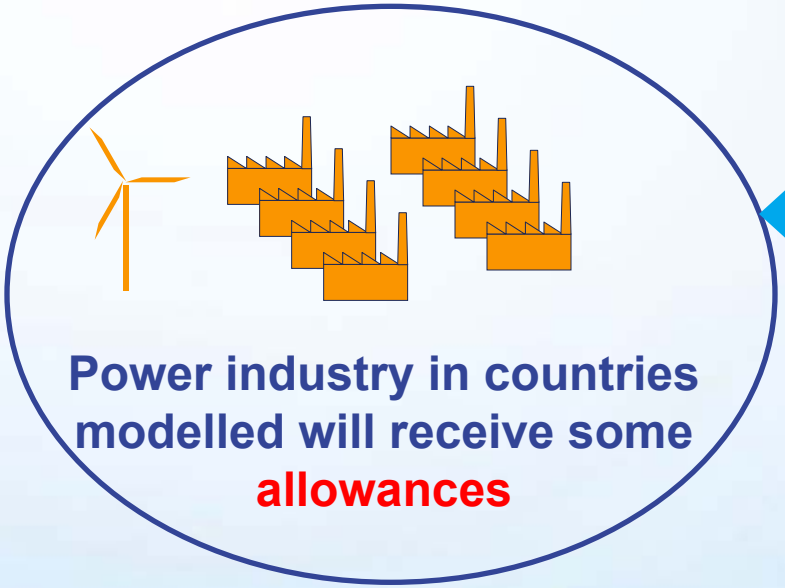
DTI, 2007

Regulatory uncertainty

- Environmental regulation:
  - Future of EU-ETS
    - Long term targets
    - Limits of CERs
    - Allocation
  - Imposed/subsidized level of renewable, CHP,…
- Future of nuclear
  - Phase out in Germany and Belgium
  - New plants in France, UK
- Market design
  - Price caps
  - Regulated tariffs
  - Capacity markets
  - And the remaining questions of Market design

CO_2 price modelling

We assume that the price of CO2 will be set by the abatement cost in the power sector. (Because we know little about the other sectors)



Power industry in countries modelled will receive some allowances

May buy allowances, mainly from

- **Other industries**
- **Projects (CDM or JIs)**

The price of CO2 is the cost of switching from a dirty technology (coal, lignite, fuel oil) to cleaner ones (gas, efficient coal). It therefore depends on fuel prices → we will use fuel scenarios

The amount of CO2 to be abated depends on NAPs, other industries and CDM supply → scenarios for environmental policy

Emission reductions

- Fuel shift coal to gas
- Efficiency improvements of existing technologies
- Renewable or non-fossile carbon free technology
- In the long term zero emission fossil generation

CCS as a backstop technology

- Uncertainty remain on
  - Technology
    - Technology choice (Precombustion/ Postcombustion/Oxyfuel)
    - Loss in efficiency -> increase of fuel consumption
  - Costs
    - Capturing
    - Transport: Need for a network
  - Storage
    - Geological
  - Public acceptance

CCS storage potential

	Geological storage capacities		Storage capacity in years*
	Aquifers	Oil and gas fiels	
Belgium	~100	n/a	1
Denmark	~16000	628	441
France	>220	2330	>3 (note 1)
Germany	23000-43000	n/a	50-89
Greece	2200	17	39
Netherlands	1600	10961	101
Norway	13000-286000	12609	857-9992
UK	>147000	10456	>88 (note 2)
Other European countries	12283 (note 3)	3805	221
* Total storage capacity divided into annual major industrial point source emissions x 1.3 (to allow for energy penalty of capture and storage)			
Notes: (1) Paris Basin only; (2) southern North Sea only; (3) Hungary not included			
n/a = not available or not applicable			

Modern Power Systems 2006

Portfolio theory argument

- Diversify idiosyncratic risk
- Invest in everything
  - Renewables:
    - Hydro
    - Wind
    - Biomass
  - Gas turbines
  - Nuclear (if possible)
  - Modern Coal
- Not in equal shares but to keep track of all technologies

EBL portfolio 2006

Low carbon mix

- 36.5% nuclear
- 33% gas
- 13.2% hydro and wind
- 15.4% coal and biomass
- 1.5% Fuel oil
- 0.4% Energy recovery

Not just what but also where to build?

Coal station:

- Coal logistic costs is important cost factor: close to harbor or to mine
- Capture ready; sufficient space for post combustion CCS
- Close to potential CCS storage (aquifier)

CCGT

- Access to gas, close to pipeline or LNG terminal.

All new builts

- Potential to sell additional services
  - heat
  - ancilliary services
- Grid access

Electricity and fuel price Risk

- New entrant favors the technology that sets the price (Roques 2007)
  - Exposed to market risks
  - No production portfolio
- In most markets new entrants choose therefore CCGT
- In Germany new entrants build Coal
  - Dong, Suedweststrom/Iberdrola, SWB, Stadtwerke

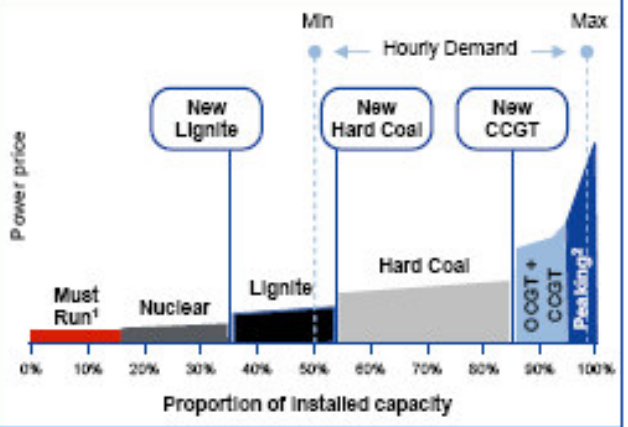
Coal vs Gas

Attractiveness of coal and gas differs in Germany and the UK

RWE

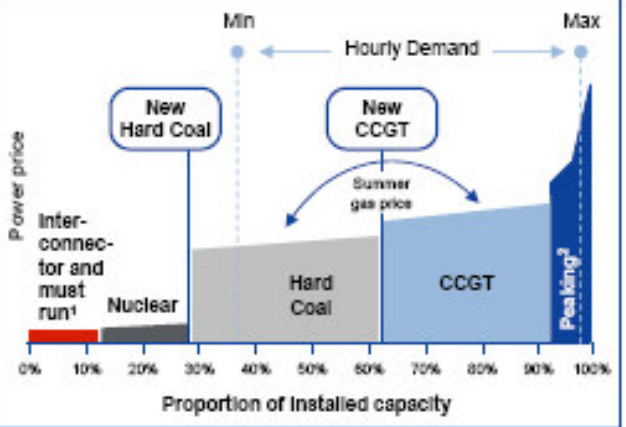
ILLUSTRATIVE

Germany



- Large proportion of low marginal cost plant from nuclear, lignite, CHP and wind
- Load factor for new coal plant somewhat higher in Germany than in UK

UK



- Higher share of high marginal cost plant
- New gas plant in UK has significantly higher load factor than in Germany

¹ Including renewables and CHP
² Oil, OCGT, Hydro, etc.

Fact Book – Generation Capacity in Europe

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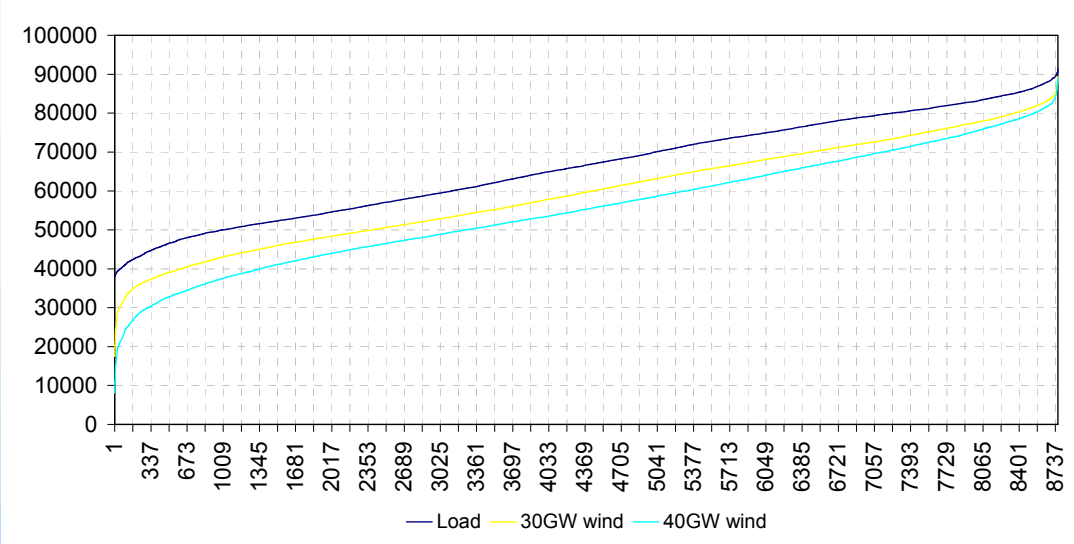
Renewables and wind

- European target: 20% renewable energy production
- Translates in 35% renewable in electricity
- Not much potential to incresese hydro: New renewable is
  - Wind
  - Biomass
  - Solar

Short term implications in the long run: Impact of wind power

- Demand pattern Germany 2005
- Hourly wind output
  - Onshore/Offshore 25GW/5GW
  - Onshore/Offshore 25GW/15GW
- Peak demand almost unchanged
- Slope increases, especially in the tails: peakier prices



Price regulation

- High peak prices as a result of
  - steeper load duration curve
  - Hourly fluctuations of wind productions:
    - Start up costs are significant for spot prices
- Price caps:
  - Complicates investment decisions further
- Regulated tarrifs
  - Who pays for curtailment?
- Demand response
  - Intelligent metering to be introduced in some markets
  - Effect not clear yet

Do we add any insight?

What we know

- There is a need for investments
- Emissions have to be reduced

- We are not able to add probabilities to the scenarios
  - Very ambiguous messages from governments
  - NPV calculations deviate substantially
  - Risk to build the wrong technology
- Stochastic models may help to asses the costs of uncertainty

Summary

- Energy companies are used to take risks: but only at a reward
- How does an equilibrium investment look like with risk averse investors given the range of uncertainties?
- What are the wellfare losses due to regulatory uncertainty

You've got the energy.