RWE Power

# *The Financial Aspects of Implementing an IGCC CCS Project in Germany*

## *Paper presented at the Expert Meeting on Financing Carbon Capture and Storage Projects*

Organised by IEA Greenhouse Gas R & D Programme
and IEA Clean Coal Centre

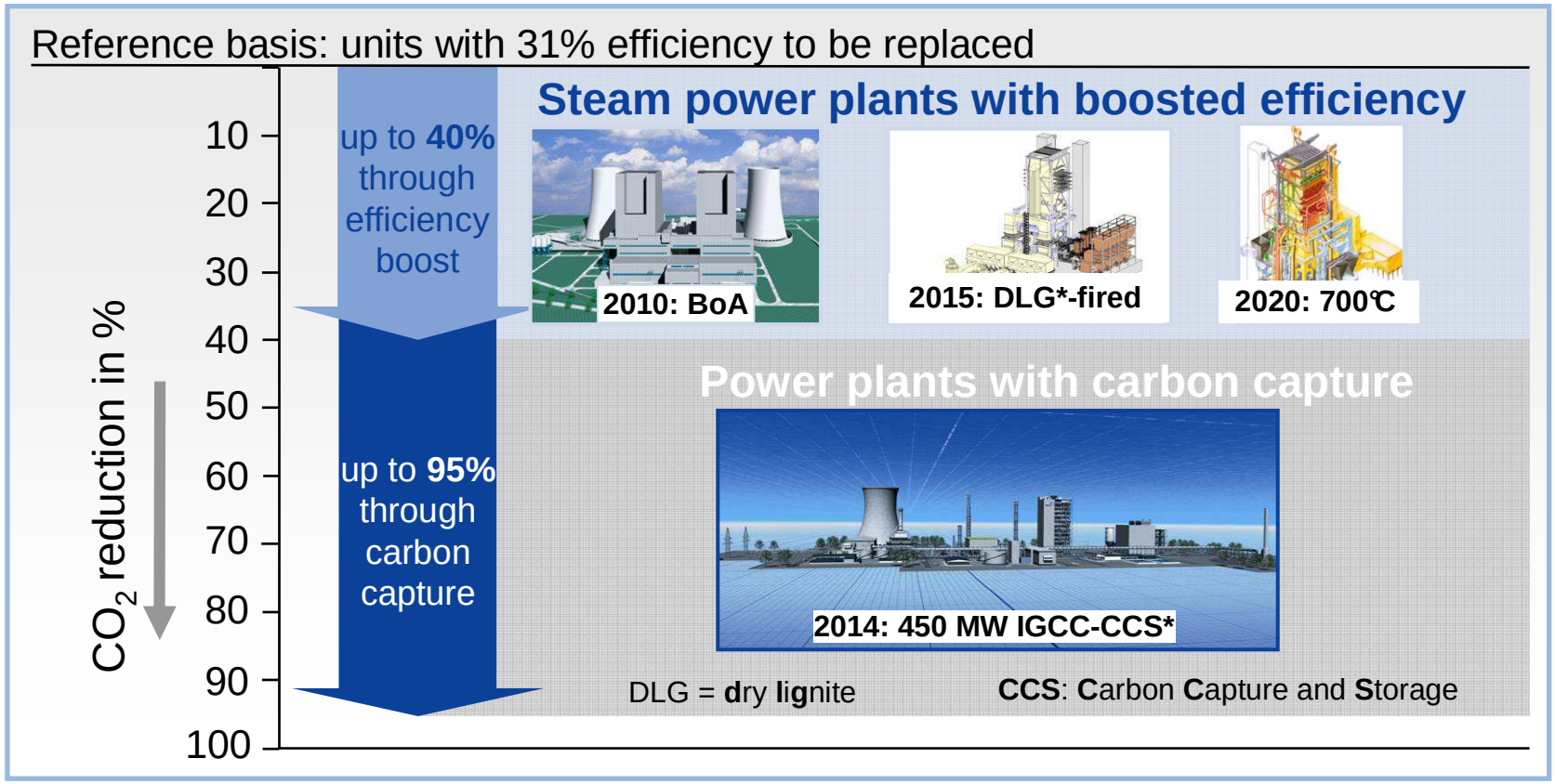
May 31, 2007, London

Dr. Hans-Wilhelm Schiffer
Senior Manager, Energy Economics
RWE Power AG, Essen

# Structure

- Potential for the reduction of $CO_2$ emissions via efficiency improvements and CCS
- RWE's decision on CCS
- RWE project of a zero-$CO_2$ 450 MW power plant (IGCC-CCS)
- Timetable of RWE's IGCC CCS project
- $CO_2$ scrubbing as a retrofit option for steam power plants
- Financial aspects of implementing CCS
- New scenario study concerning the development of the German energy market by 2030 (scenario design)
- Assumption for CCS in the scenario study
- Results concerning $CO_2$ prices, energy mix in power generation and CCS share
- Conclusion

# *Zero-$CO_2$ coal-fired power plants can slash carbon emissions further*




Efficiency boost also required for zero-$CO_2$ power plant:
The higher the efficiency the less carbon must be captured and stored

# *Horizon 3: RWE's decisions on CCS*

1. RWE Power develops and builds a **zero-$CO_2$ 450 MW coal-fired power plant** based on IGCC technology incl. $CO_2$ transport and storage;
start of operation is planned for 2014.

2. In parallel, RWE will develop the technology of **$CO_2$ scrubbing** for future advanced coal-fired steam power plants and as a retrofit option for modern installations.
   - RWE Power will focus on $CO_2$ scrubbing for lignite
   - RWE npower will perform a feasibility study for a Clean Coal 1,000 MW steam power plant in Tilbury and carry out tests for $CO_2$ scrubbing in hard coal plants.

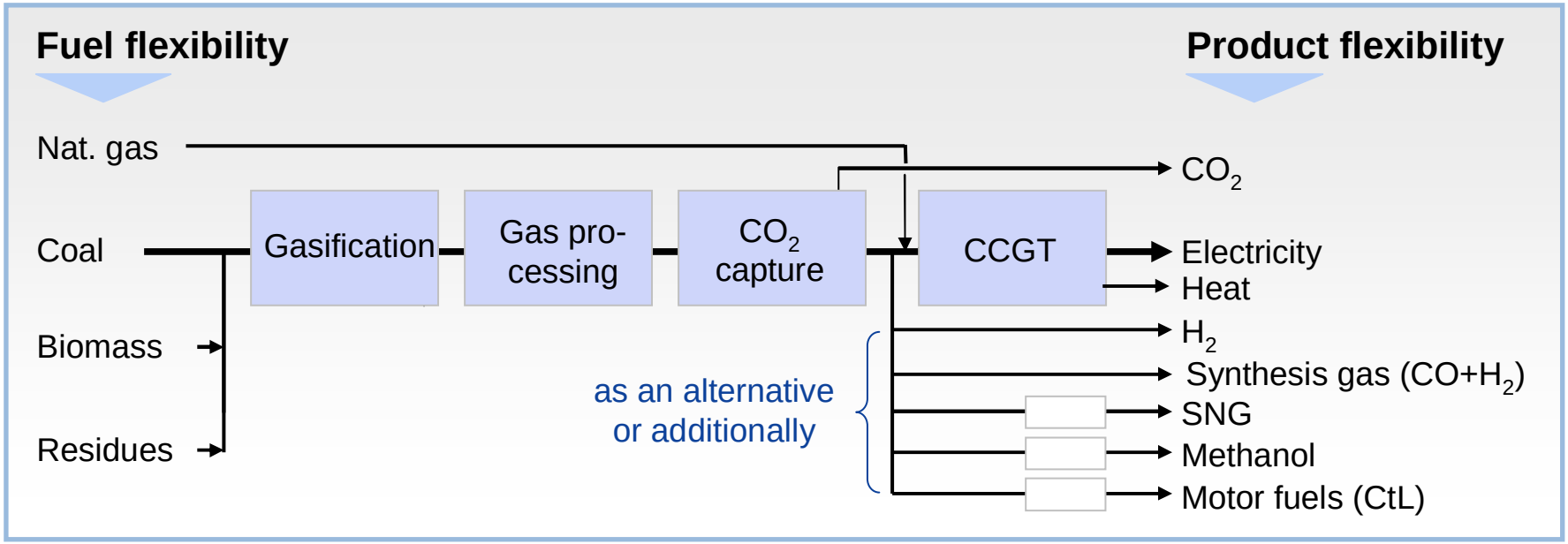
# *RWE's project of a zero-$CO_2$ 450 MW power plant with carbon storage (IGCC-CCS)*

- Basic technology: IGCC
- El. capacity: 450 $MW_{gross}$, 360 $MW_{net}$
- Net efficiency: 40 %
- $CO_2$ storage: 2.3 mill. t/a in gas deposits or deep saline formations
- Commissioning: 2014

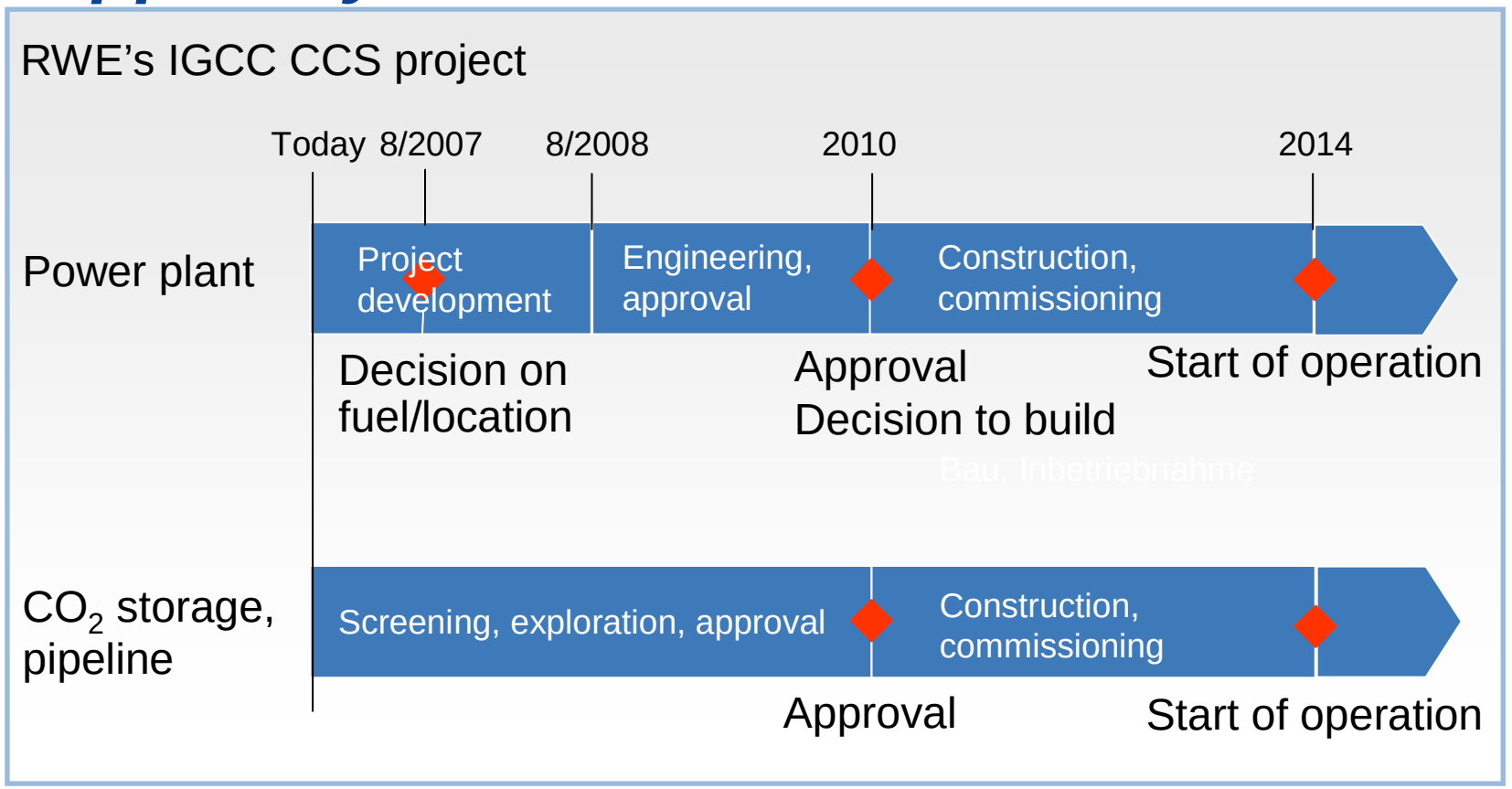
RWE Power has inhouse power plant and gasification know-how and RWE Dea has basic $CO_2$ storage know-how.

# *IGCC is particularly attractive for the zero-$CO_2$ power plant and, at the same time, offers the key to other coal-derived products*

- All process steps are commercially available
- Technical and economic figures are robust
- Power plant can also be operated efficiently without carbon capture
- IGCC offers additional potential for emission reduction
- High fuel and product flexibility



# *The timetable of RWE's IGCC-CCS project is ambitious and requires support by the overall environment*



# *The development of the $CO_2$ storage site must be step by step and on several levels*

| Phase 1 | 2008 | Phase 2 | 2010 | Phase 3 | 2014 |
|---|---|---|---|---|---|
| **Screening:**<br>■ Screening of potential reservoirs<br>■ Evaluation and feasibility study for 2 – 3 sites | | **Exploration:**<br>■ Exploration (3D seismics)<br>■ Selection of storage site<br>■ Approvals | | **Construction:**<br>■ Drilling of wells and construction of storage facility<br>■ Surface installations | |

## The following tasks must be tackled in parallel:

- Development of standards for the evaluation of $CO_2$ storage sites and their long-term tightness
- Creation of underlying legal and regulatory conditions
  - Legal norm must be defined
  - Regulatory frameworks below the law level must be created
- Reaching public acceptance

⇒ Joint tasks of companies, policy-makers and authorities

# *Parallel RWE programme on the development of $CO_2$ scrubbing for steam power plants*

*This opens up the retrofit option*

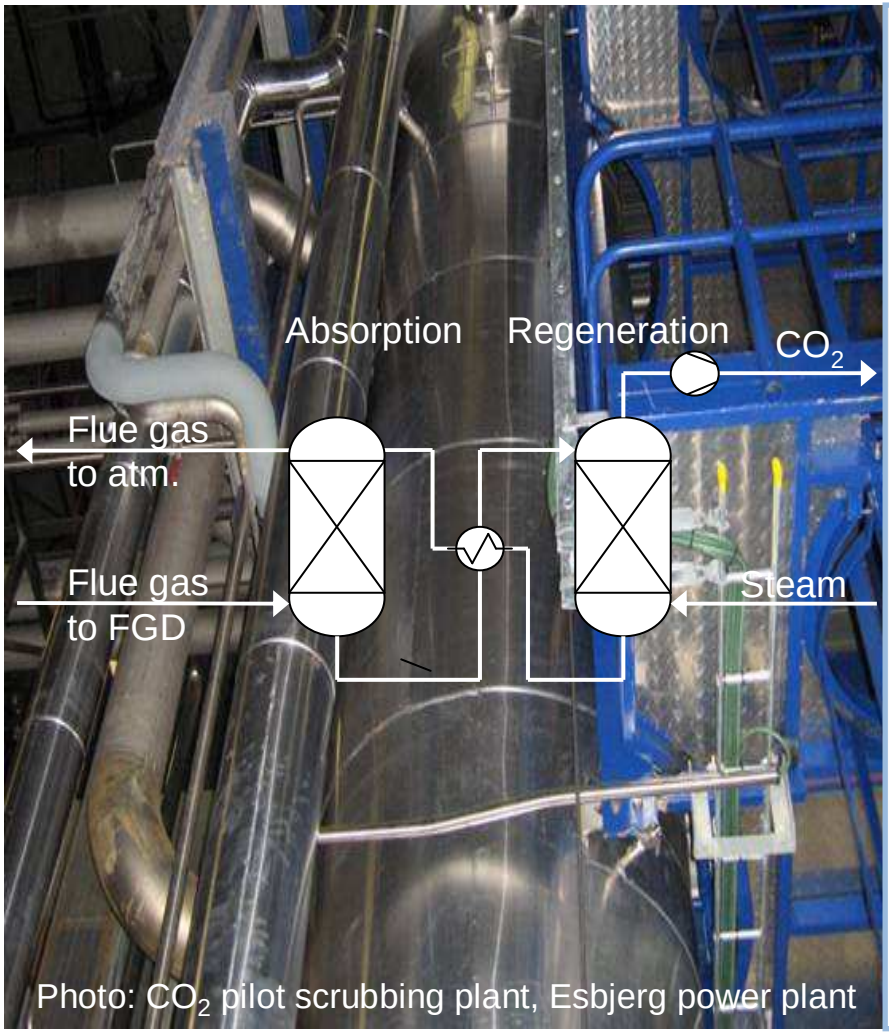
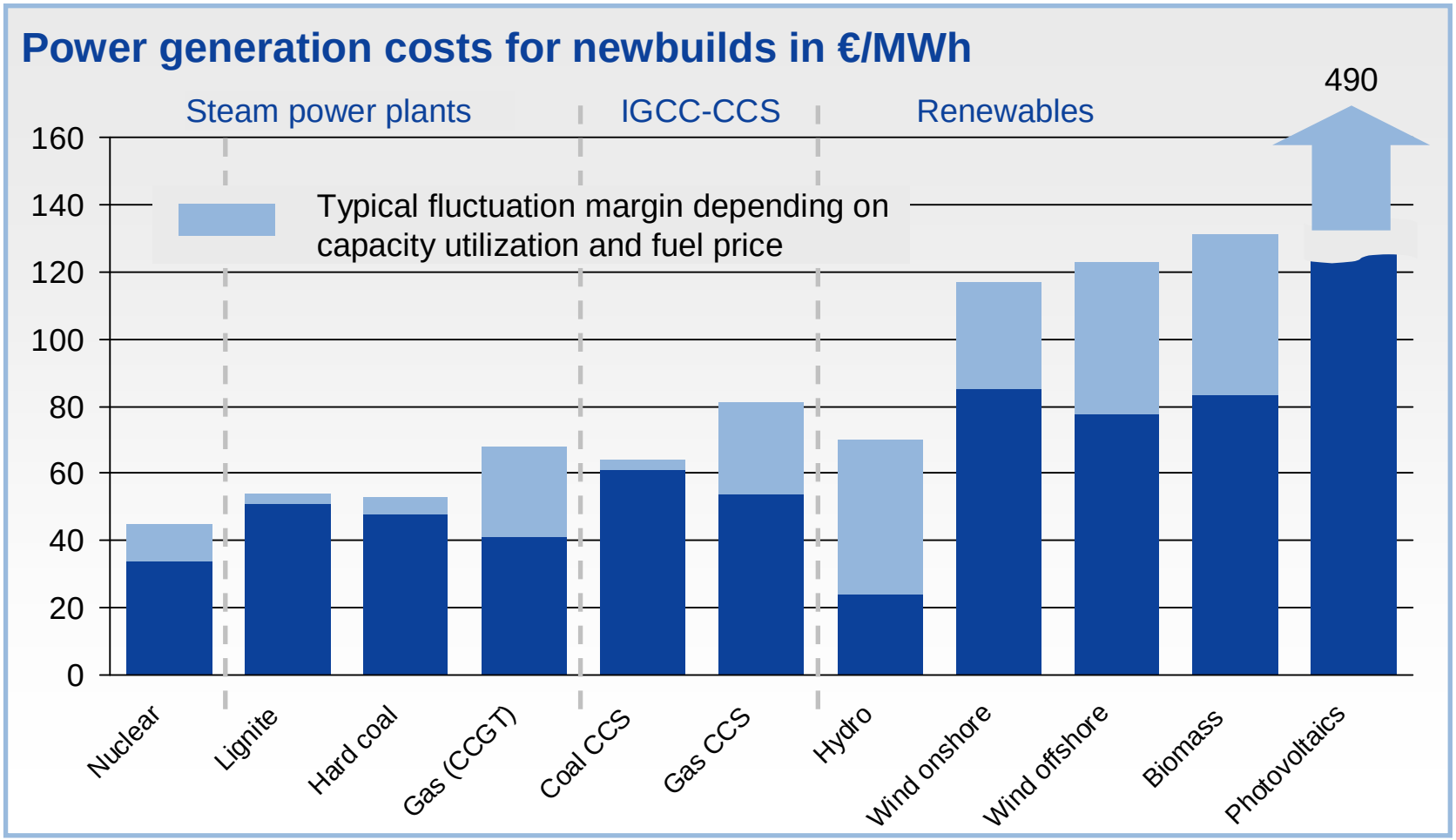



Photo: $CO_2$ pilot scrubbing plant, Esbjerg power plant

- RWE involvement:
  First pilot plant for HC in operation at the Esbjerg power plant (DK) as part of the EU CASTOR project
- RWE developments:
  - RWE Power for lignite:
    - until 2008: pilot project
    - from 2009: demonstration plant
  - RWE npower for hard coal:
  - Pilot test plant
  - Study for 1,000 MW Tilbury plant with $CO_2$ scrubbing
- Currently formation of partnerships with plant makers and chemical industry
- Budget: ~ €90 million

# *Comparison of power generation costs for various technologies*




Source: VGB (German Technical Association of Large Power Plant Operators), supplemented by $CO_2$ allowances costs of €20/t and plants with carbon capture

# *Scenario design in the EWI/EEFA study*

**Scenario 1:** Consideration of the stipulations made by the European Council in March 2007 with regard to the reduction of greenhouse gas emissions in the EU-27 (- 20 % by 2020 over 1990) with unchanged energy policy conditions in Germany

**Scenario 2:** Equal consideration of supply security, economic efficiency and environmental compatibility/backing of market mechanisms (no restrictions for nuclear energy use, EU-wide harmonized funding model for renewable energies, free allocation of $CO_2$ certificates based on fuel-specific benchmarks)

**Scenario 2a:** Like Scenario 2, but 100 % auctioning of $CO_2$ emission allowances after 2012

**Scenario 3:** Priority on environmental protection and nuclear phase-out (100 % auctioning of $CO_2$ certificates after 2012 – as in Scenario 2a)

# *Overview of policy scenarios (1)*

| | Scenario 2 | Scenario 2/2a | Scenario 3 |
|---|---|---|---|
| **GHG reduction**[1)] | | | |
| **EU** 2010<br>2020<br>2030 | - 8 %<br>- 20 %<br>- 25 % | - 8 %<br>- 20 %<br>- 25 % | - 8 %<br>- 30 %<br>- 40 % |
| **DE** 2010<br>2020<br>2030 | - 21 %<br>- 25 %<br>- 30 % | - 21 %<br>- 25 %<br>- 30 % | - 21 %<br>- 40 %<br>- 50 % |
| NAP | Unchanged NAP II after 2012 | 100 % auctioning after 2012 | |
| JI/CDM[2)] | max. 50 % of each reduction (stipulated by EU Commission) | | |

1) over 1990
2) optionally: over base year, 2004 or forecast, if appropriate
Source: EWI/EEFA, "*Energiewirtschaftliches Gesamtkonzept 2030*" (Overall Energy Policy Concept), 23/05/2007

# *Overview of policy scenarios (2)*

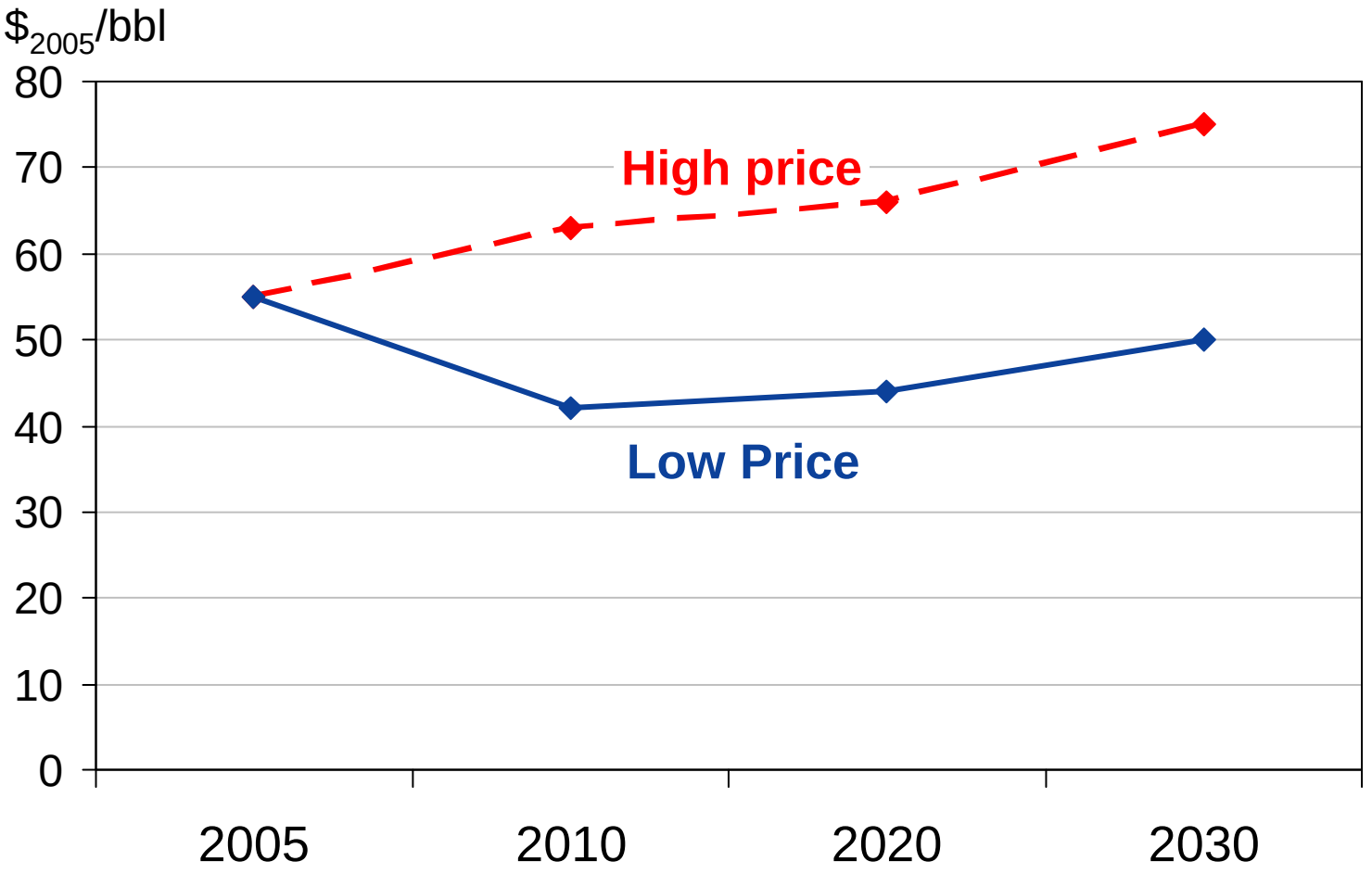
| Renewable energies targets[1)] | Unchanged Renewable Energies Act | Market economy integration model of the EU | Forcing Renewable Energies Act |
|---|---|---|---|
| **EU** 2010 | 17 % | 17 % | 22 % |
| 2020 | 22 % | 22 % | 30 % |
| 2030 | 27 % | 27 % | 35 % |
| **DE** 2010 | 13 % | 13 % | 15 % |
| 2020 | 20 % | Market result | 25 % |
| 2030 | 26 % | Market result | 35 % |
| **CHP** | Unchanged CHP Moder-nization Act | Production discontinued | Ratio: Doubling of CHP power generation by 2030 |
| **Nuclear energy** | Phase-out | No restrictions | Phase-out |

1) Share in gross power consumption

Source: EWI/EEFA, "*Energiewirtschaftliches Gesamtkonzept 2030*" (Overall Energy Policy Concept), 23/05/2007

# Crude oil price

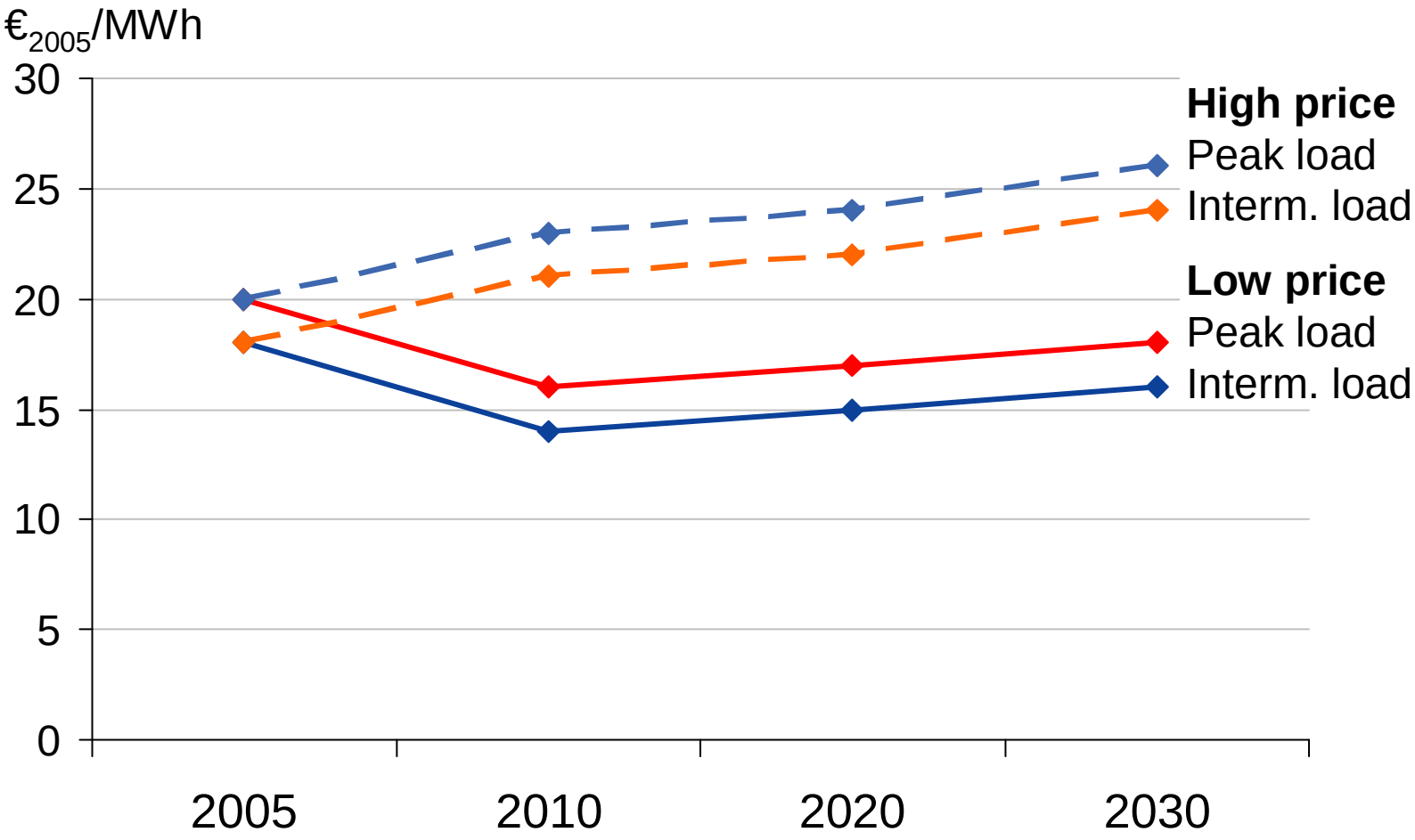
## *High-price and low-price path*




Source: EWI/EEFA, *"Energiewirtschaftliches Gesamtkonzept 2030"*, (Overall Energy Policy Concept), 23/05/2007

# Gas prices free power plant

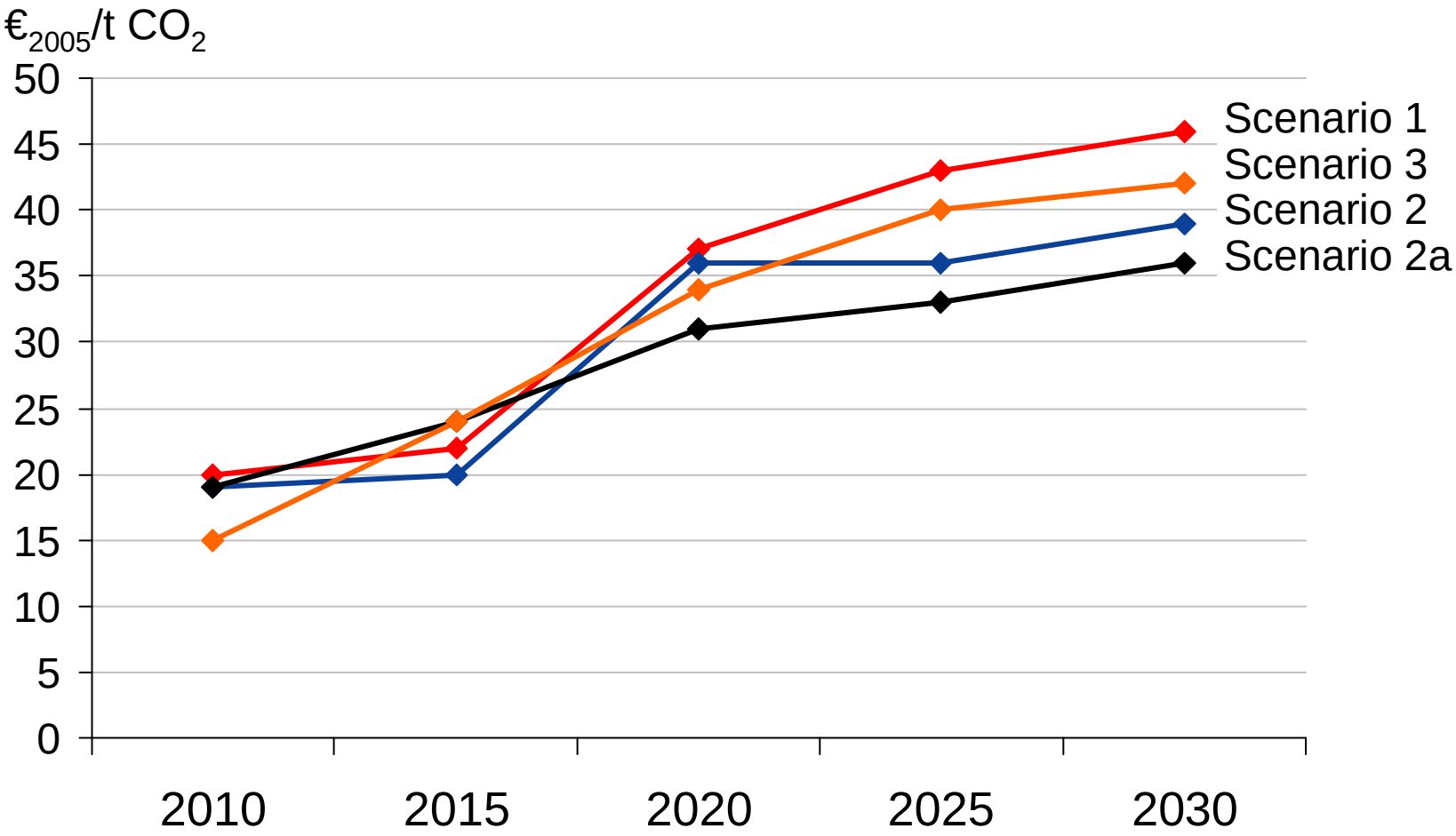
*Low and high price, intermediate and peak load*




Source: EWI/EEFA, *"Energiewirtschaftliches Gesamtkonzept 2030"*, (Overall Energy Policy Concept), 23/05/2007

# Real $CO_2$ prices in scenarios

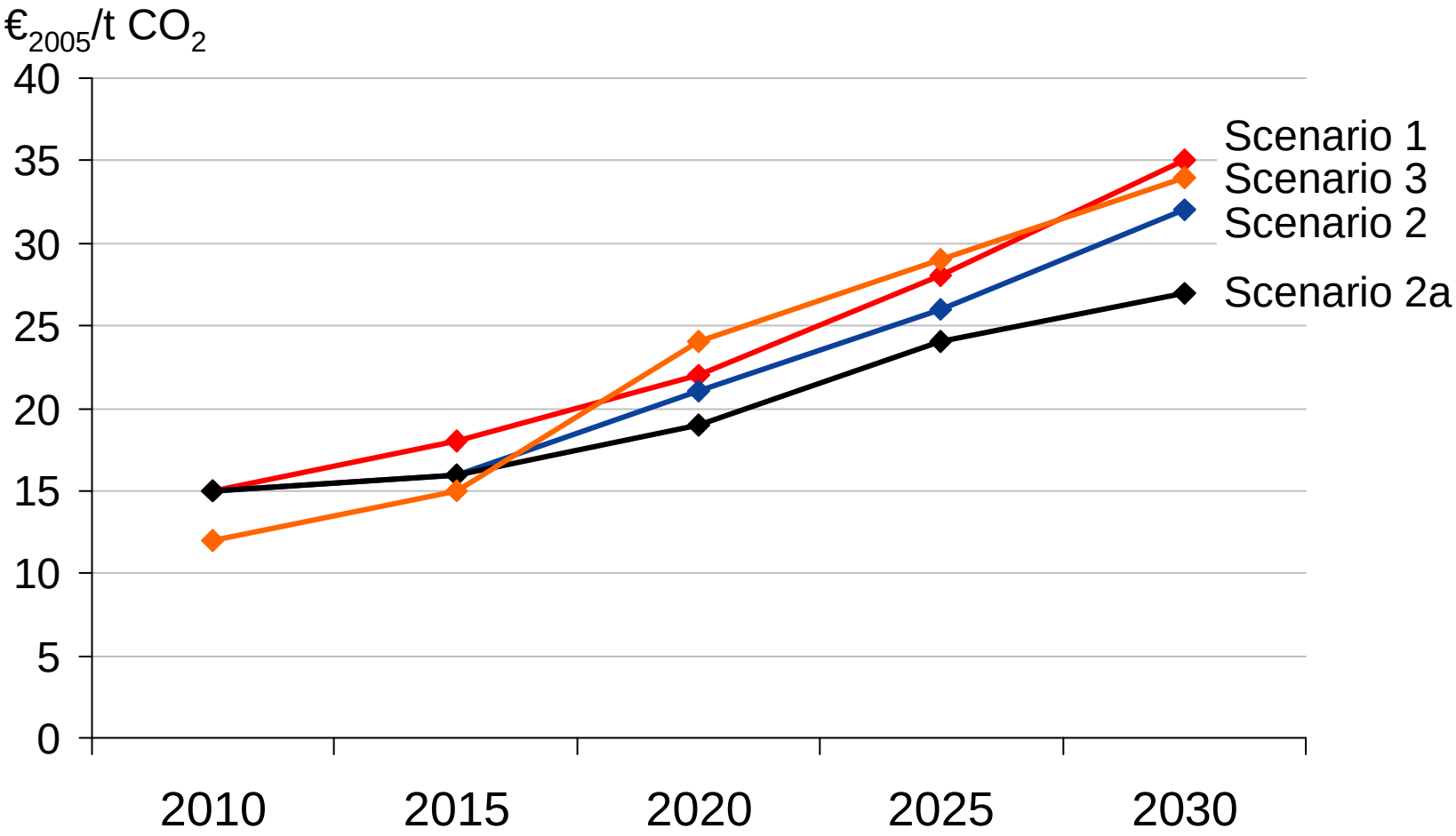
*Price basis 2005, high price*




Source: EWI/EEFA, *"Energiewirtschaftliches Gesamtkonzept 2030"*, (Overall Energy Policy Concept), 23/05/2007

# Real $CO_2$ prices in scenarios

*Price basis 2005, low price*




Source: EWI/EEFA, *"Energiewirtschaftliches Gesamtkonzept 2030"*, (Overall Energy Policy Concept), 23/05/2007

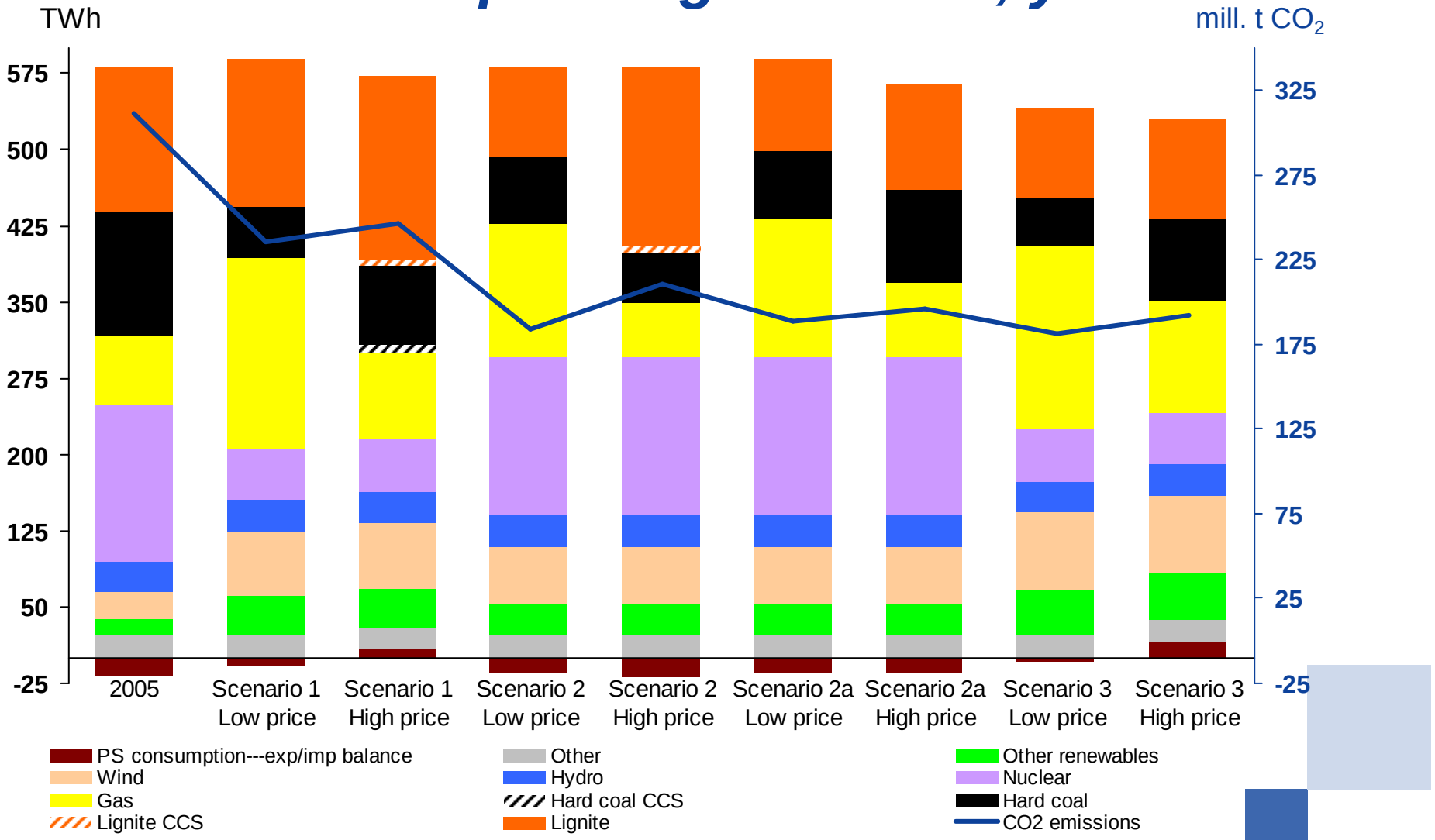
# *Assumptions concerning costs and efficiency of newbuild coal-fired plants*

| | Hard coal | Lignite |
|---|---|---|
| Investment costs in € mill./$MW_{el}$ | | |
| without CCS | 1.20 | 1.35 |
| with CCS | 1.68 | 1.75 |
| Efficiency after 2020 in % | | |
| without CCS | 52 | 51 |
| with CCS | 44 | 43 |

An emission reduction of 90 % was assumed for plants with CCS. The costs of transport and storage are based on an aggregate amount of €14/t $CO_2$.

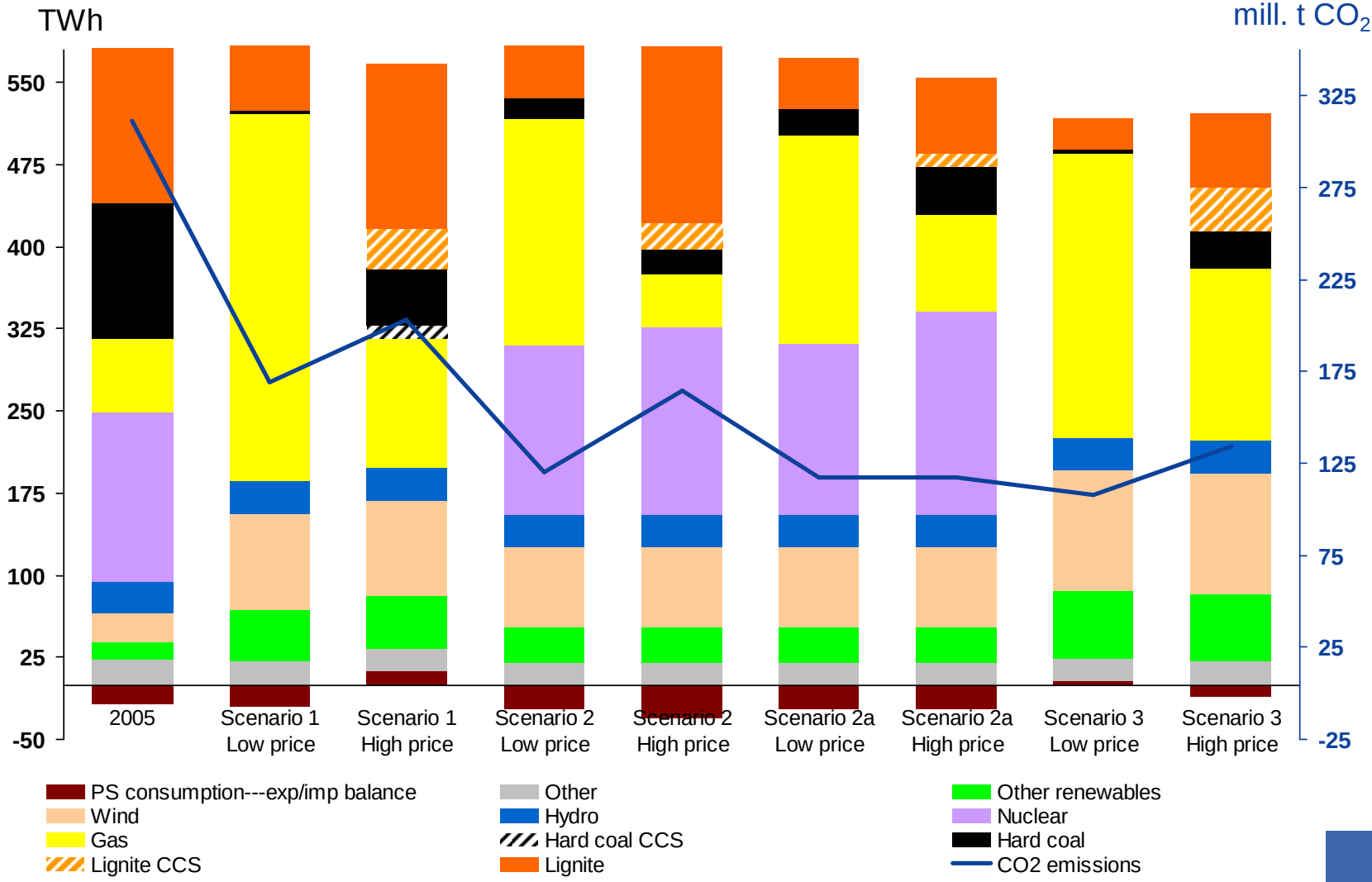
Source: EWI/EEFA "Energiewirtschaftliches Gesamtkonzept 2030" (Overall Economic Energy Policy Concept), 23/05/2007

# *Net power output in Germany/$CO_2$ emissions from power generation, year 2020*




Source: EWI/EEFA study: "Energiewirtschaftliches Gesamtkonzept 2030" - overview of scenarios - status: 23/05/07

# *Net power output in Germany/$CO_2$ emissions from power generation, year 2030*




Source: EWI/EEFA study: "Energiewirtschaftliches Gesamtkonzept 2030" - overview of scenarios - status: 23/05/07

# *Main findings:*

- Coal will remain an important pillar in the energy mix.
- Increase in efficiency and CCS are the decisive levers for securing the future of coal-based electricity generation.
- Technological solutions for CCS can be made available.
- Politicians have to create the legal framework for $CO_2$ transport and storage.
- RWE is willing to make the necessary investment using own funds for their large-scale demonstration project.
- CCS can be made available at competitive conditions from 2020 onwards – depending on gas and $CO_2$ prices.
- Incentives to promote CCS are necessary, in particular appropriate rules as part of the ETS.