Flexibility of new and optimized fossil fired Power Plants

Seminar on Adaption of Thermal Power Plants to Fluctuating Renewable Energies
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Axel Meschgbiz
RWE Technology International

Major Efficiency and Flexibility Measures

- Fuel change, Blending, Fuel handling
- Optimisation/adaption of the combustion
- Technical optimisation, modification operation regime
- Choosing new material
- Optimisation of the turbine
- Optimisation of Flue gas cleaning system
- Optimisation of instrumentation and control system
- R&D activities regarding efficiency increase and flexibility

Technology retrospect

RWE made in the last decade a lot of effort to increase the availability, flexibility and efficiency of the PF Boilers – Example Lignite:

	150 MW-Blöcke	300 MW - Blöcke	600 MW - Blöcke	1000 MW - BoA - Block
IBN:	1963	1965 - 1971	1974	2003
η:	31%	32-34%	35-36%	> 43%
Kohle:	1,2 kg/kWh	1,1 kg/kWh	1,1 kg/kWh	0,9 kg/kWh

Next Project:
2x 550 MW
Pre-dried lignite
CFBC Units

?

What does Flexibility mean?

High flexibility can be described as follow:

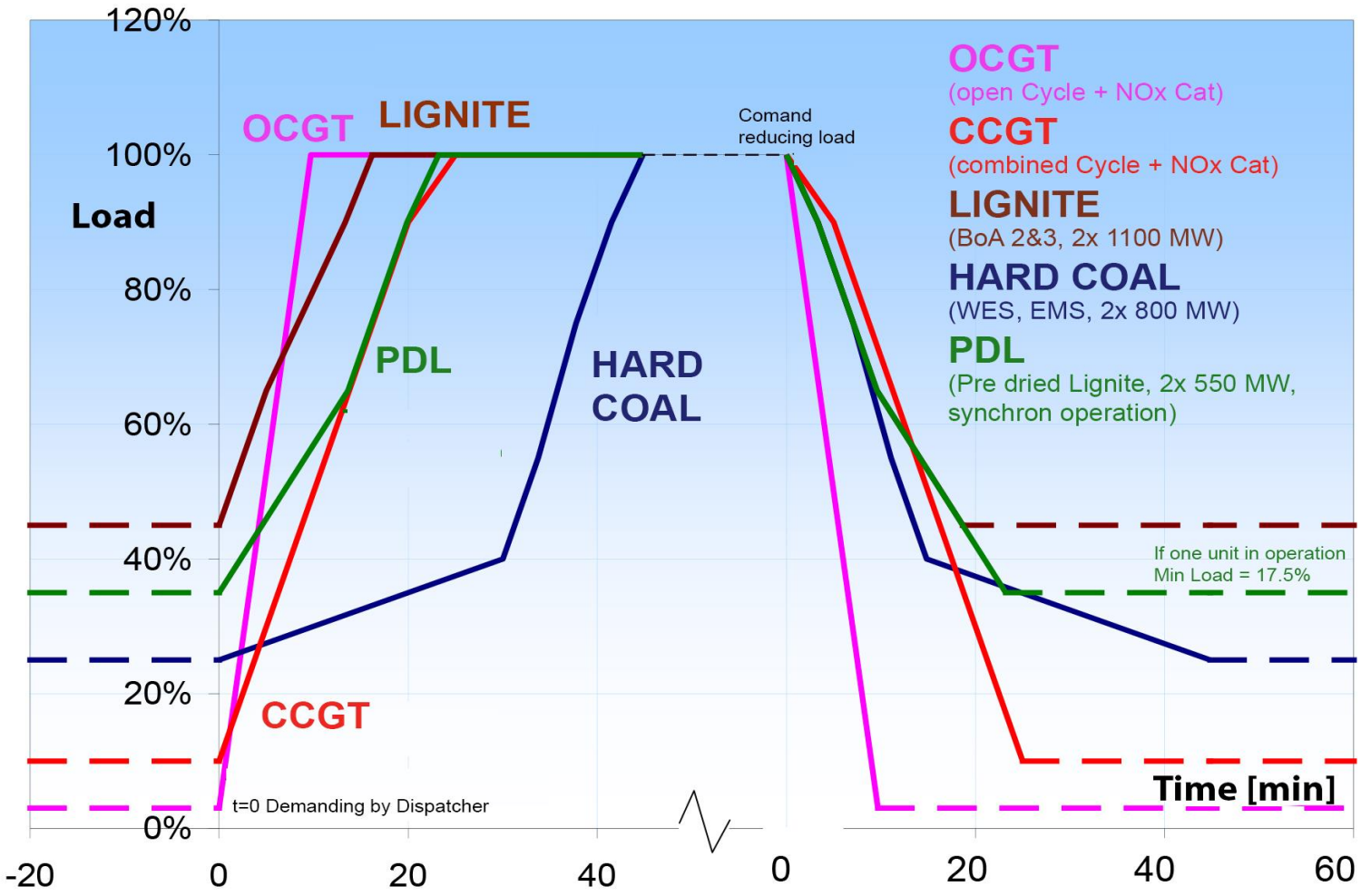
Dynamic

> high operational gradient (load change speeds)
> short start-up minimum and nominal load
> short minimum downtime

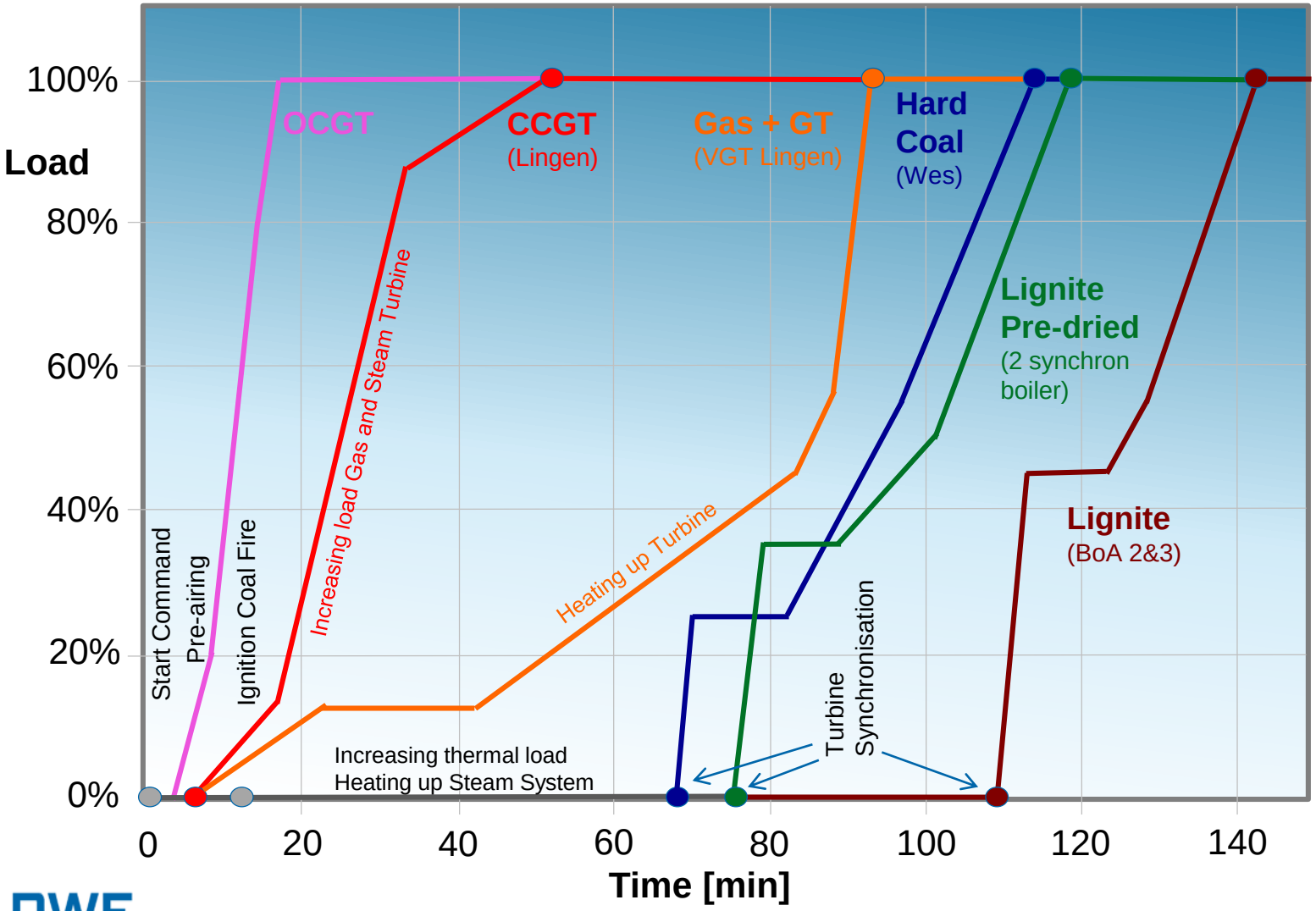
Operational

> high starting number and load cycles at reduced Lifetime consumption
> lowest possible minimum load at high efficiency
> uniform, high efficiency curve across the load

Load Change Rate between minimum and nominal load



Load Change Rate - Cold Start



Short Minimum Downtime

Current Design

	With high Life Time reduction	With low Life Time reduction
CCGT	<< 30 min run out of the GT is the time leader	
Hard Coal	min. 30 min	< 240 min
Lignite	min. 30 min	< 240 min
Pre-dried Lignite	min. 30 min	< 240 min

- After command " fire off " measures must be carried out to bring the unit back into the " Ready " operating state. Hereby, the condition of the unit must be considered.
- Time leader in coal firing is the pre-ventilation due to security.
- Gentle cooling of the steam generator before air purging, which increases the life time but it is time-consuming. This measure avoids the temperature stresses.
- Lifetime consumption is considered in the design of our plants.

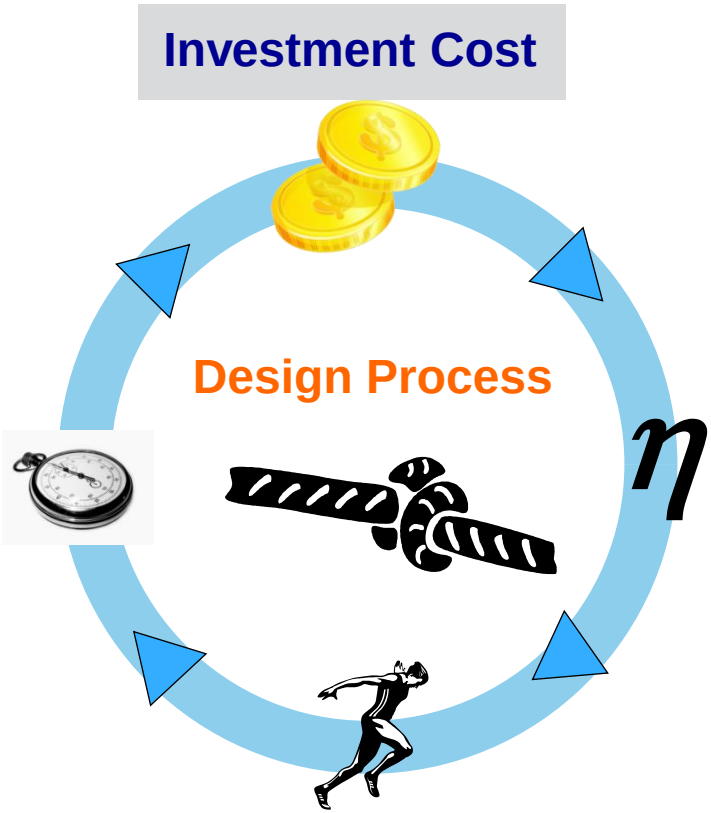
Design Specifications new Power Plants
Example: Power Plant Westfalen

Operational Characteristics (Hard Coal, 800 MW)

- Base and medium load
- Plant runs through in times of low demand
- Minimum load 25 - 30%, 7,500 operation hours per year

Operation Mode	Per year	40 years
Cold Starts	6	240
Warm Starts	42	1,680
Hot Starts	84	3,360
Load Cycles	1,200	48,000

Future design priorities

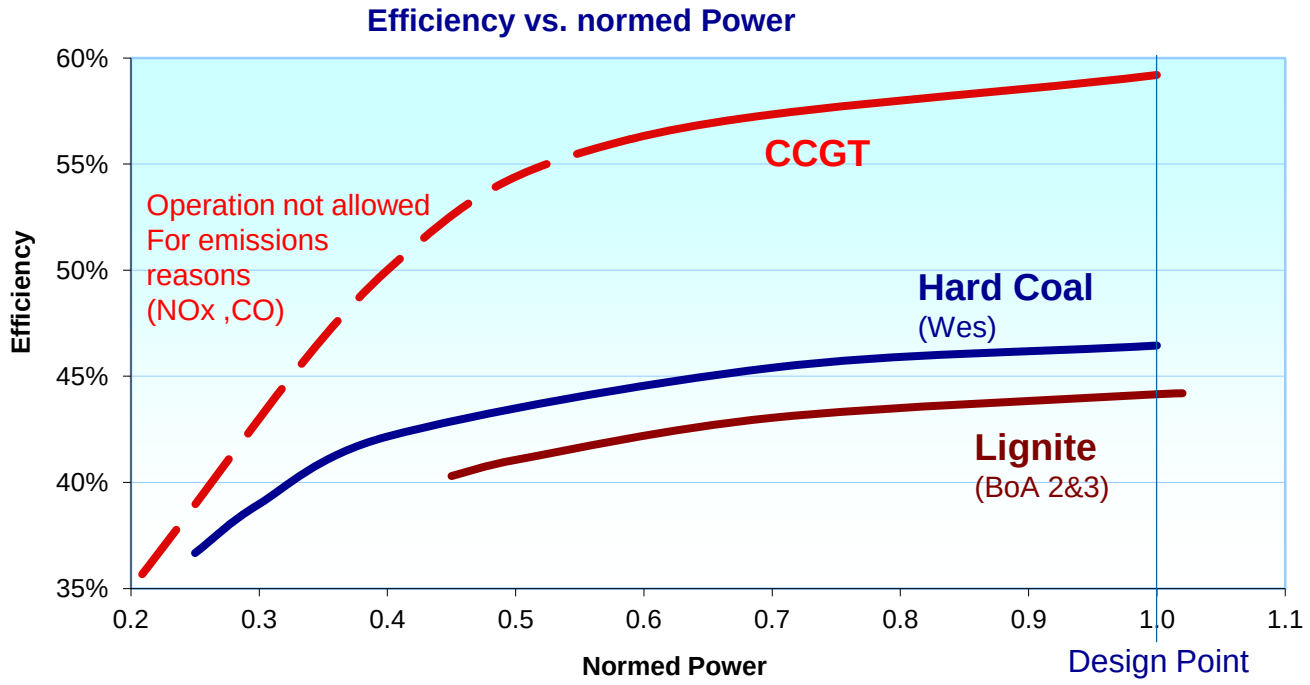


The prioritization is based on the value of flexibility !

Efficiency of units at Part Load

The Plant is designed for the rated nominal operation point (optimum efficiency)

- Efficiency drop occurs in part load operation for all plants
- Operating efficiency decreases with frequent part load trips



Determined Potentials to increase the Flexibility

Plant	CCGT	Coal fired
Operating gradient	Potential ± 7 %	Potential ± 6 %
Measures	▪ Wall thickness reduction ▪ Once through steam generator	▪ Separation of milling and combustion process ▪ Wall thickness reduction ▪ Matched components design
Minimum Load	Potential approx. 0% load	Potential approx. 20% load
Measures	▪ NOx- Catalysator ▪ Post-combustion of CO	▪ Increasing the number of mills ▪ Improving the milling process

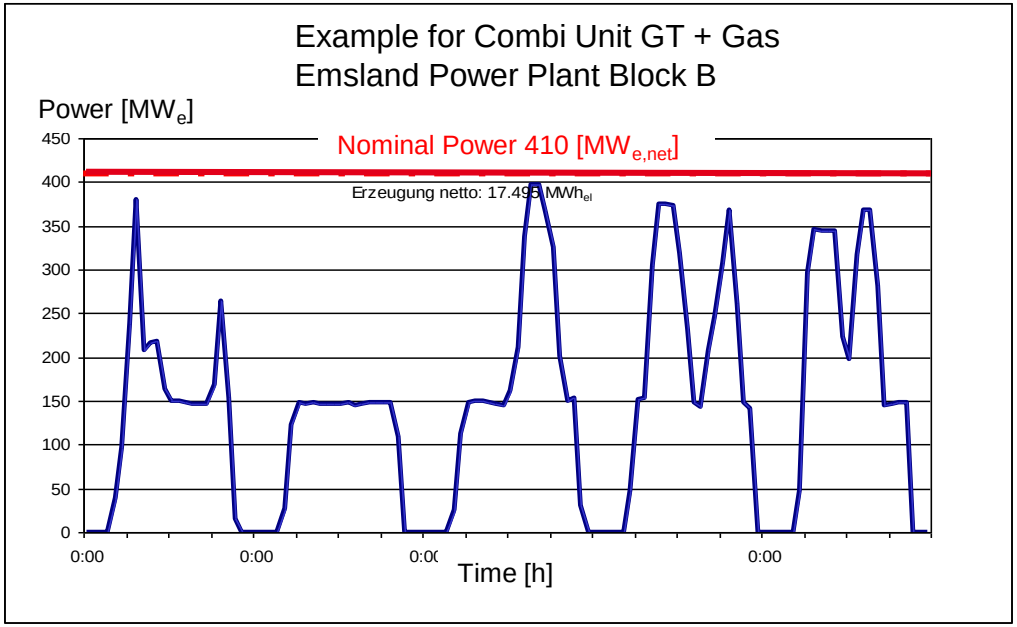
Flexibility improvement by Optimizing the Power Plant Portfolio - Example Combi Unit (Gas + GT)

Existing Unit

- Only steam turbine Controlled (GT drives at nominal load, 55 MW)
- From > 150 MW operating gradient about 40 MW / min.
- Full flexibility of the Plant is not accessed today from the dispatcher, although the plant is in the secondary control mode

Modernisation

- Replacement of the V93 turbines by 2 Trent aero derivative turbines allows higher gradient



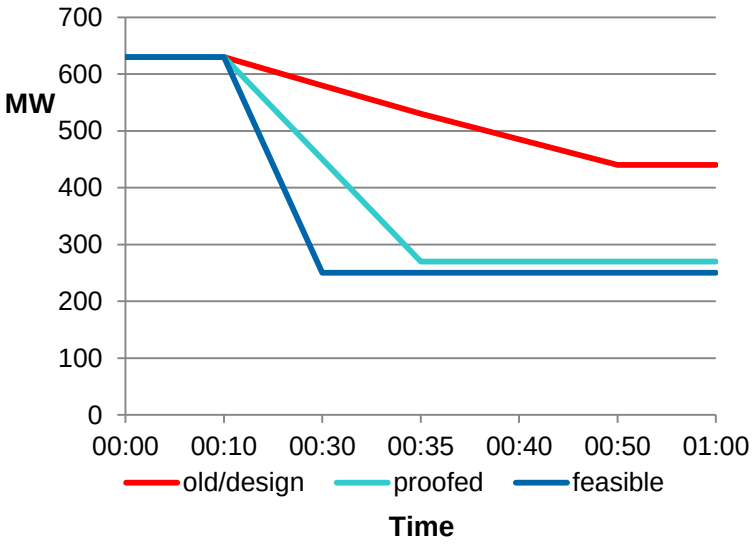
I&C Optimisation makes modern Power Plants even faster

Lingen CCGT (875 MW)

- Increase in start-up gradient 4 MW/min → 12 MW/min

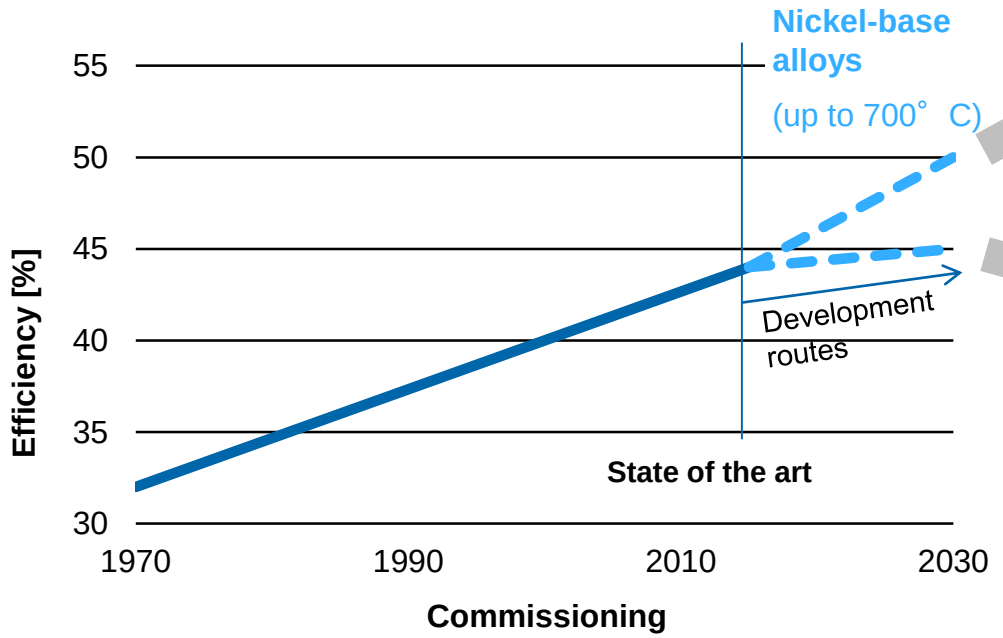
Neurath lignite-fired plant (600 MW)

- Reduction in minimum load of 20%-points
- Increase in load change rate 5 MW/min → 15 MW/min



New advanced Materials allow Increase in Flexibility or Efficiency

Efficiency development of lignite-fired plants



High efficiency
- Increase in steam parameters for newbuild power plants (700° C power plant)

High flexibility
- Constant steam parameters in existing plants and newbuilds (600° C live steam temperature)

Use of nickel-base alloys depends on operating conditions of future power plants

R&D Activities related to Flexibility Increase

- New materials for thin-walled flexible components
- New measurement methods and IT based monitoring to assess the life consumption to avoid damage of highly stressed components
- Predictive Maintenance: monitoring of components using Big Data
- Temporary electricity storage, when the produced electricity from conventional power plants is not required
- New combustion systems for lignite based dry lignite in order to increase the flexibility

THANK YOU VERY MUCH FOR YOUR ATTENTION