

The Role of Coal: How to Overcome Challenges for Innovation

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RWE
The energy to lead

Coal as integral part of future EU energy mix: 80% reduction of CO₂-emissions of electricity generation by 2050 achievable*

- > Multiplication of wind power capacity via repowering and offshore



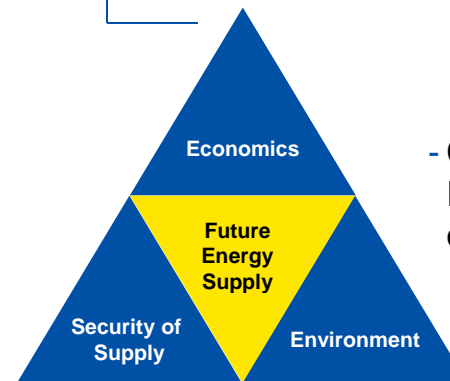
- > Modernisation of coal-fired power plants and implementation of CCS



- > Nuclear Energy: Life time extension and replacement



- Coal and nuclear cost-effective
- Wind with largest potential of renewable energies



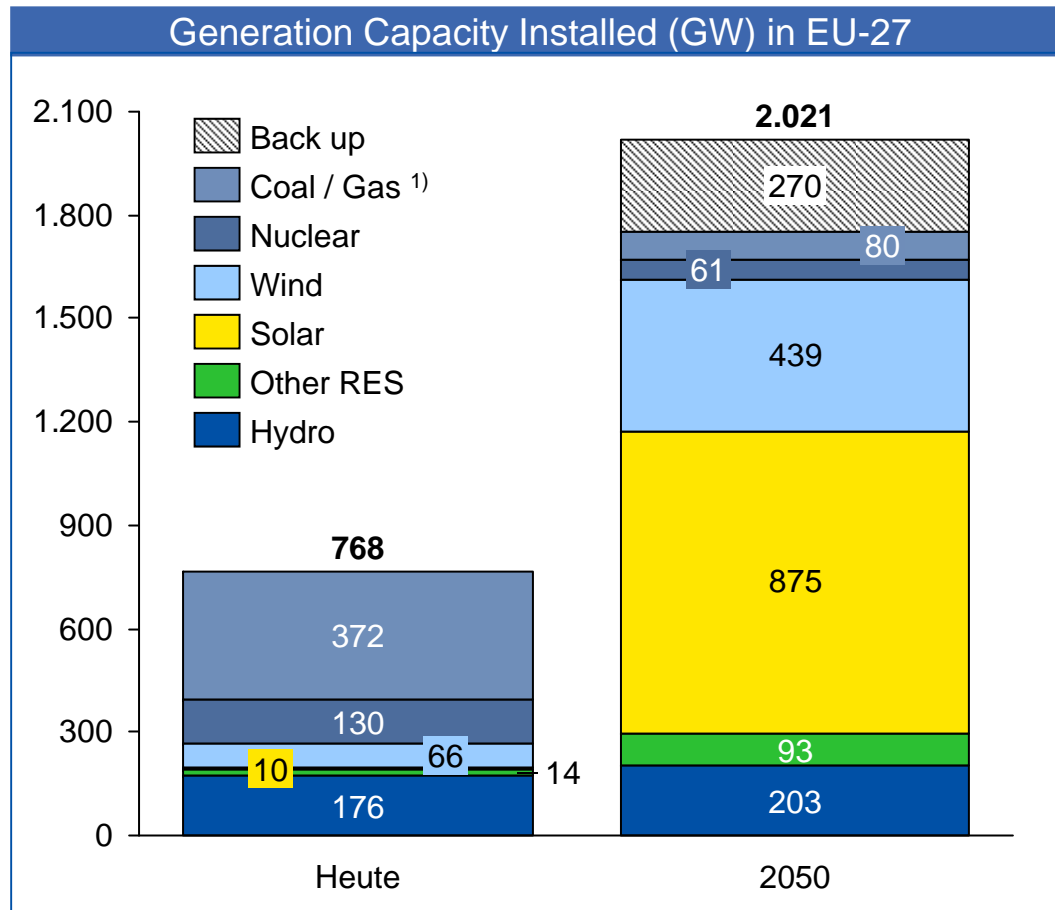
- CCS, Nuclear and Renewables as low-CO₂ options for generation

- Reliable supply of coal and uranium
- Integration of intermittent generation into electricity system

* Compared to 1990

First Challenge: support an increasing share of fluctuating renewables by coal-fired power plants

⇒ Ensure sufficient and flexible reserve capacity



> In a 2050-scenario with 80% RES, 270 GW conventional reserve capacity are needed to bridge calms

> Economic incentives indispensable to ensure sufficient capacity

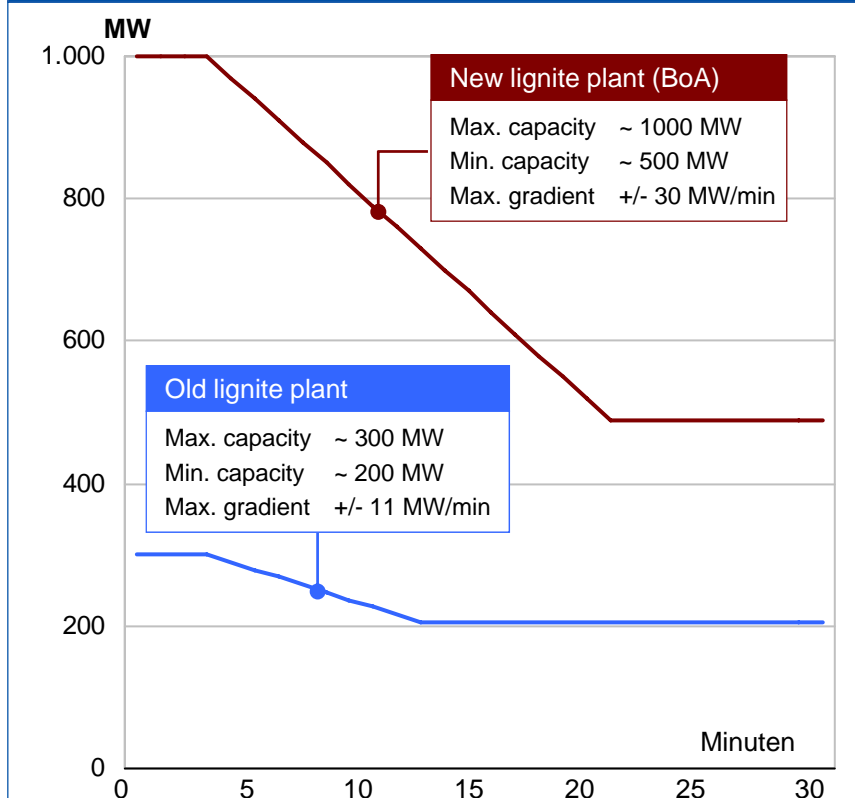
> Energy storage systems can only serve as short-term buffer

⇒ Load gradients of new-built coal-fired power plants are high enough to provide the flexibility needed to support intermittent generation

Source: ECF, Roadmap 2050: A practical guide to a prosperous low carbon Europe 80%-RES Scenario, ¹⁾ In 2050 incl. CCS

New coal-fired power plants are flexible partners for renewable energies: support new-buils

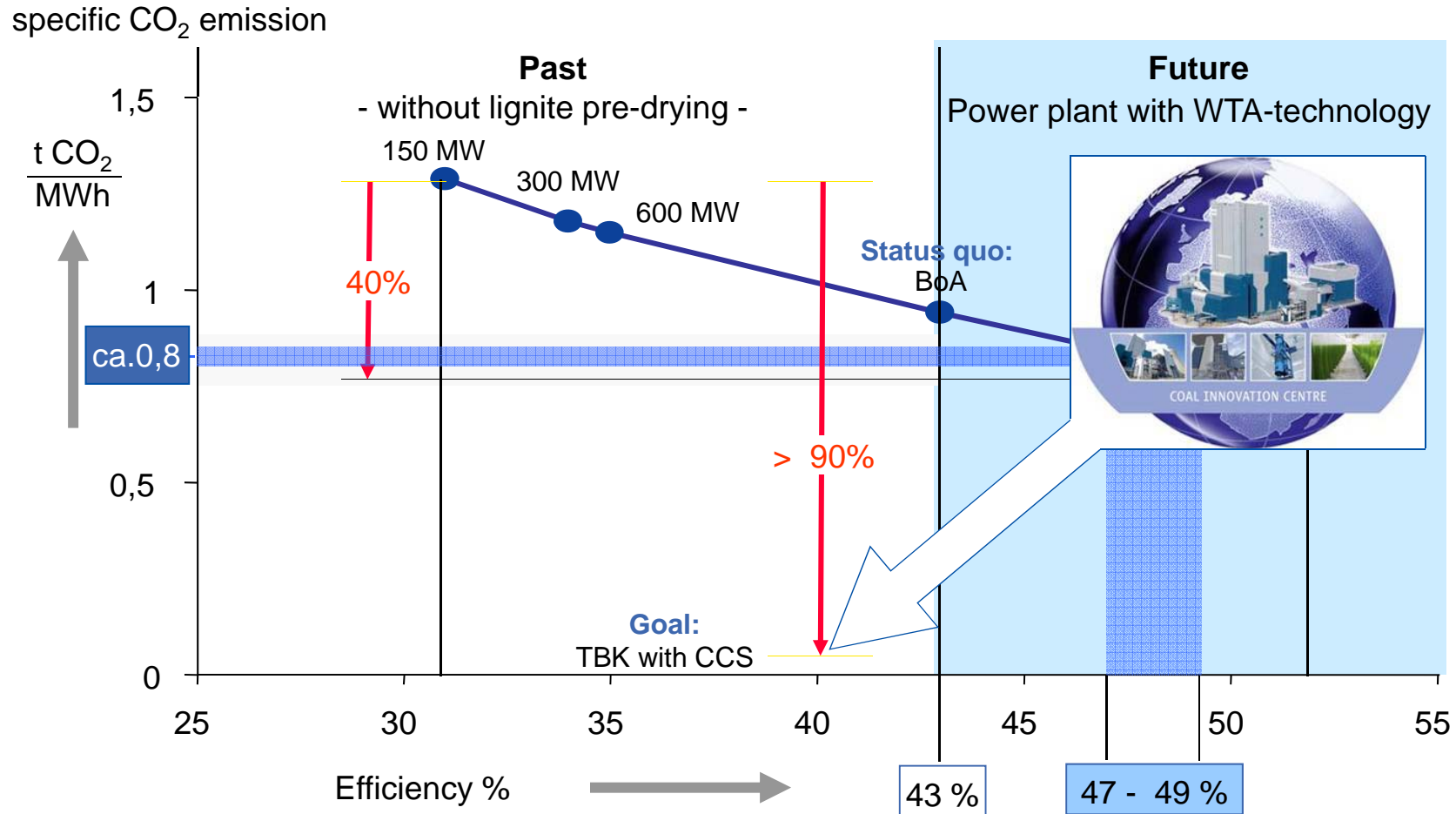
Comparison of flexibility between new and old lignite-fired power plants



Graphs are showing how fast different types of lignite-fired power plants can decrease active power: the faster a generation facility can decrease its active power and increase it again, the more flexible it is

RWE Power's Goal for CCS Development

Efficiency enhancement



Efficiency increase through RWE's fluidized-bed drying process with internal waste heat utilization (WTA®)

WTA prototyp at Niederaussem:

- WTA technology (fluidized-bed drying with internal waste heat utilization)
- Efficiency increase in new lignite-fired power plants by some 10% (+ 4%points)
- Own development of RWE
- Internationally successful marketing
- Dry lignite-fired power plant with > 47%

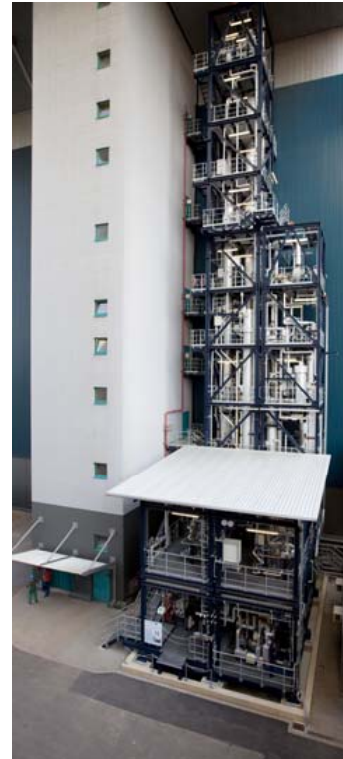
Performance data of the prototype:

- | | |
|---------------------------------------|------------|
| ▪ Raw-coal throughput | 210 t/h |
| ▪ Dry-coal production | 110 t/h |
| ▪ Fuel share of <i>BoA 1</i> | ~ 28% |
| ▪ Efficiency increase of <i>BoA 1</i> | ~ 1.4%-pts |



CO₂ scrubbing pilot plant: making coal-based power generation more climate-friendly

- Development targets:
 - Applying known gas-scrubbing technologies to power plant flue gas
 - Reducing energy requirements to efficiency losses <10% points in the power plant
- CO₂ capture rate: > 90% (app. 300 kg CO₂/h)
- Project partners: Linde and BASF
- RWE Power budget: €9 mill.
- Funding by the Federal Ministry of Economics and Technology (BMWi)
- In operation since July 2009



Research and Development - Coal Innovation Centre: Join forces for the sake of climate protection

High-performance scrubber

REAprus: optimized flue gas desulphurization and dust collection (test plant; since 2009)



Algae plant

CO₂ binding by microalgae (pilot plant; since 2008)

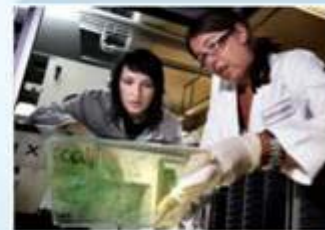
WTA plant

Predrying of lignite with waste heat utilization, resulting in higher efficiency and lower CO₂ emissions of electricity generation (prototype; since 2008)



Biomass stove

Distribution of 30,000 wood-saving, climate-sparing cookers in Zambia (sponsorship project; since 2009)



White biotechnology

Conversion of CO₂ to biomass or feedstock by microorganisms (laboratory; since 2010)



Catalysis

Use of CO₂ from flue gas cleaning for the production of synthetic material (laboratory; since 2010)



CO₂ scrubbing

Capture of the CO₂ contained in the flue gas using a scrubbing solution (pilot plant; since 2009)

Coal is an integral part of a broad and balanced energy mix in Europe - Summary

- Coal can cost-efficiently contribute to EU objectives for climate protection:
 - As back-up capacity for renewables
 - With power plant renewals/modernization and increases in efficiency
 - By R&D for and implementation of Clean Coal technologies (CCS/CCU)
- To support innovation in coal technologies, political promotion is needed in the EU and its Member States:
 - Non-discrimination of coal in legislation on climate protection
 - No exclusion of coal in R&D programmes
 - Extension of Member States' option to 2020 to cover 15% investment costs of capture-ready plants
 - Promotion of CCS demonstration programme and CCS infrastructure, also by including it in the energy infrastructure package
 - Joint action for public acceptance of coal