

Flexibility of new and optimized fossil fired Power Plants

**VGB Flexibility Workshop – IGEF Study Tour
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What does Flexibility mean?

High flexibility can be described as follow:

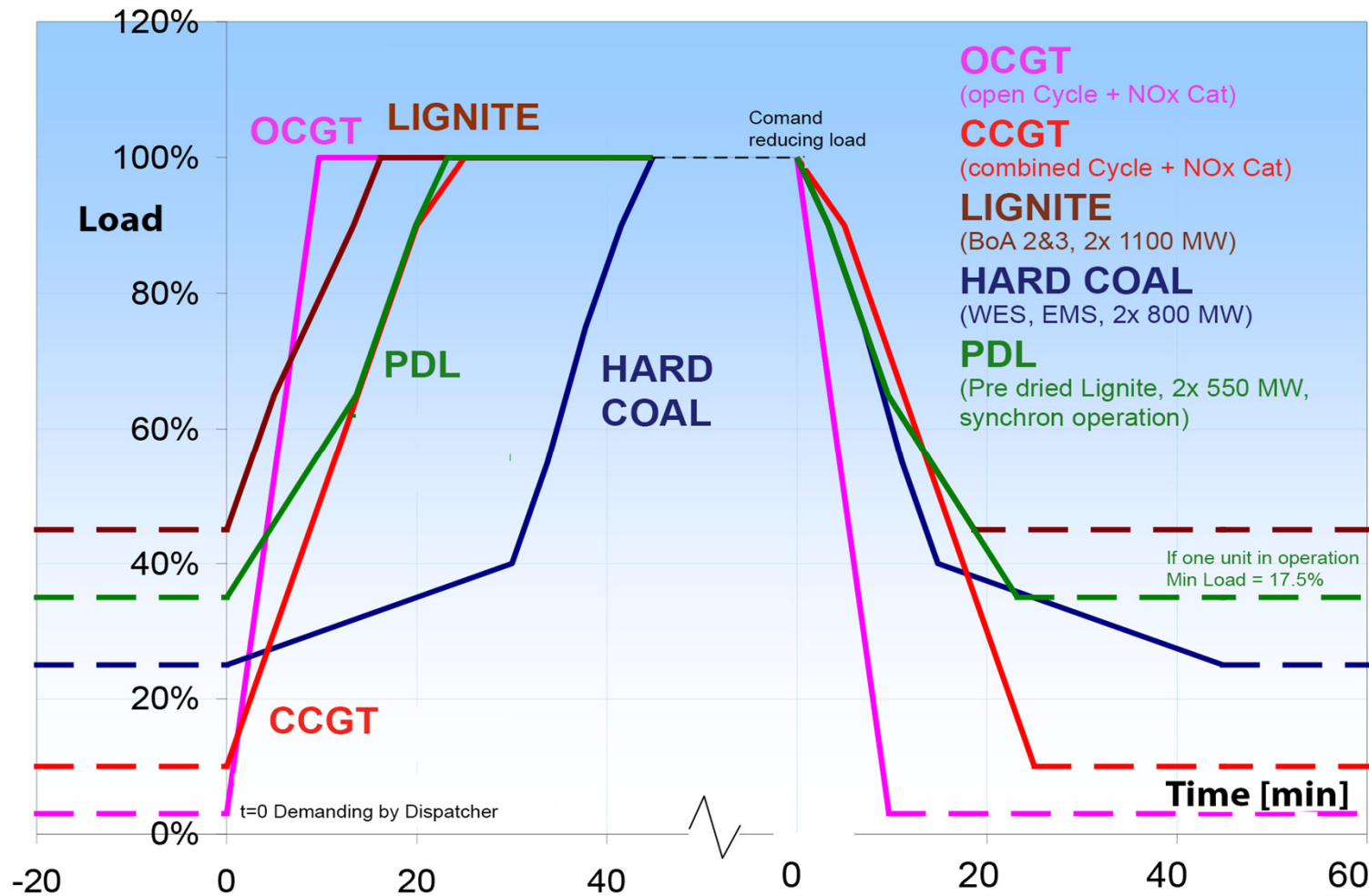
Dynamic

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

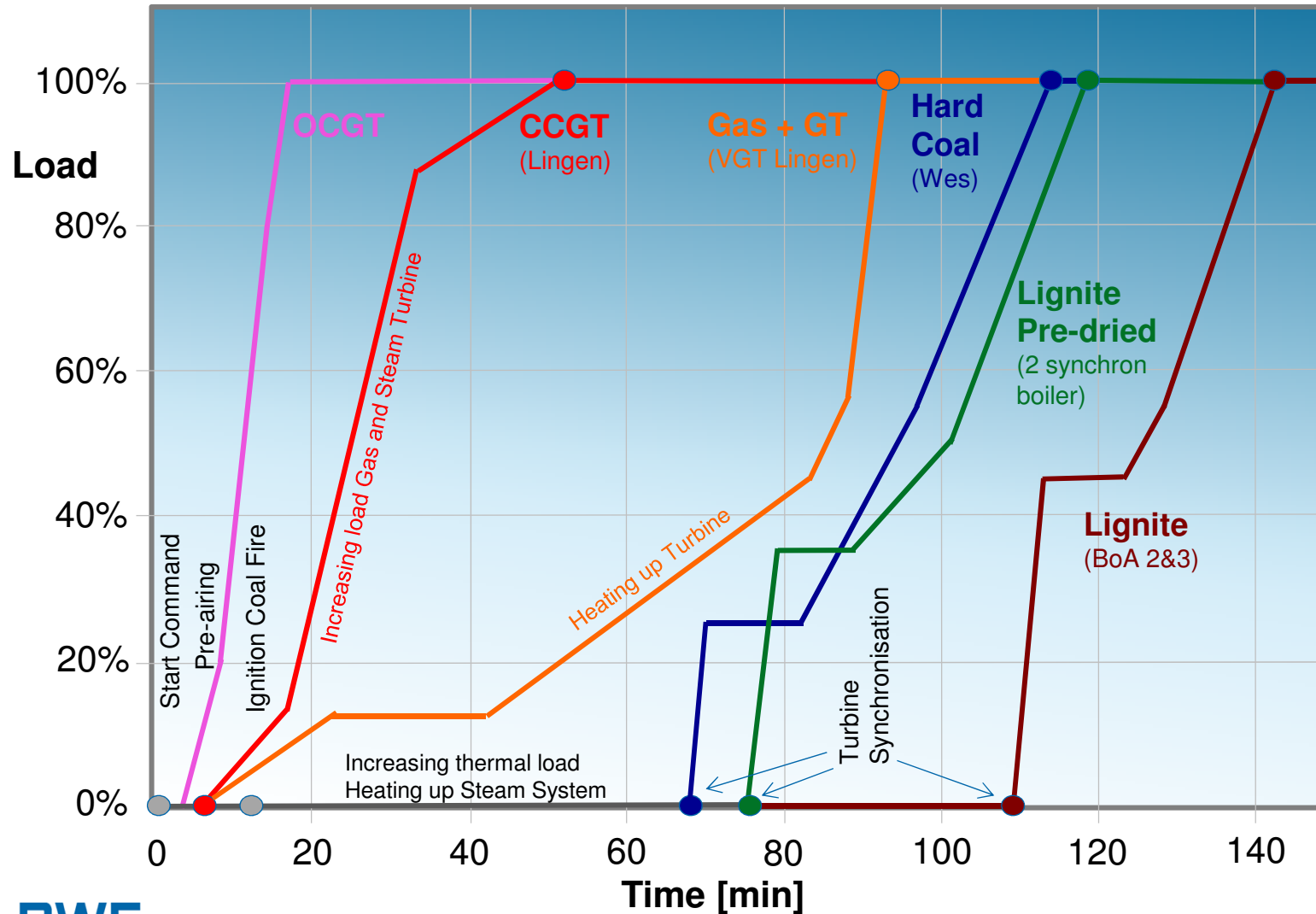
Operational

- > 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 <u>high</u> Life Time reduction	With <u>low</u> Life Time reduction
CCGT	<< 30 min <small>run out of the GT is the time leader</small>	
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

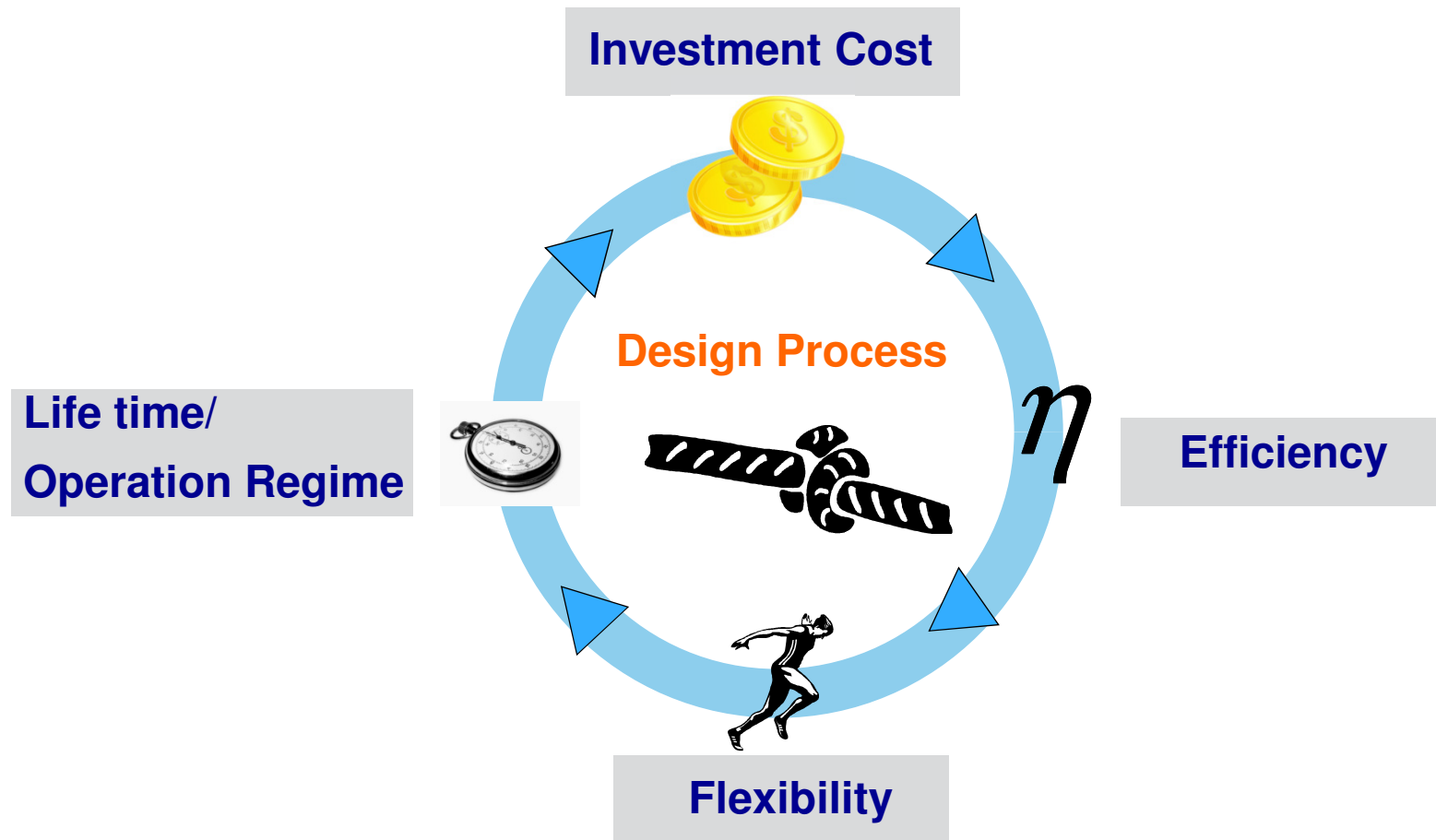
Example: Westfalen

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 !*

Potentials to increase the Flexibility

Plant	CCGT	Coal fired
Operating gradient	Potential $\pm 7\%$	Potential $\pm 6\%$
Measures	<ul style="list-style-type: none"> ▪ Wall thickness reduction ▪ Once through steam generator 	<ul style="list-style-type: none"> ▪ Separation of milling and combustion process ▪ Wall thickness reduction ▪ Matched components design
Minimum Load	Potential approx. 0% load	Potential approx. 20% load
Measures	<ul style="list-style-type: none"> ▪ NOx- Catalysator ▪ Post-combustion of CO 	<ul style="list-style-type: none"> ▪ Increasing the number of mills ▪ Improving the milling process

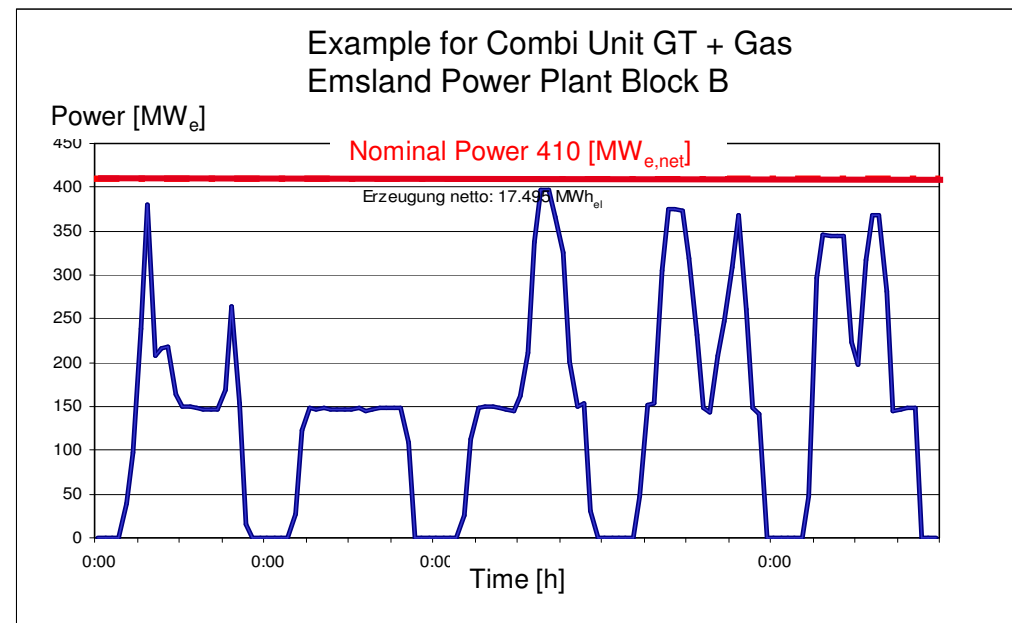
Flexibility improvement by Optimizing the Power Plant Portfolio - Example Combi Unit (Gas + GT)

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

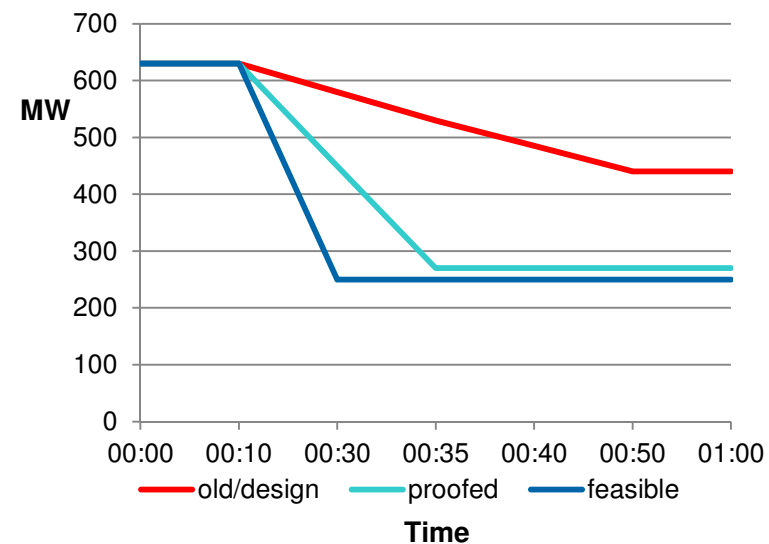
Lingen CCGT (875 MW)

- > Increase in start-up gradient
4 MW/min \rightarrow 12 MW/min



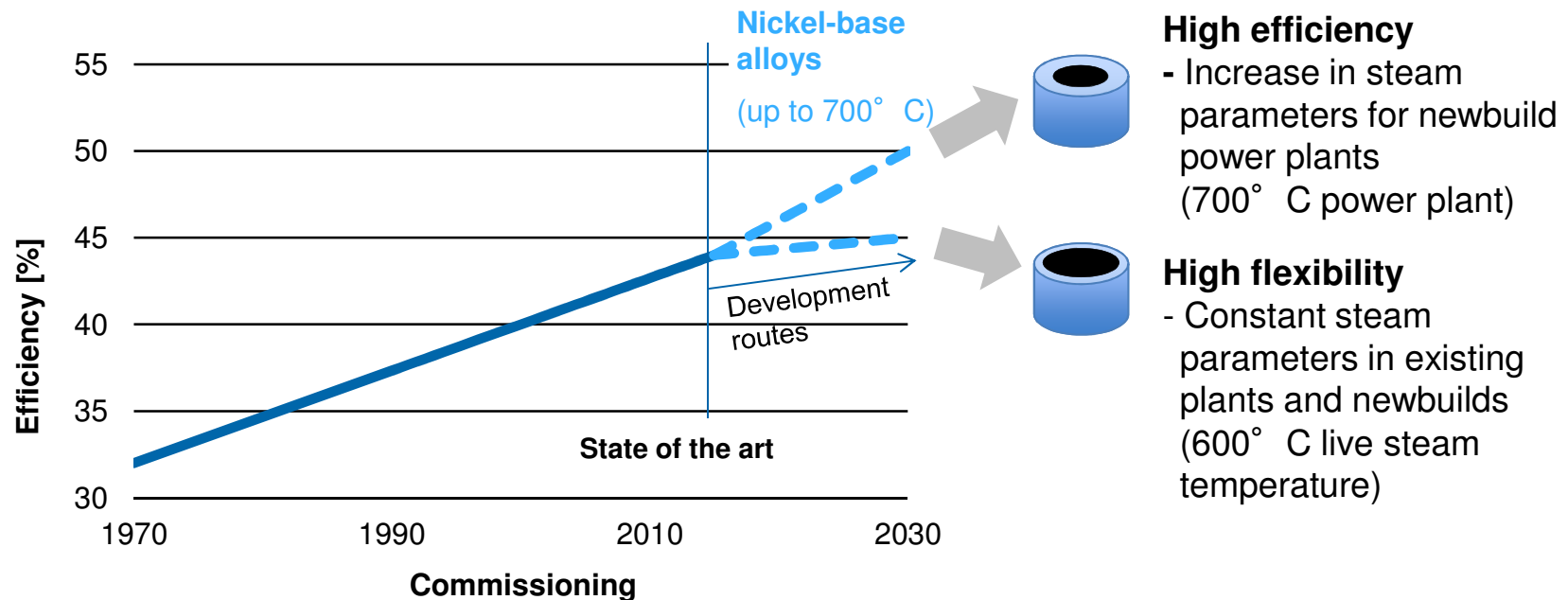
Neurath lignite-fired plant (600 MW)

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



New advanced Materials allow Increase in Flexibility or Efficiency

Efficiency development of lignite-fired plants



➔ 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

