

VGB-igef Workshop “It’s all about Flexibility”

Adapting lignite power plants to new market conditions

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Agenda

1 Introduction of lignite business in Eastern Germany

2 Market conditions under framework of “Energiewende”

3 Adaption of lignite assets to changing conditions

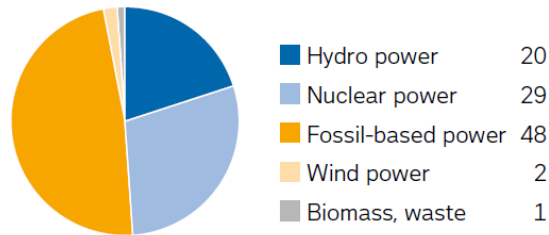
4 Brief summary

Vattenfall in Europe

- 100 %-owned by the Swedish state
- Value chain:
 - electricity and heat production, distribution and sales
 - Sales of gas
 - Energy trading

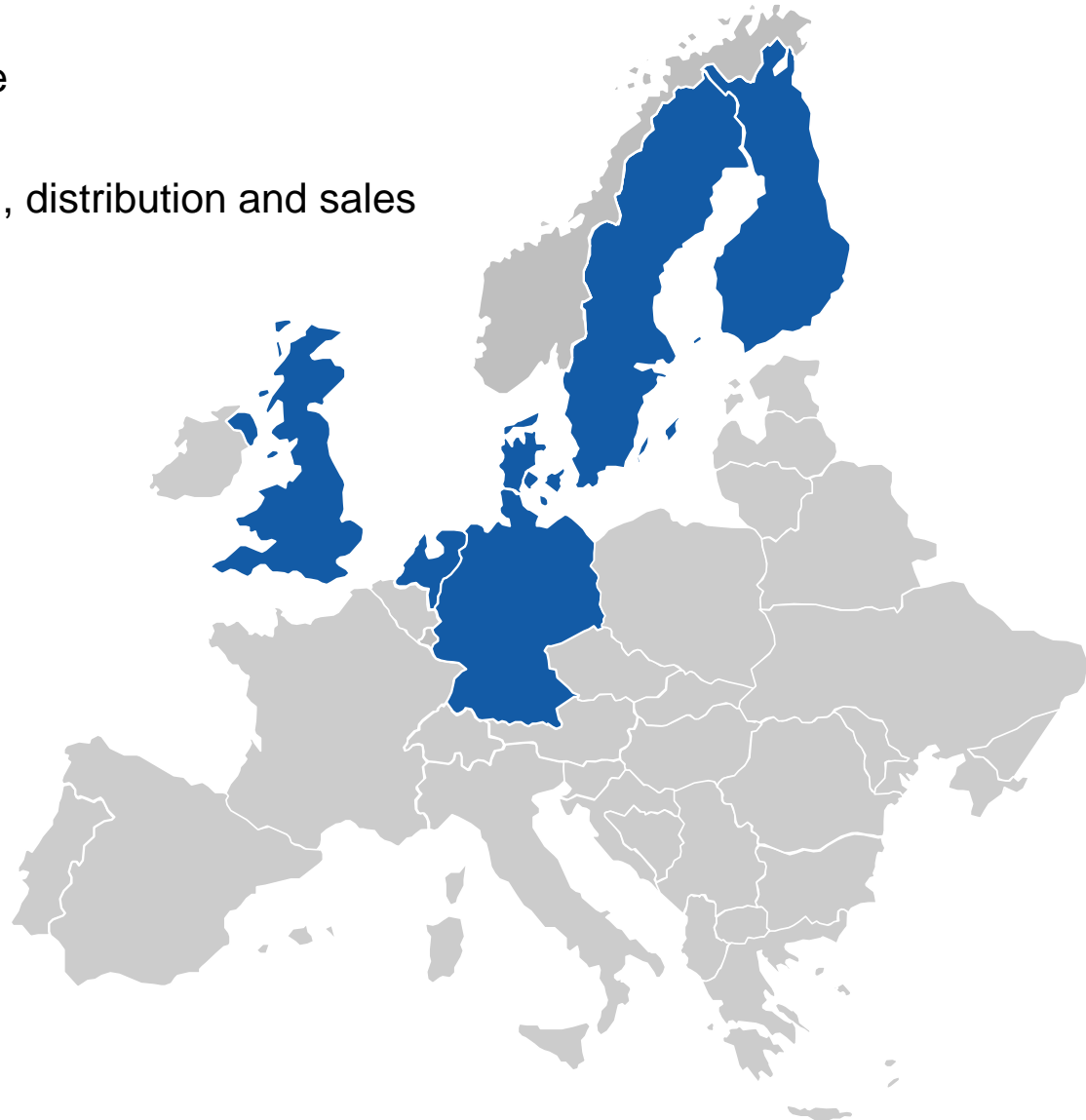
Facts and figures 2015:

- Electricity generation: 173.4 TWh



- Electricity sales: 197.2 TWh
- Sales of heat: 22.6 TWh
- Sales of gas: 50.7 TWh
- Employees: 28,567

Source: Vattenfall Annual and sustainability report 2015



Vattenfall's Transformation

Vattenfall's production mix in 2015



■ Fossil-based power, 49% ■ Nuclear power, 24%
■ Hydro power, 23% ■ Wind power, 3%
■ Biomass and waste, 1%

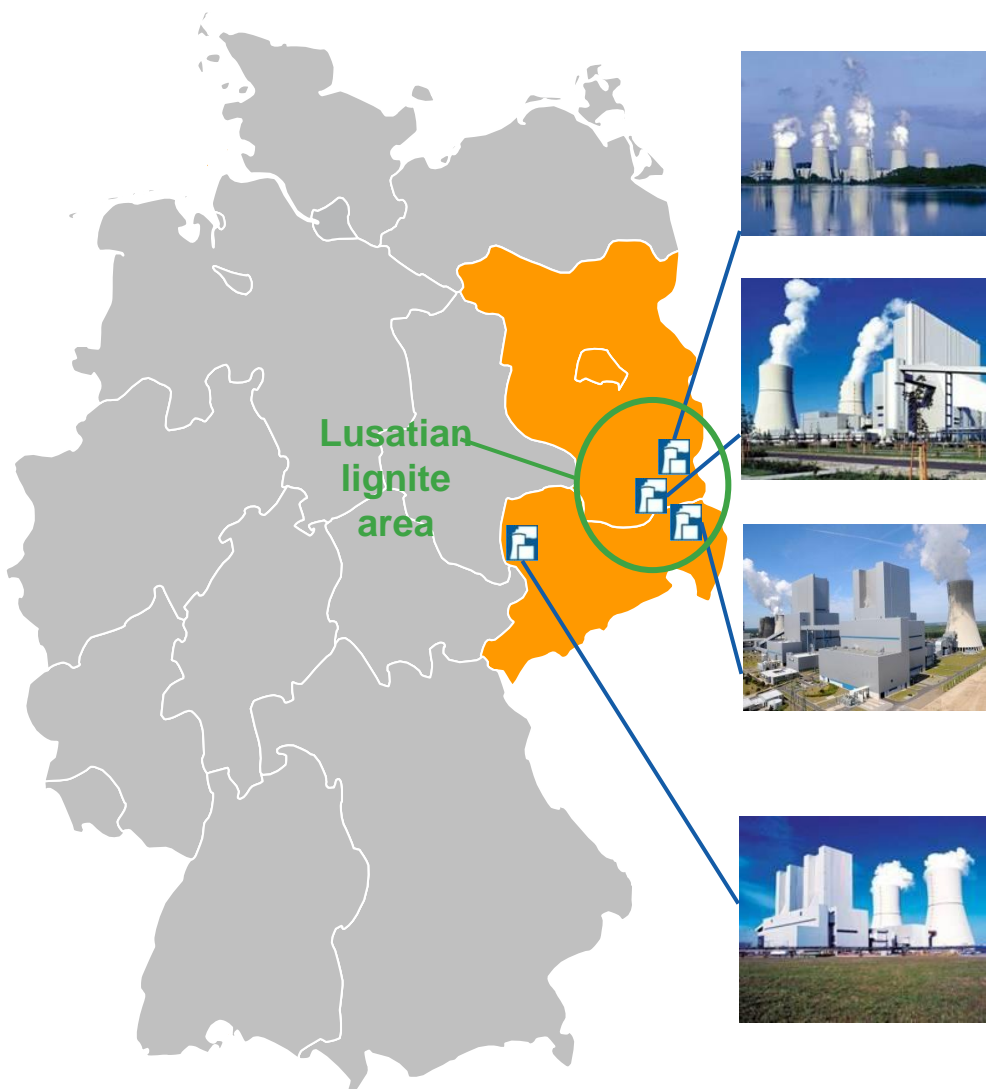
Vattenfall's production mix post lignite divestment¹



■ Fossil-based power, 24% ■ Nuclear power, 36%
■ Hydro power, 34% ■ Wind power, 5%
■ Biomass and waste, 1%

1) Based on total generated electricity in 2015

Locations of Vattenfall's lignite power plants



Lusatian
lignite
area



Power plant

Capacity

Jänschwalde

3,000 MW

6 blocks a 500 MW



Schwarze Pumpe

1,600 MW

2 blocks a 800 MW



Boxberg

2,575 MW

2 blocks a 500 MW

1 block 900 MW

1 block 675 MW



Lippendorf

920 MW

2 blocks a 920 MW

Total

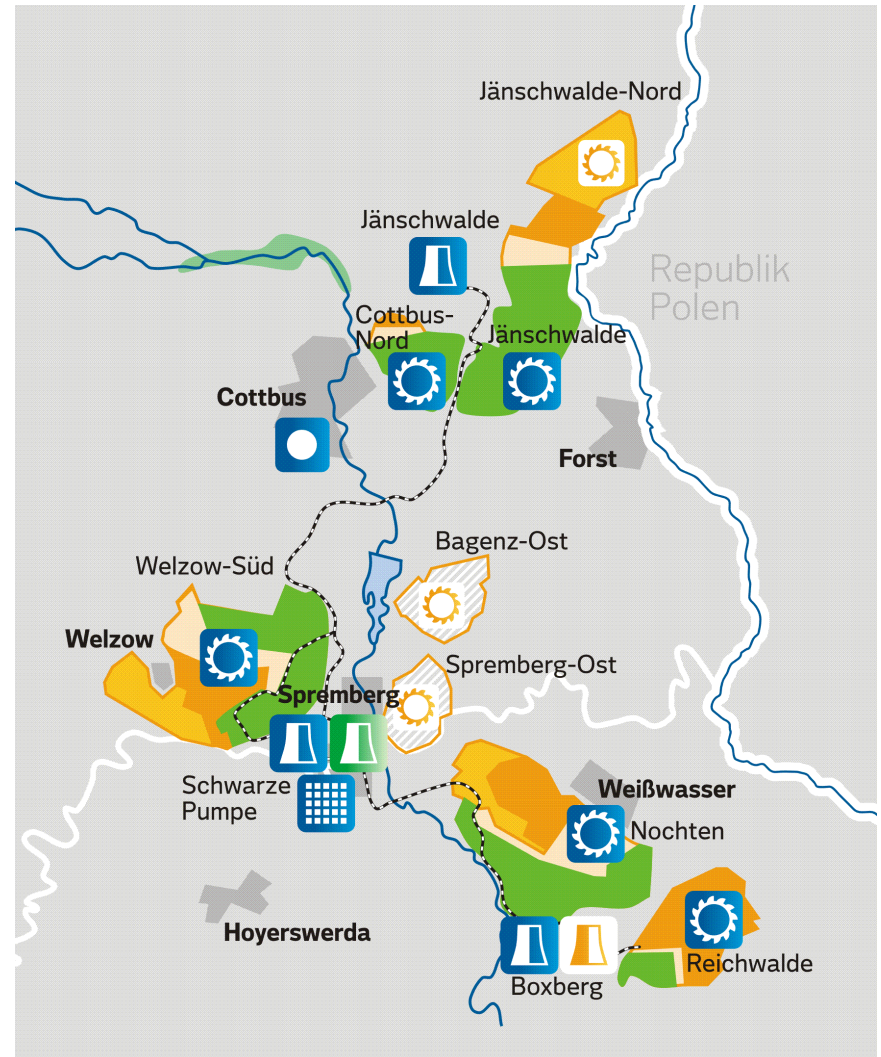
8,095 MW

Lusatian mining area – Locations and coal reserves

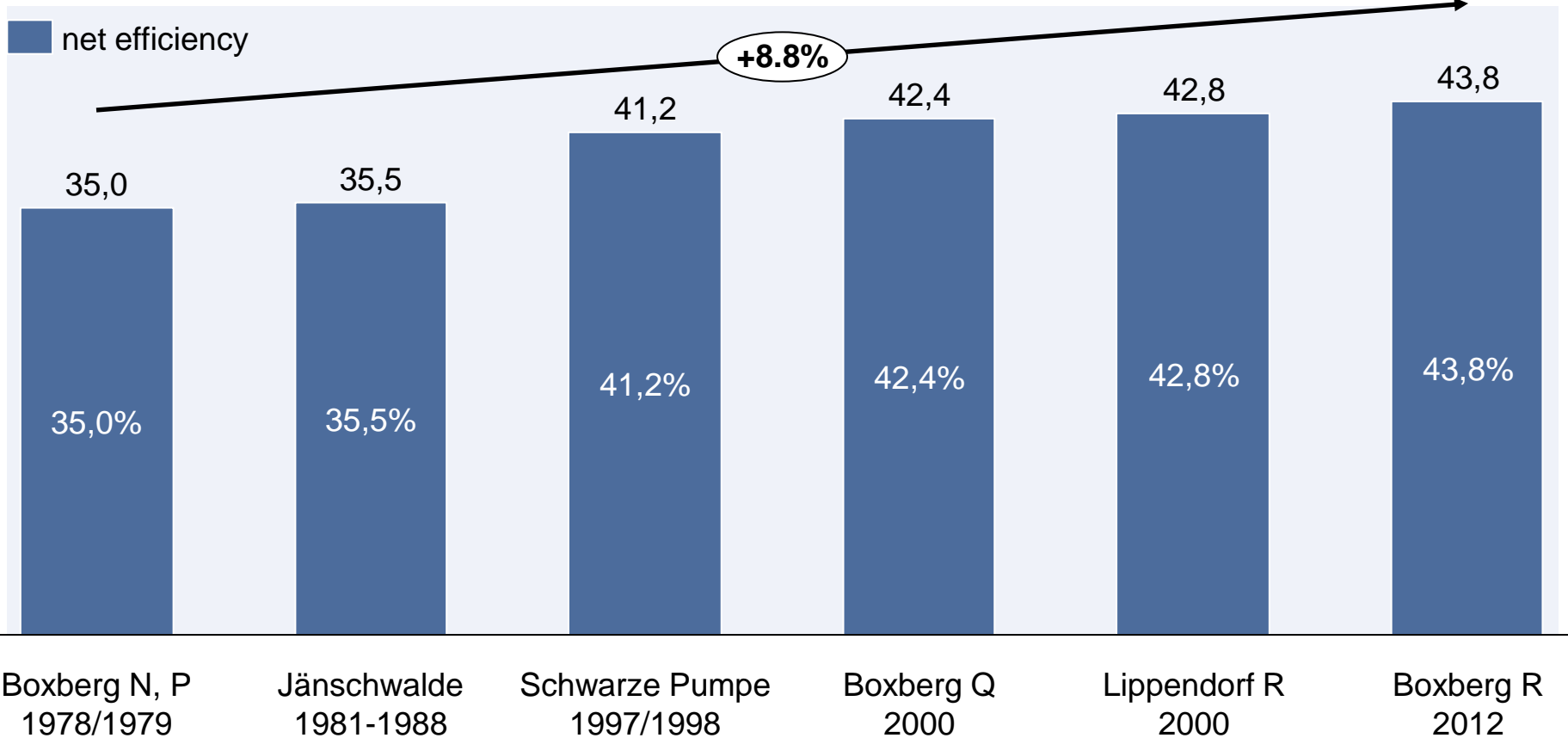


Approved mining fields	1,044 mill. t
Jänschwalde	91.1 mill. t
Cottbus-Nord	8.5 mill. t
Welzow-Süd	307.1 mill. t
Nochten	296.0 mill. t
Reichwalde	341.3 mill. t
Continuations	514 mill. t
Welzow-Süd, partial section II	204 mill. t
Nochten, mining field 2	310 mill. t
Total	1,558 mill. t
Future fields	690 mill. t
Jänschwalde-Nord	250 mill. t
Spremberg-Ost	220 mill. t
Bagenz-Ost	220 mill. t
Geological resources	~ 12 bill. t
Power plants (installed capacity)	7,175 MW
Jänschwalde	3,000 MW
Boxberg	2,575 MW
Schwarze Pumpe	1,600 MW

as of: 01.01.2014



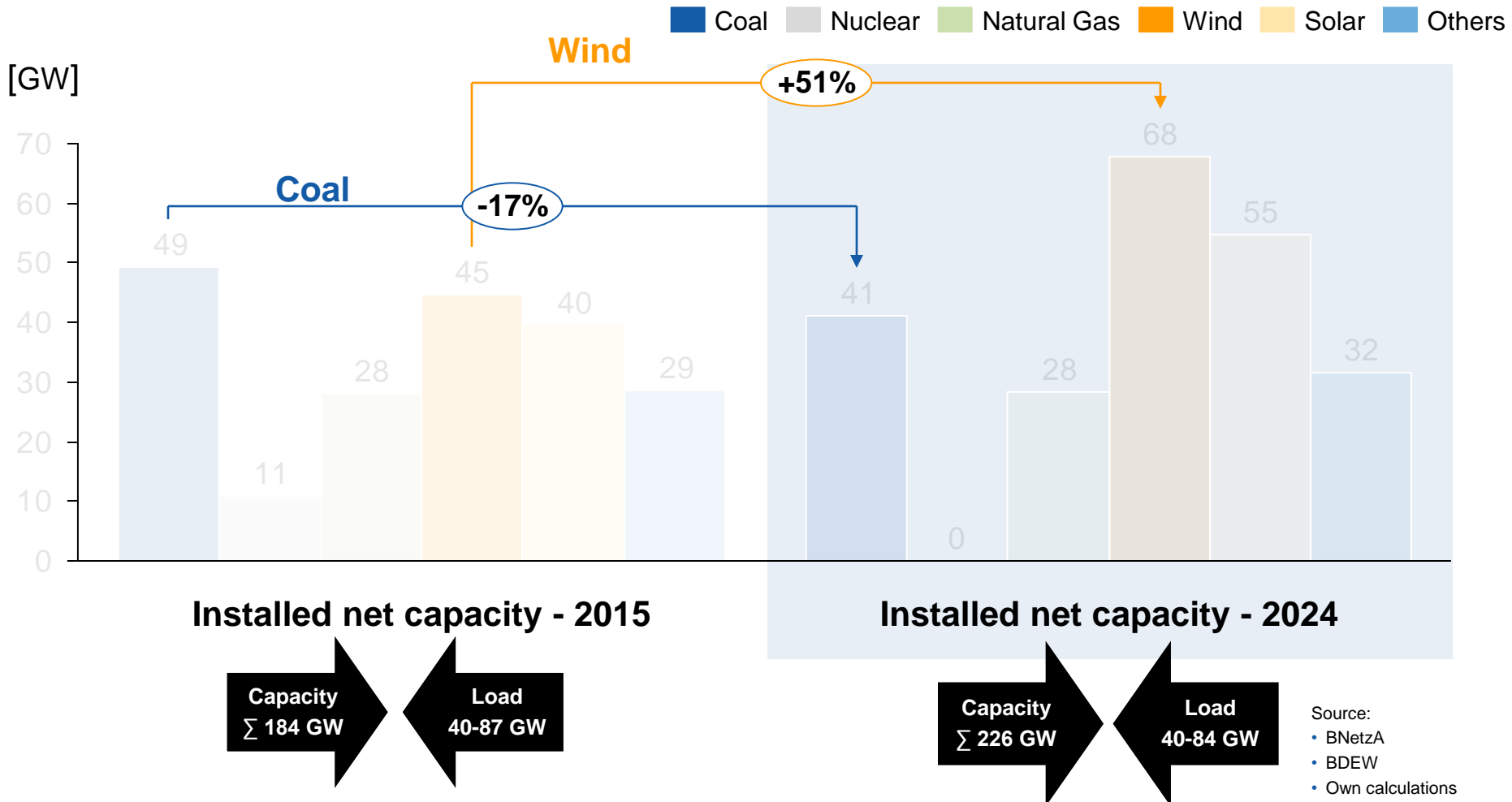
Development of net efficiency – Assets of BU Lignite



Adapting lignite power plants to new market conditions



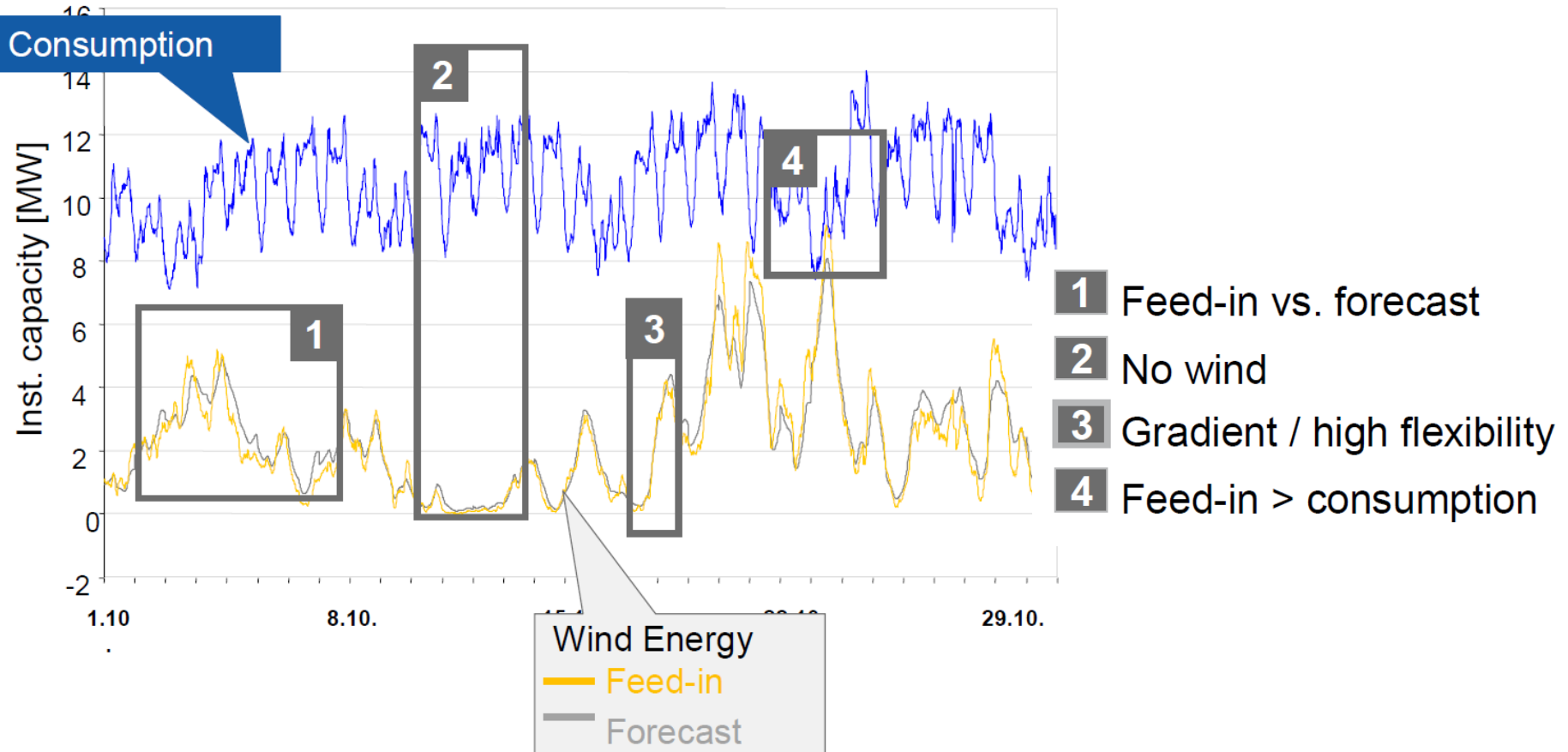
Development of installed capacity in Germany



The installed capacity in RES will double within the next 10 years. The demand instead will remain unchanged.

Changing of market conditions

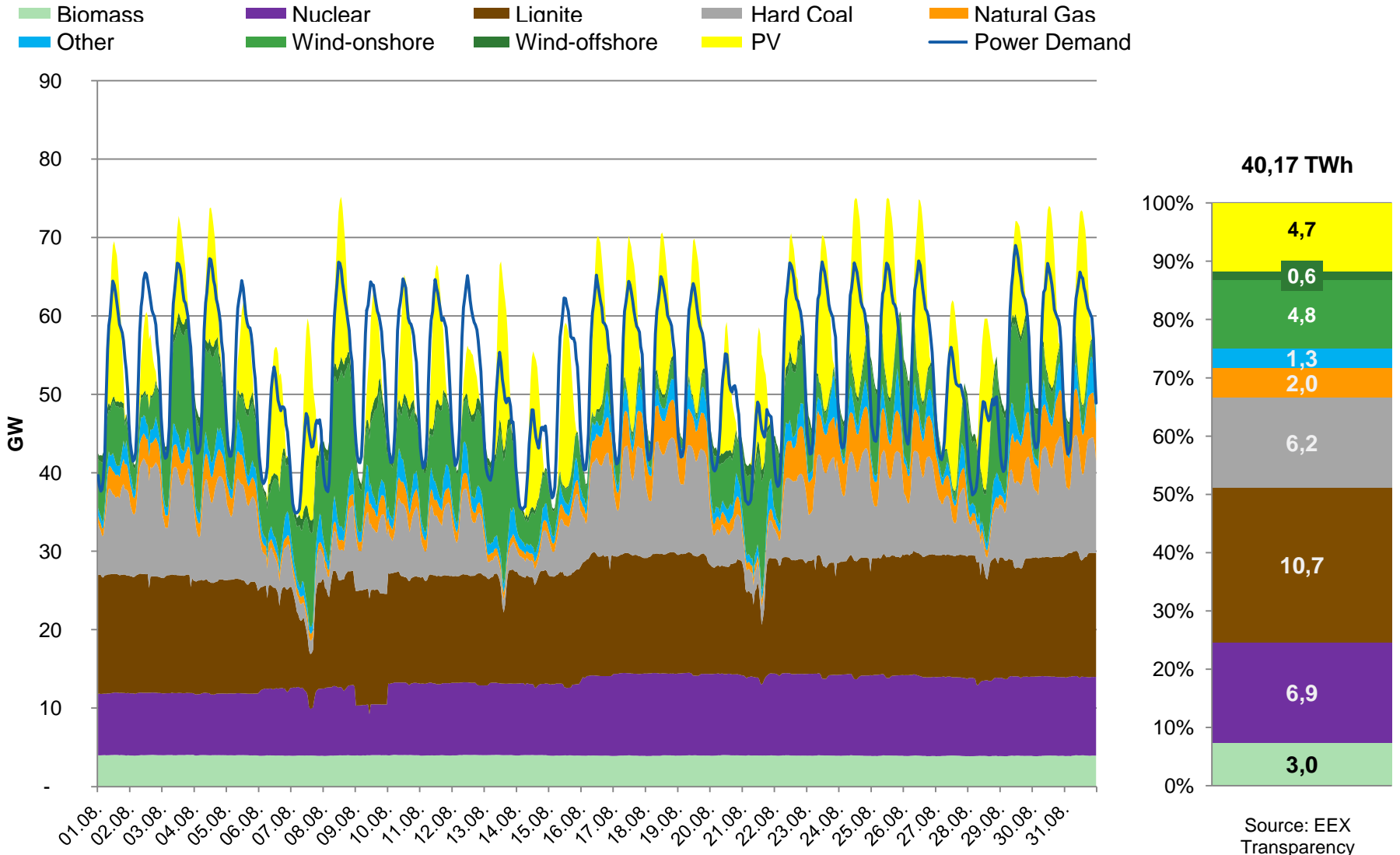
Load profile October 2015



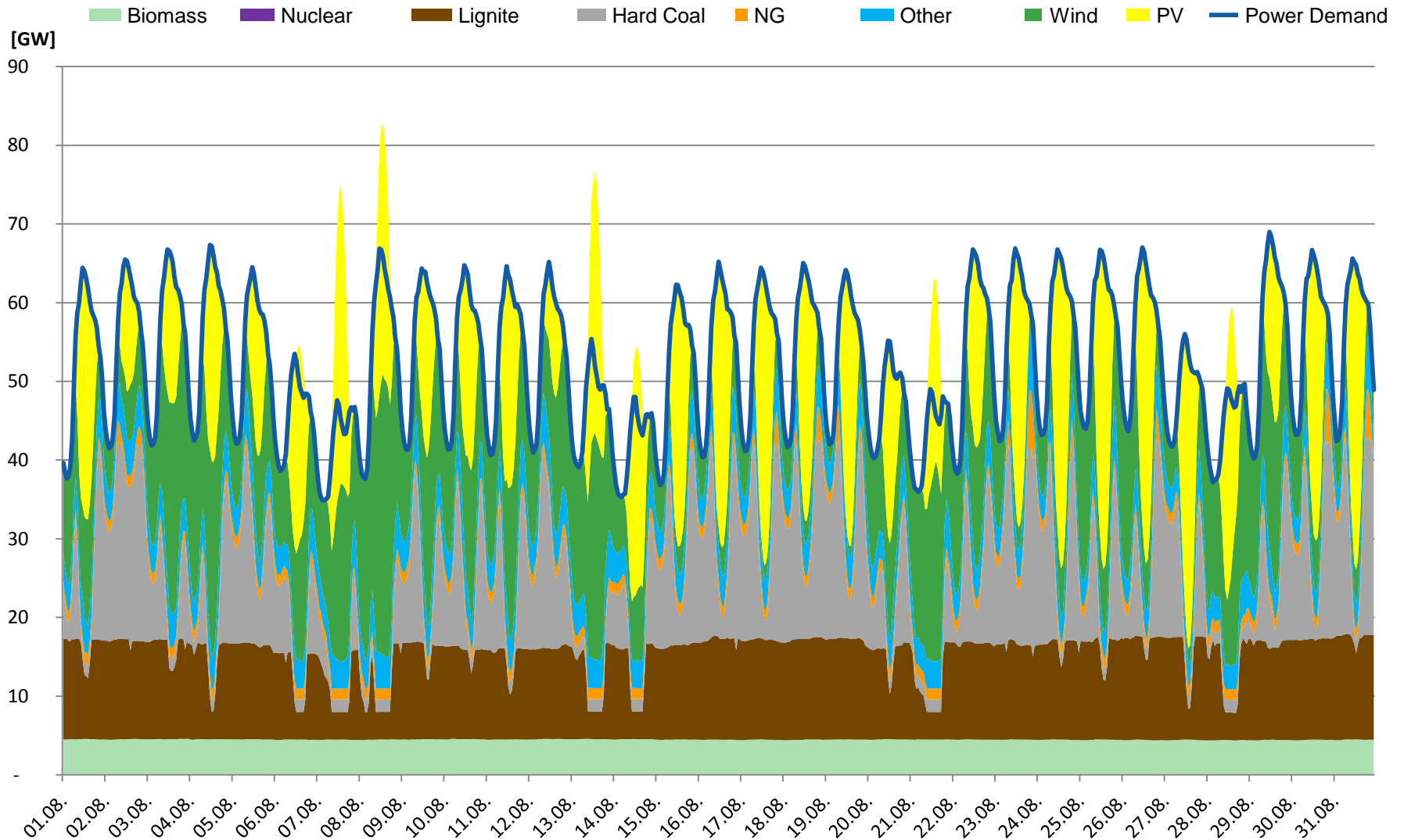
Data source: 50Hertz Transmission

Power Generation Mix August 2016 in Germany

real data



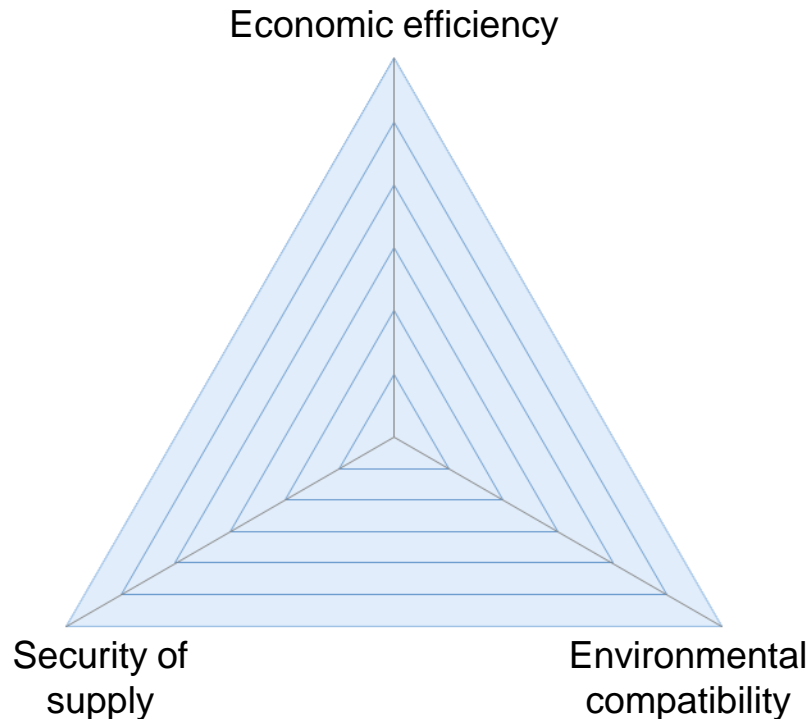
Projected Power Generation Mix August 2023 in Germany



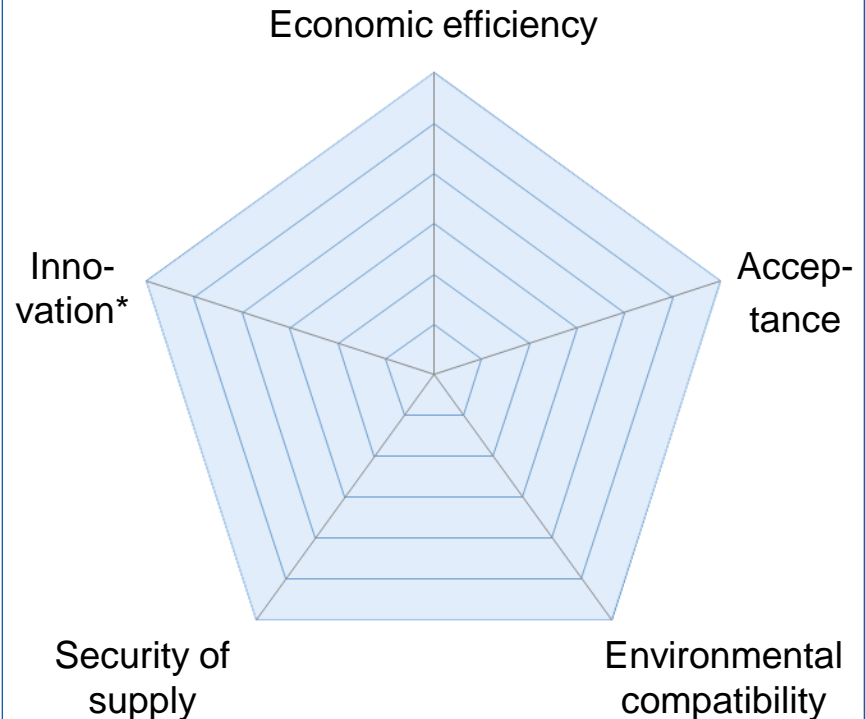
Source: In-house calculation

New Targets for power utilities

Old target triangle of the energy turnaround



New target pentagon of the energy turnaround

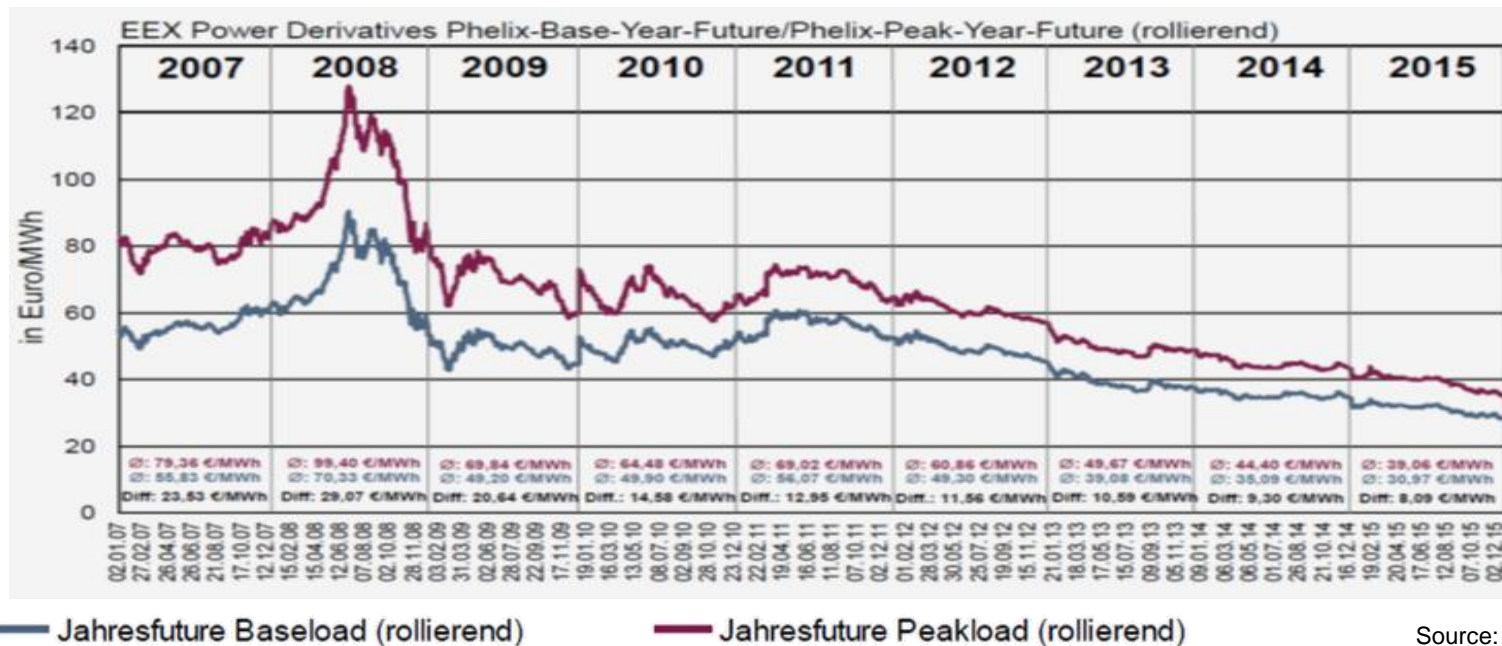


The German energy turnaround is a modernization project of the complete economy which is completely innovative. The energy supply companies need to deal with the higher complexity of the energy turnaround.

* (Load) flexibility as an important part of innovation

Source: BDI Energie-Navigator 2012

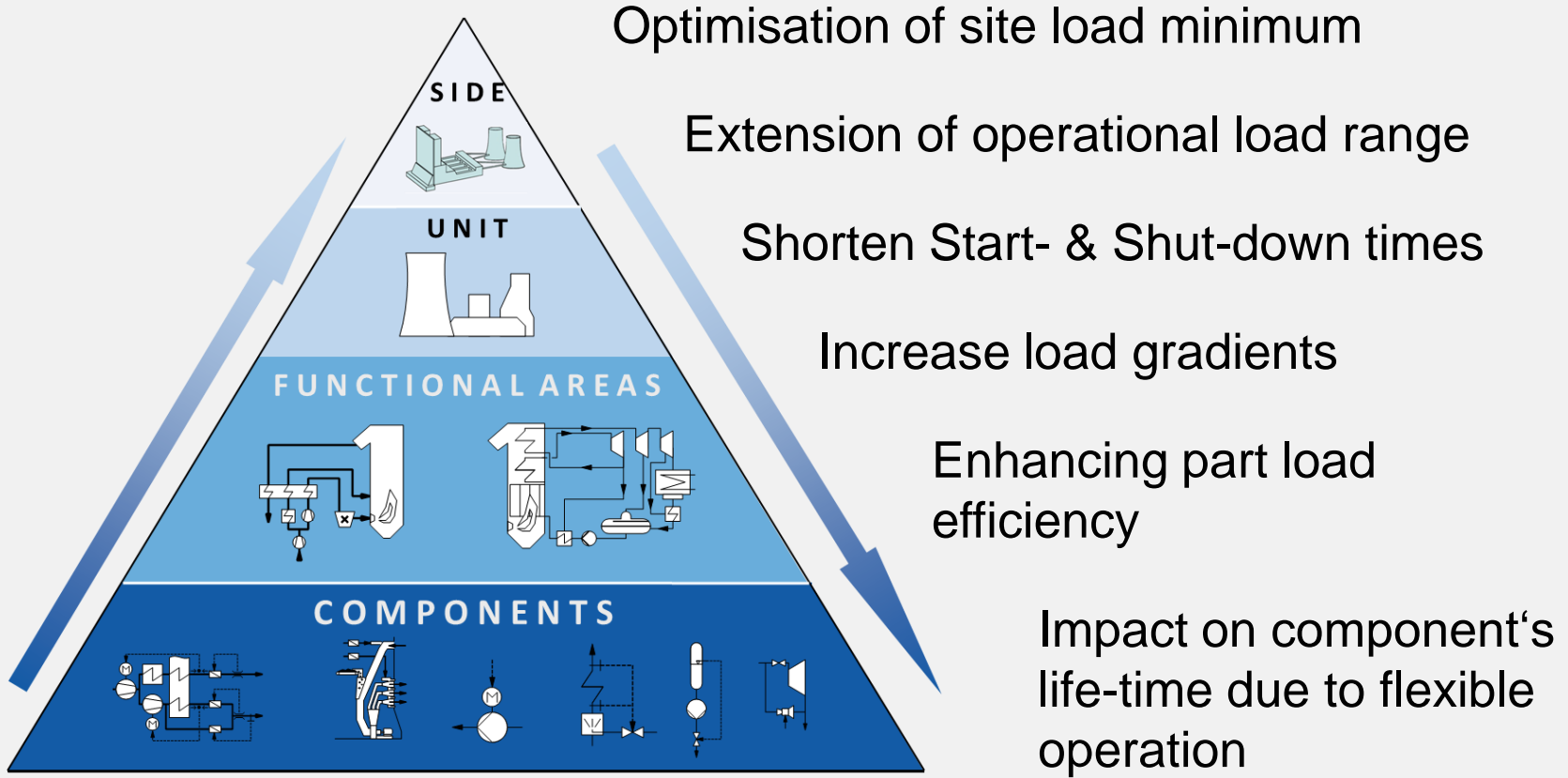
Impacts of Energy Turnaround on Energy Market



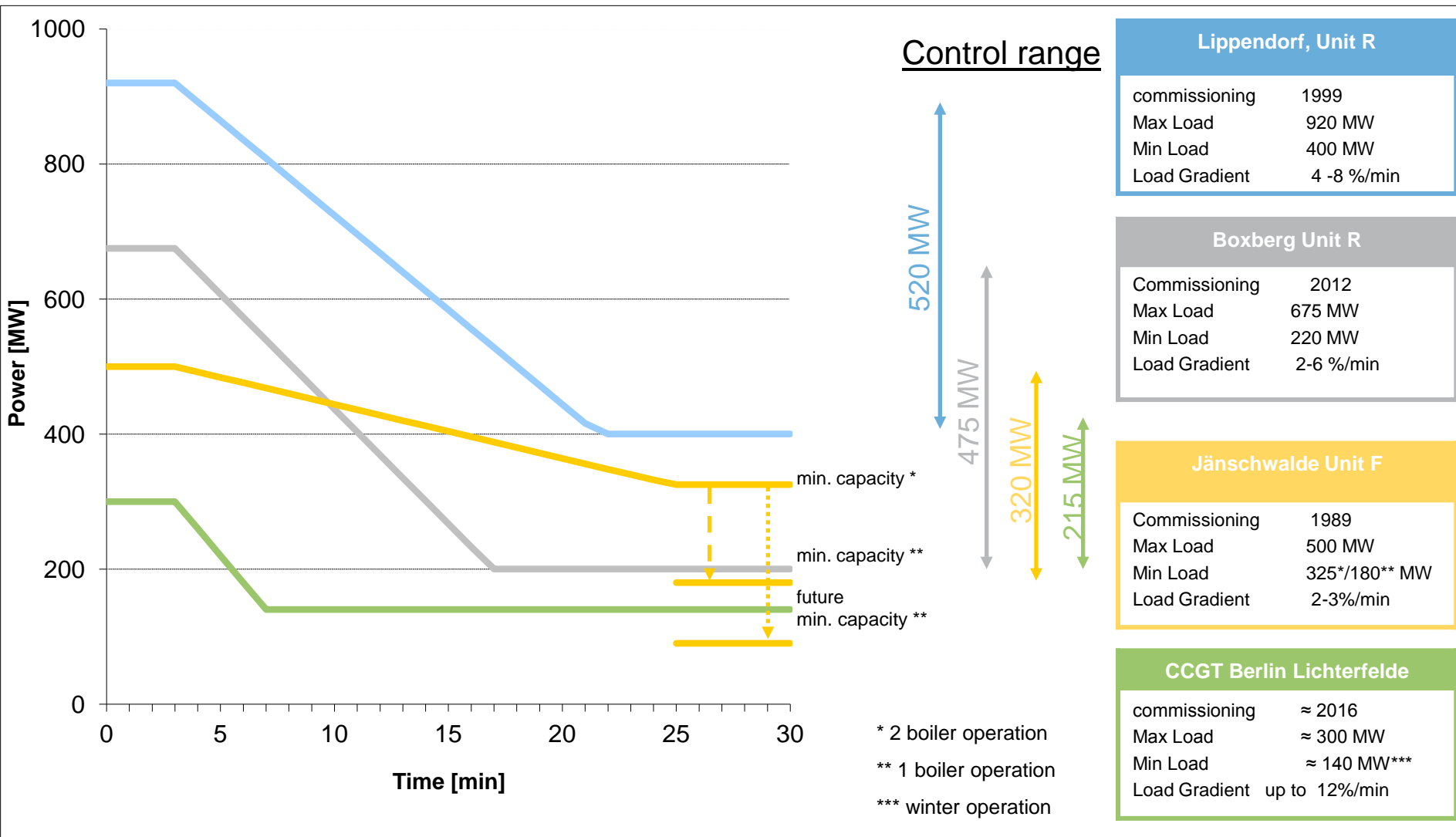
- Strong increase of renewable capacities caused falling energy prices on EEX
- Investments in grid and storage expansions as well as new backup capacities don't follow the increase of renewable capacities
- Conventional capacities have to adapt to the changing market conditions
- Conventional power plants (especially gas) lose more and more operating hours and therefore their profitability
- Regulatory uncertainty of energy industry (e. g. new laws regarding fees, taxes)

Increase Flexibility

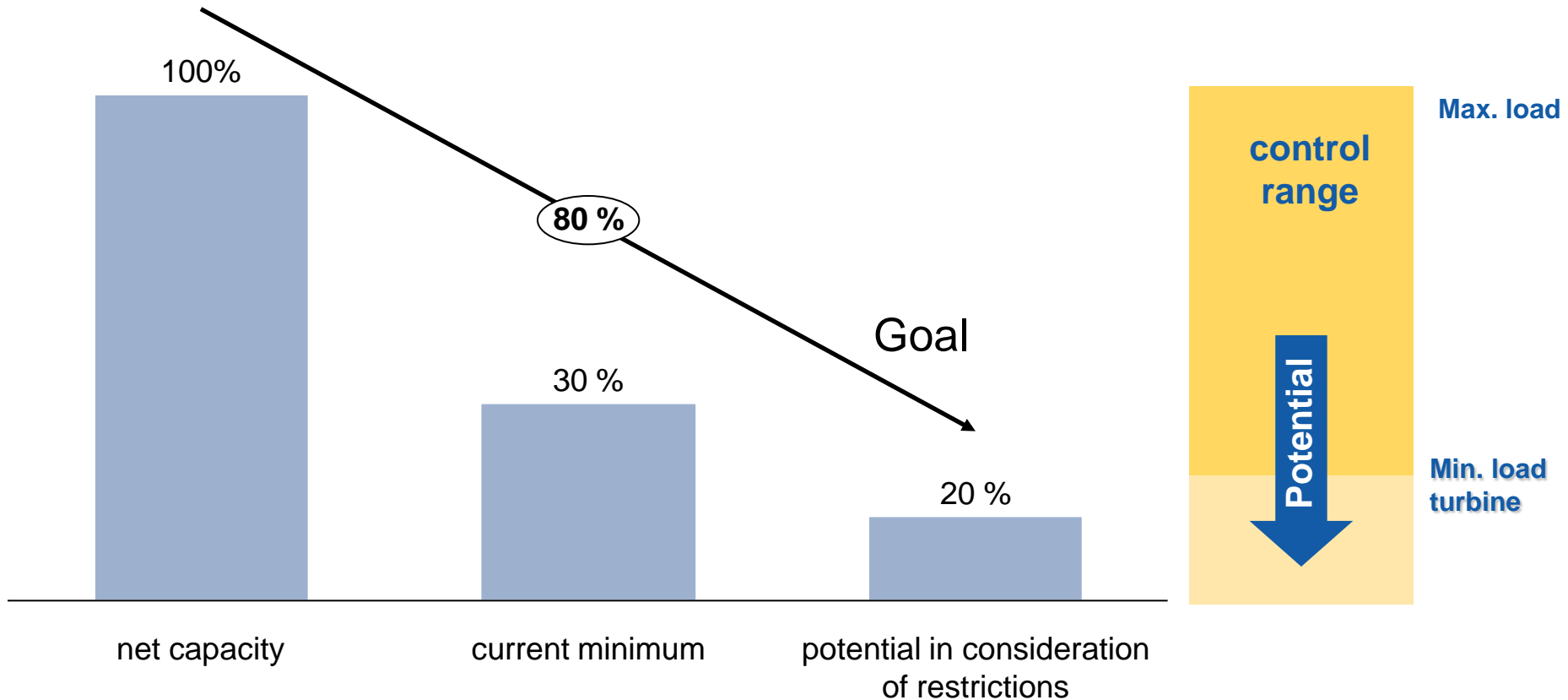
Requirements for Lignite Power Plants



Comparison – load flexibility of conventional power plants



Site minimum load of Power Plant

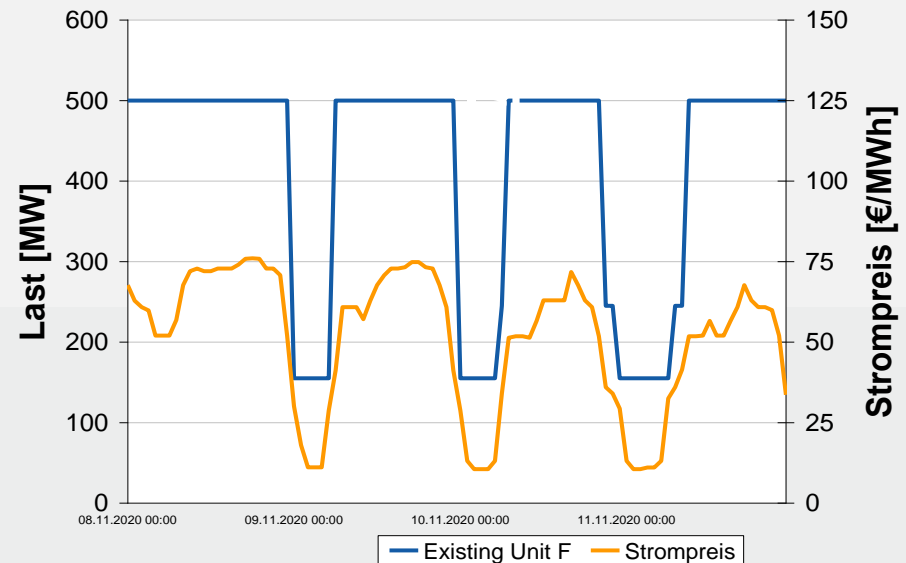
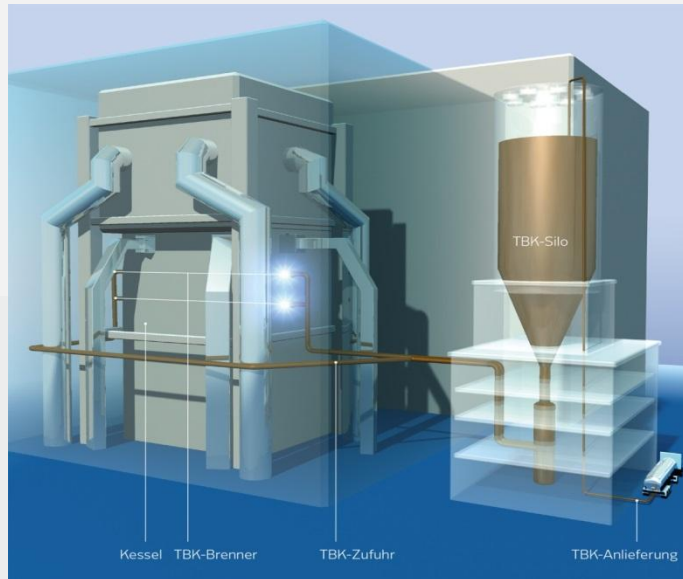


Reduction of the site minimum load by removal of restrictions in the power plants:

- creation of temporally alternative supply capabilities for district heating and process steam
- increase the flexibility: ⇨ increase load change speed
⇨ optimization of start-up and shut-down processes

Project “Dry Lignite Supplementary Firing”

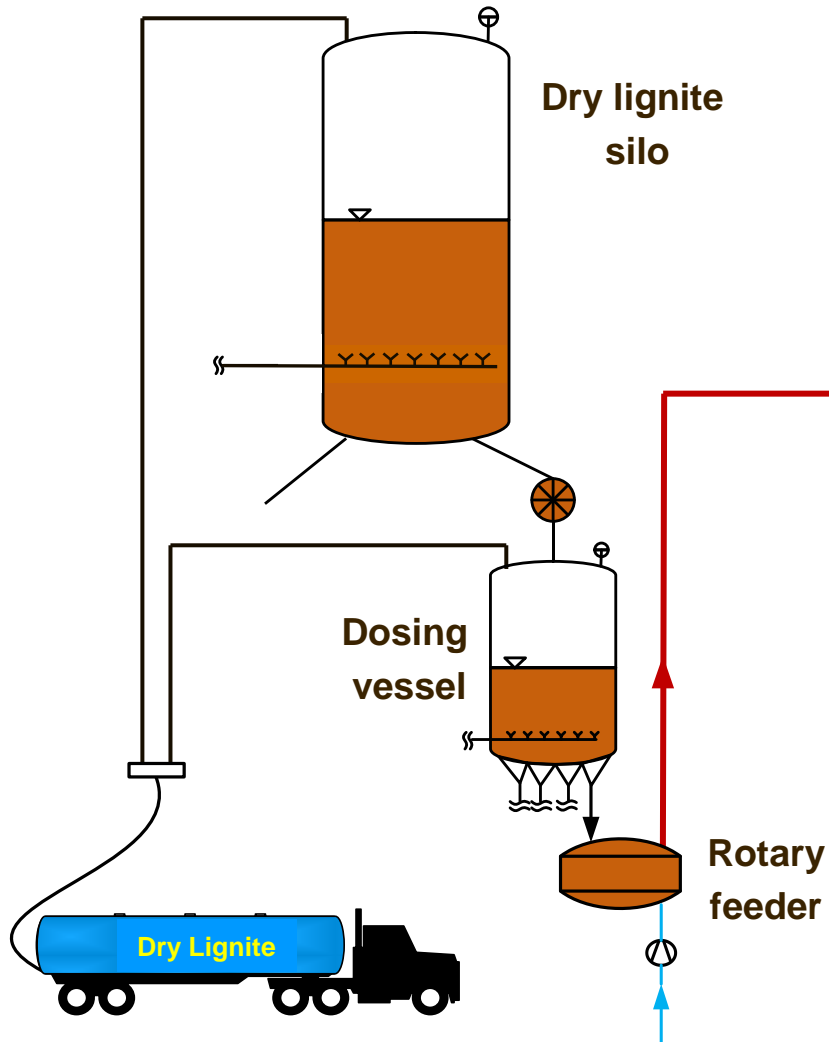
- Replacement of 8 oil-burners by dry lignite burners at a 850 t/h boiler
- Target: Increasing flexibility by reducing technical minimum load from 180 MW to ~ 90 MW and increasing load gradients
- Reducing start-up costs as well as decreasing number of start-up and shut-down processes
- In operation since Nov 2014



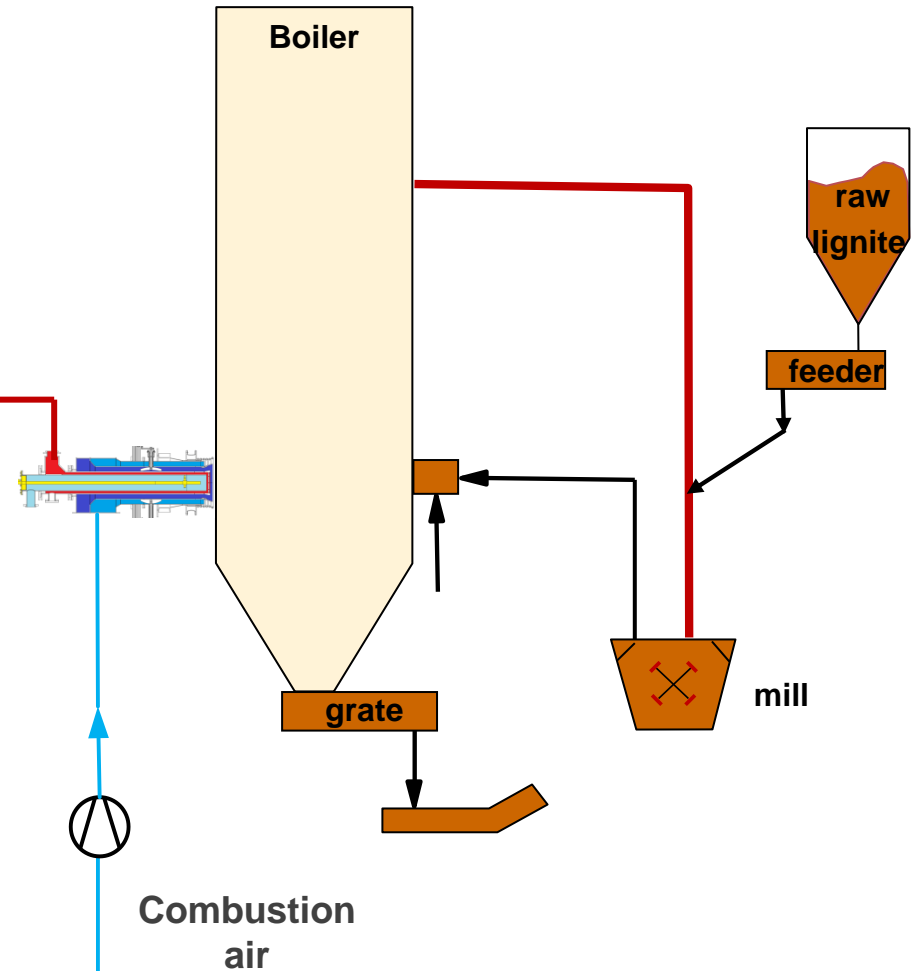
Use of dry lignite to set new benchmark for high efficient and flexible lignite power plants.

Overview of dry lignite handling , dosage and combustion

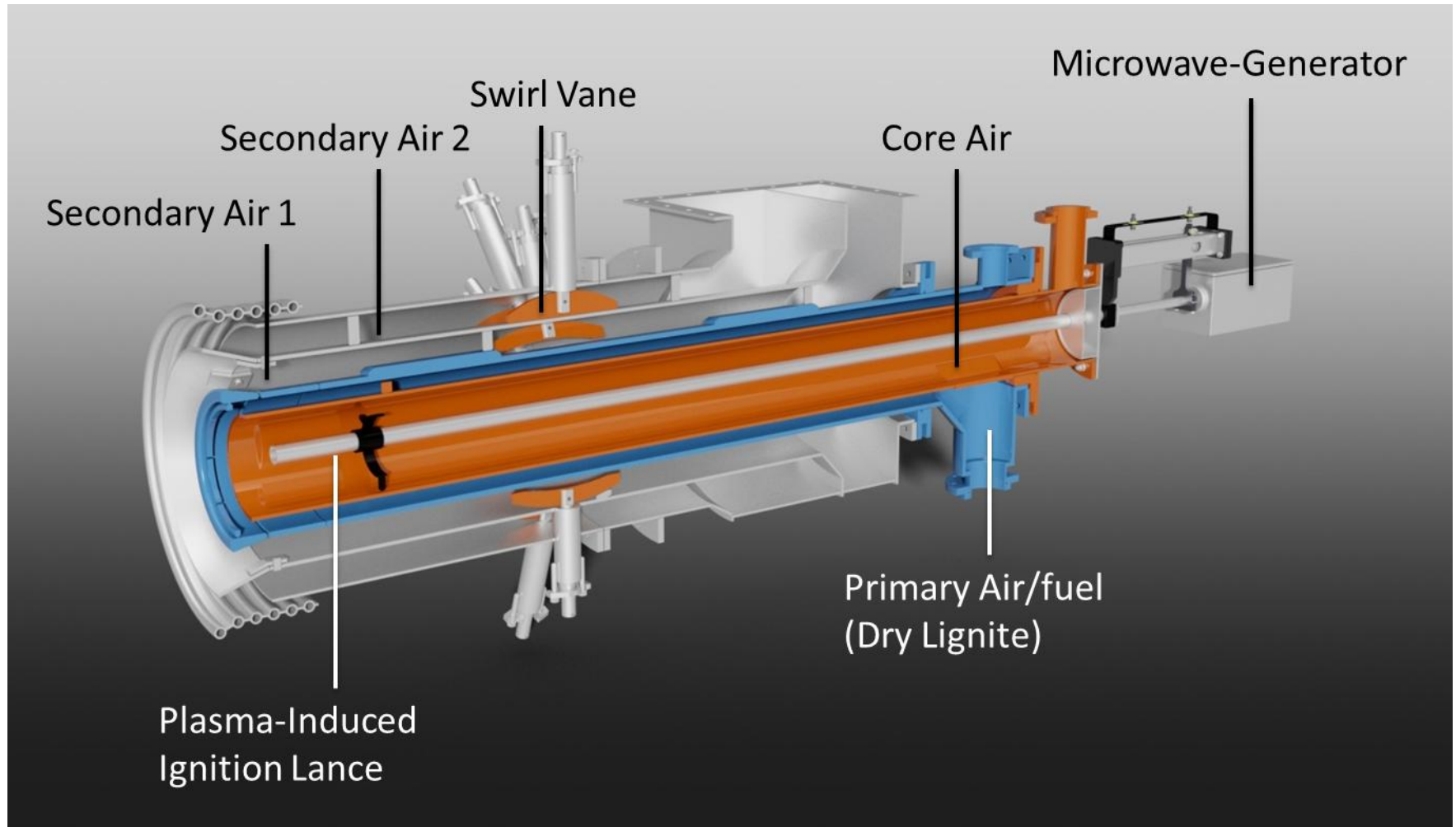
Dry lignite system



Raw lignite system

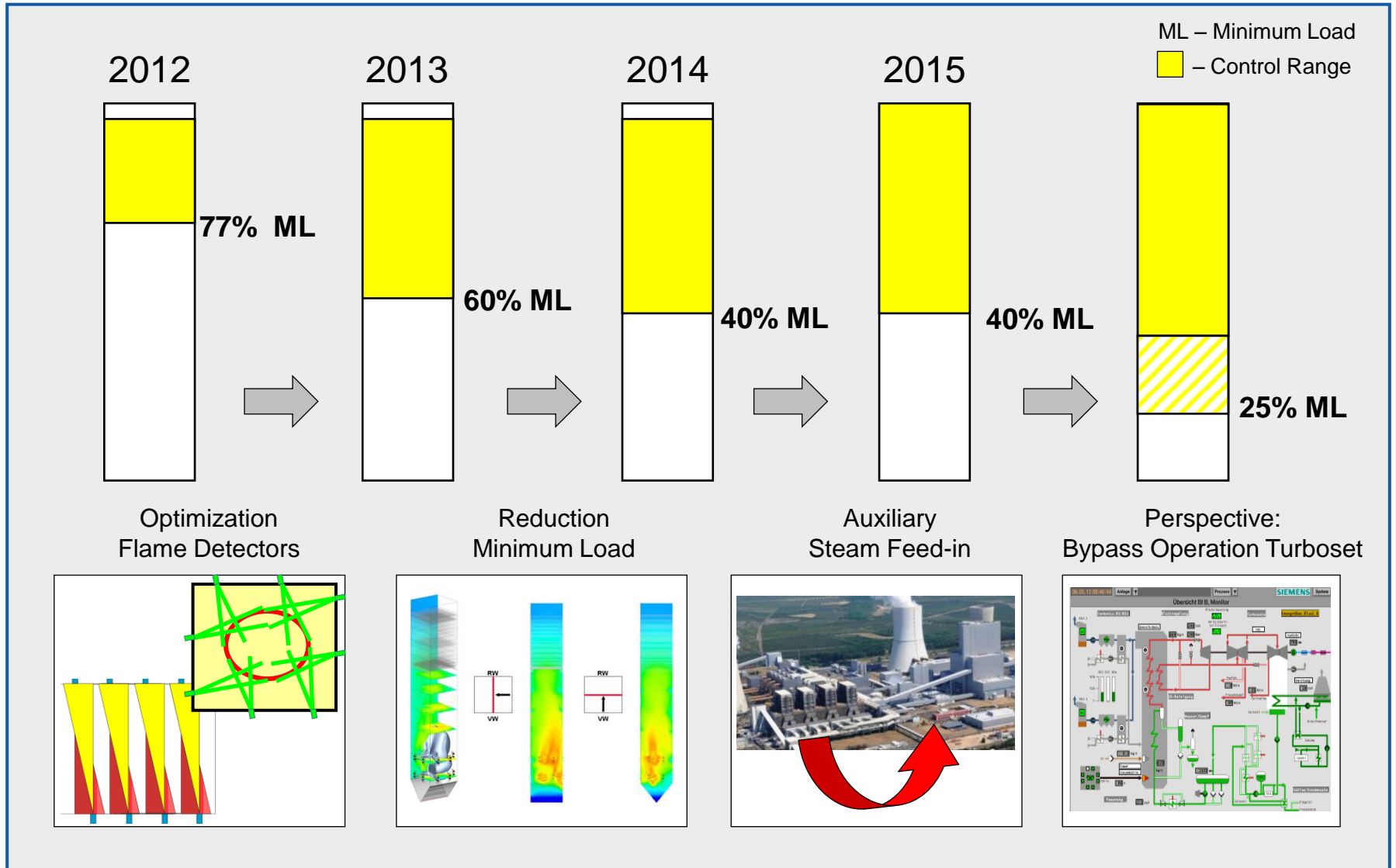


Design of Dry Lignite Burner



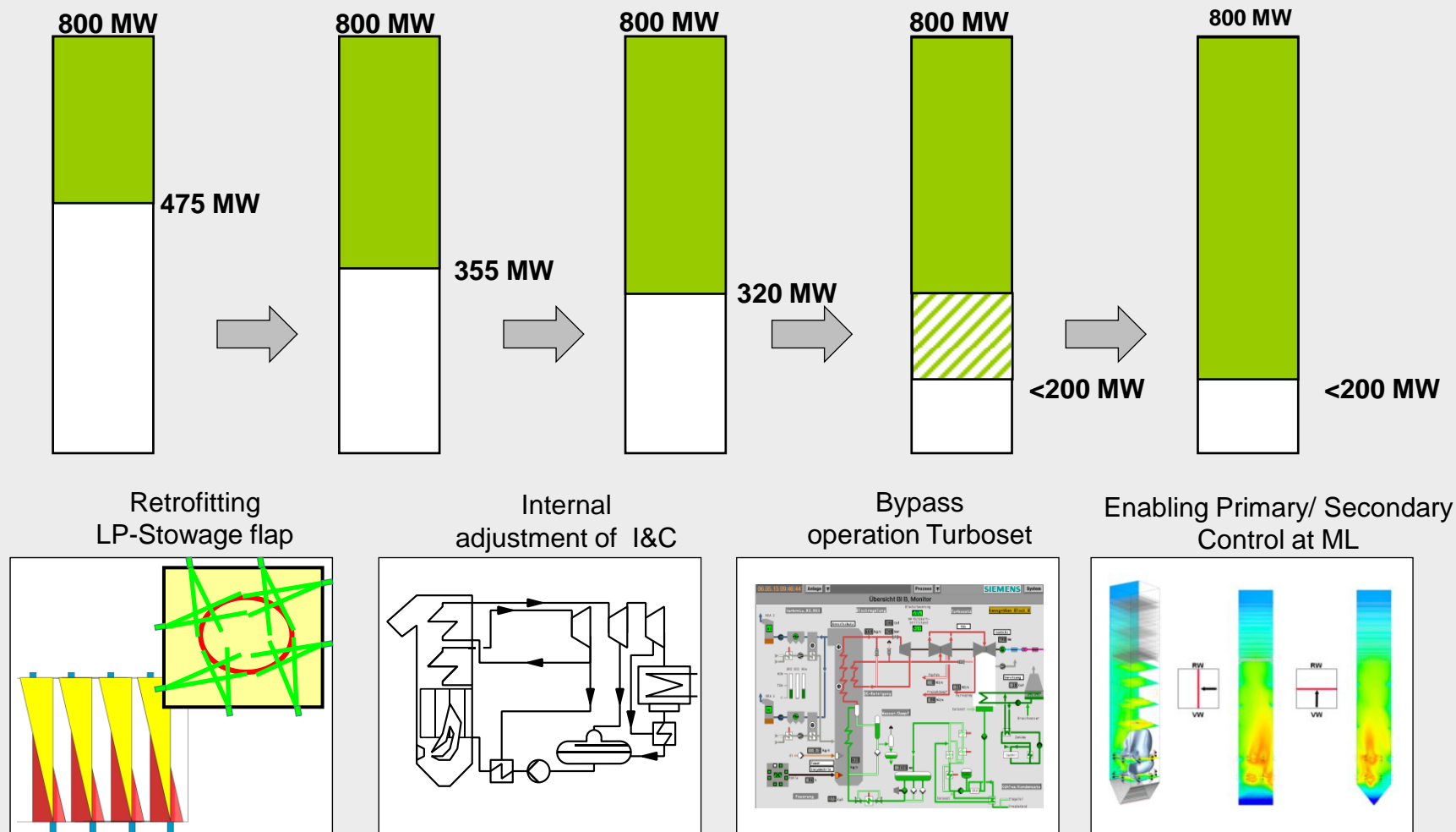
Source: BBS

Example Boxberg Q – Extension of load range



Example PP Schwarze Pumpe – Increasing flexibility

Figures in MW_{gross}



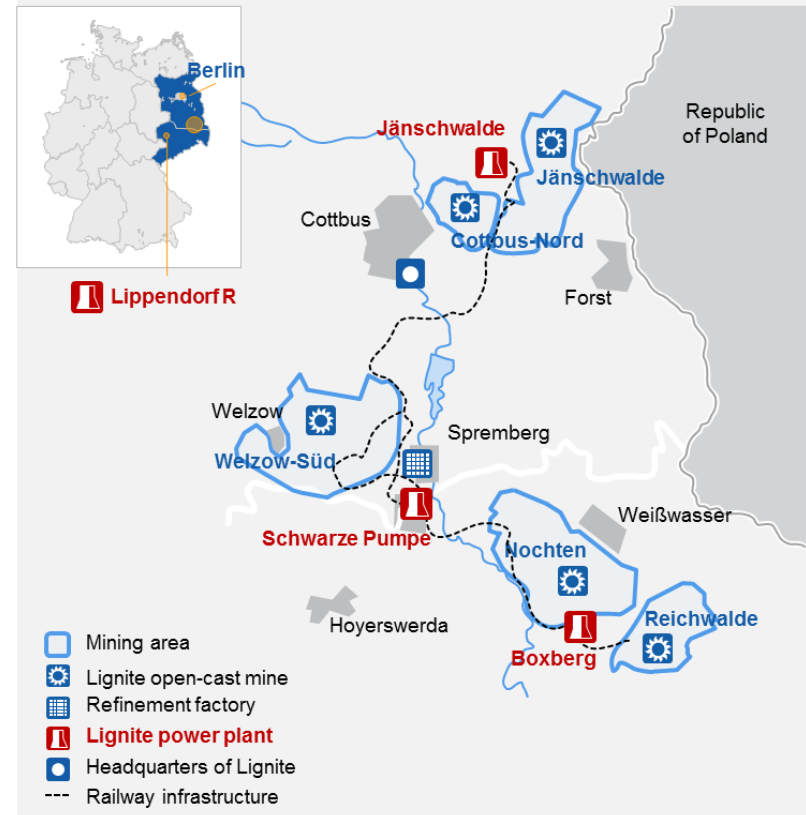
A large industrial turbine component, possibly a compressor or turbine section, is the central focus of the image. It consists of numerous curved blades or vanes arranged in a semi-circular pattern. A technician in a blue uniform and white hard hat is crouching in the foreground, working on the inner part of the component. In the background, two other technicians in blue uniforms and white hard hats are standing and observing. A large analog pressure gauge is visible in the upper left corner. The setting is a well-lit industrial workshop with various tools and equipment visible.

Adapting maintenance strategy

Maintenance strategy: Where do we come from?

- Uniform maintenance strategy for all (13 + 1) lignite units
- Always value-based maintenance but dependent on component:
 - Event-based (reactive) maintenance
 - Time-base maintenance
 - Condition-based maintenance
- Secure highest availabilities of power plants → lost margins for take outs overwhelm maintenance cost

Power Plant Locations



Responsibility →

Planning and realizing all measures necessary for safe and economic power plant operation while keeping maintenance budgets

Maintenance strategy: Where are we going to?

- Specific maintenance for different plant-classes
- Maintenance strategy for class one:
 - Reducing excess wear
 - Event-based (reactive) approach
 - Keep up safety without compromises
 - Risk minor drops in availability
- Maintenance strategy for class two:
 - Knowledge- and value-based
 - Keep up safety without compromises
 - Keep availability on today's level

Task → Fulfil responsibility with new approaches but significantly reduced budgets and conservative operation

Short Summary



Brief Summary

- Unbroken trend of falling wholesale prices for electricity in Germany
- Current market prices lead to constant need of re-evaluation of the way we used to do things
- Contradiction of long-term oriented business with high investment volumes and short-term changes on markets and in regulation/politics
- Several technical opportunities to manage the new requirements regarding flexibility
- Reliable and cost efficient energy source of sufficient quantity

Lignite business will be ready for future!

Thank you for your attention!

