Power Generation Flexibilisation Case Studies from Germany

By Ronald Rost & Arun Kumar Sarna

VPC
Sustainable Engineering & Consulting

encotec
A member of VPC Group

Agenda

About VPC & Encotec

Moorburg Flexibilisation

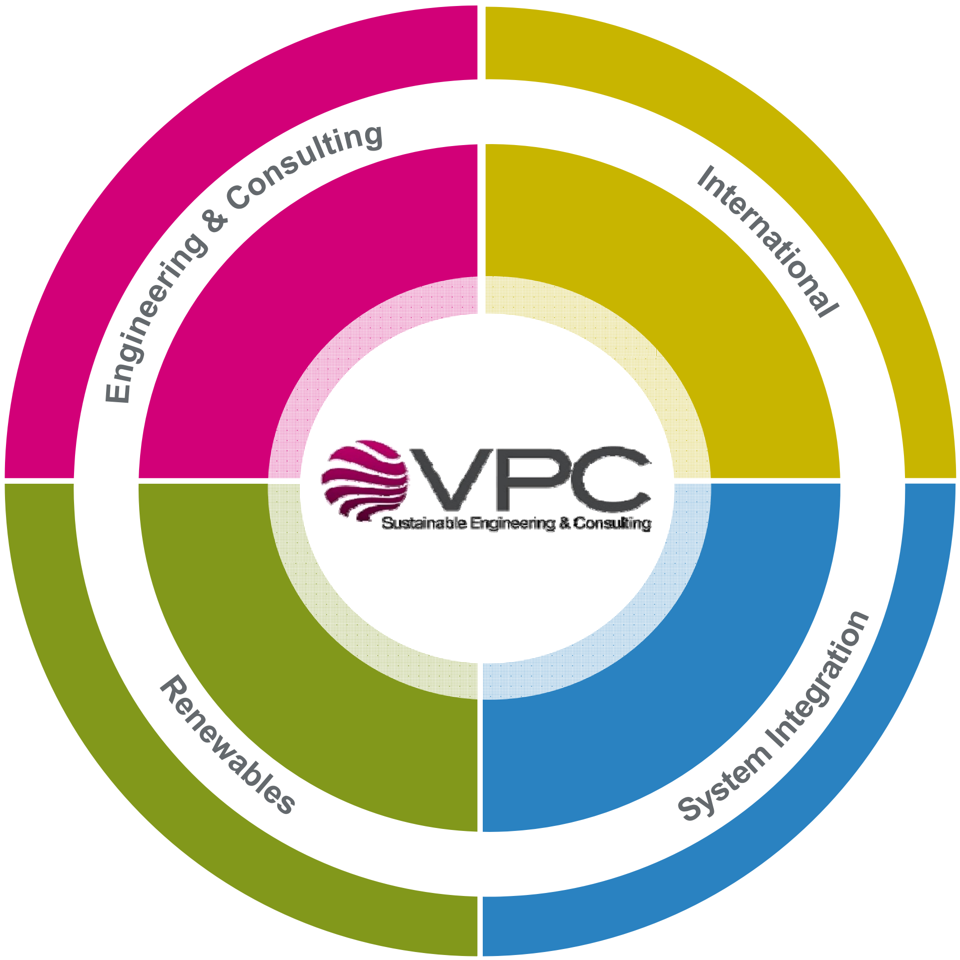
flex**Gen** Jaenschwalde

VPC – Profile

Shareholder	palero
Range of services	• Engineering services for power generation and distribution plants • Measurements and materials engineering • Engineering with delivery (EPC-M) • Operation and maintenance of power stations • Trade of power plant components • Renewable Energy Services
Sales	approx. 55 million euros
Workforce	approx. 750
Certified to	ISO 9001, ISO 14001, OHSAS 18001, KTA 1401, SCC, DAkkS accredited

D-IS-14178-01-00 nach DIN EN ISI/IEC 17020 2012

VPC – Services Portfolio



Encotec - Profile

A Member of VPC Group

Shareholding Structure	50 : 50 Indo German Company
Range of services	Engineering services, Erection & Commissioning services, Operation & Maintenance services, Supply of Chinese Spares & Overhauling of Thermal Power plants; Operation & Maintenance services for Substations; EPC of Solar PV Projects, Renewable & Climate Change
Sales	US$ 9.3 Million
Workforce	1200*
Certified to	ISO 9001 : 2008, ISO 14001 : 2015 & OHSAS 18001 : 2007


British Certifications Inc.
Registration Certificate
ENCOTEC ENERGY (INDIA) PVT. LTD.
OHSAS 18001:2007
The Occupational Health and Safety Management System


CERTIFICATE
ENCOTEC ENERGY (INDIA) PVT. LTD.
ISO 9001:2015


ims INTERNATIONAL
Certificate of Registration
ENCOTEC ENERGY (INDIA) PVT. LTD.

*as on October 31, 2017

ENCOTEC Profile

- **Coastal Gujarat Power Ltd.**
- Reliance Butibori
- APNRL Jamshedpur
- CEPL Tuticorin
- Reliance Rosa
- Adani Udupi
- Sterlite Bhopal
- Sterlite Dhule
- SWPGL Warora
- CLP Jhajjar
- SKS Raigarh
- JSWEL Bellary
- Reliance Sasan
- L&T Rajpura
- TSPL Mansa
- ITPCL Cuddalore
- Corporate Office Noida

Clients (extract)

…& many more.

Agenda

About VPC & Encotec

Moorburg Flexibilisation

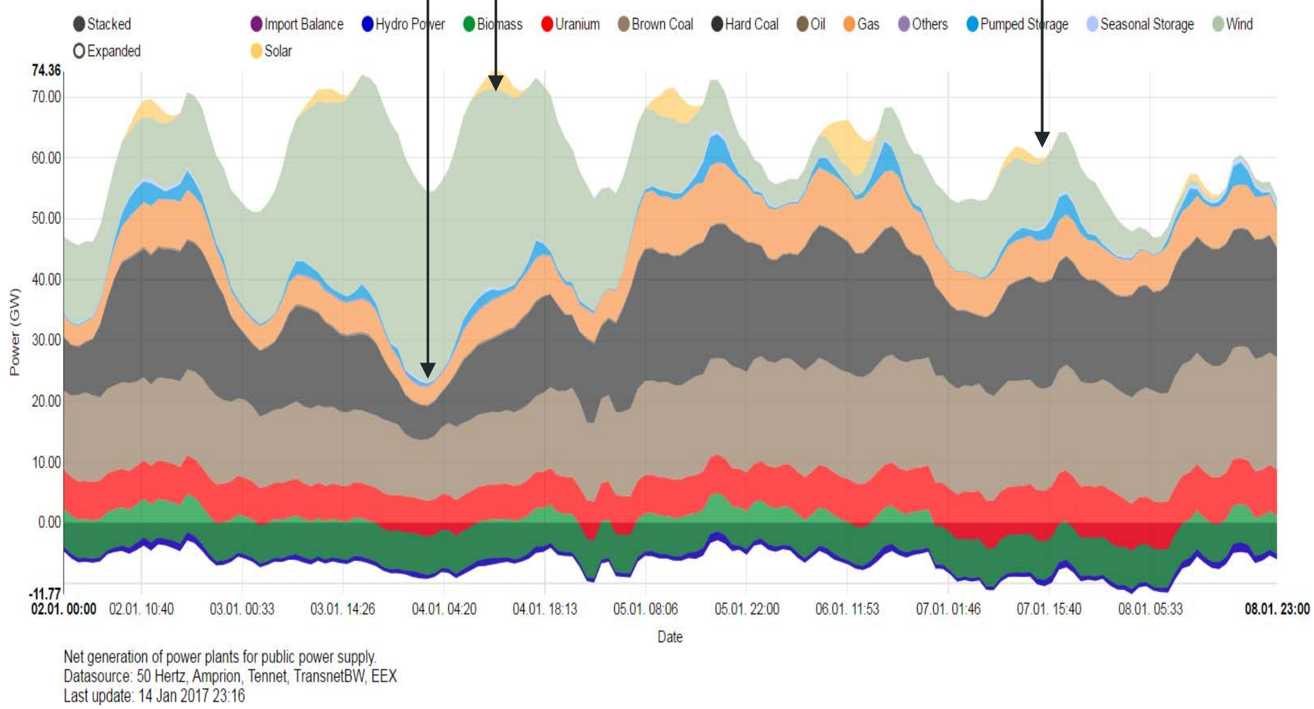
flex**Gen** Jaenschwalde

Power production in Germany – calendar week 01/2017

Reduction of peak demand over weekend

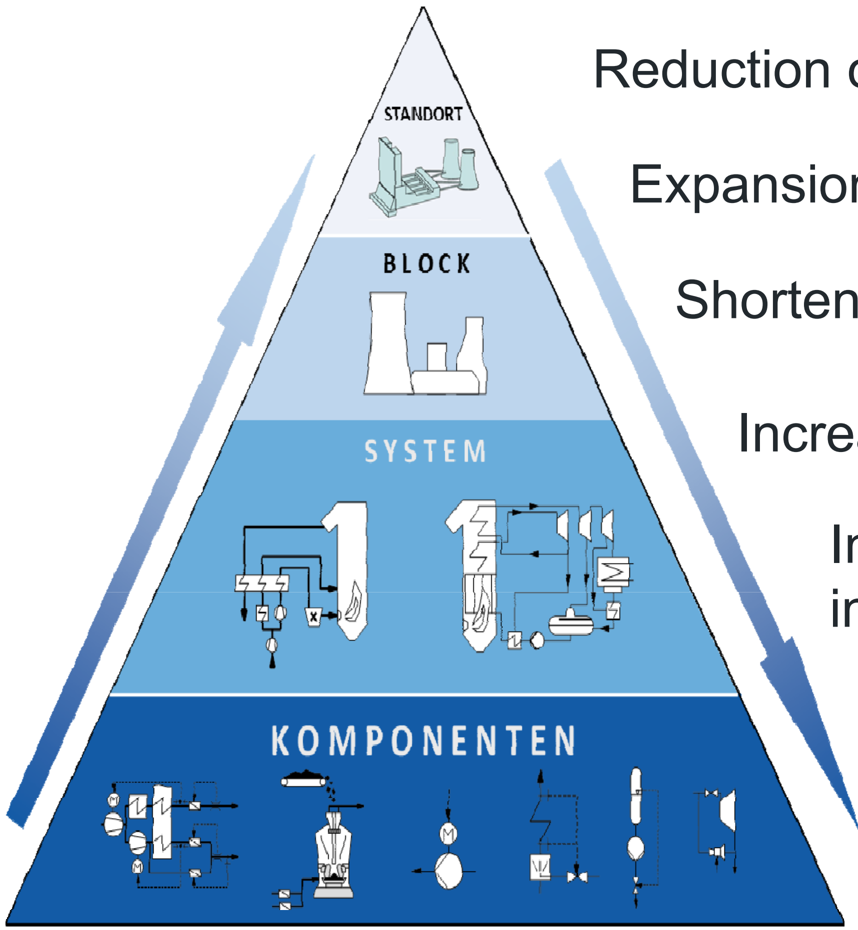
High wind & low solar production

Load reduction of coal & gas



Source: Fraunhofer ISE,

Focal points of Vattenfall's flexGen program



- Reduction of plant minimum load
- Expansion of control range
- Shortening of start-up and shut-down
- Increased load gradients
- Increased efficiency in partial load range
- Effects of increased load changes on lifetime consumption and O&M

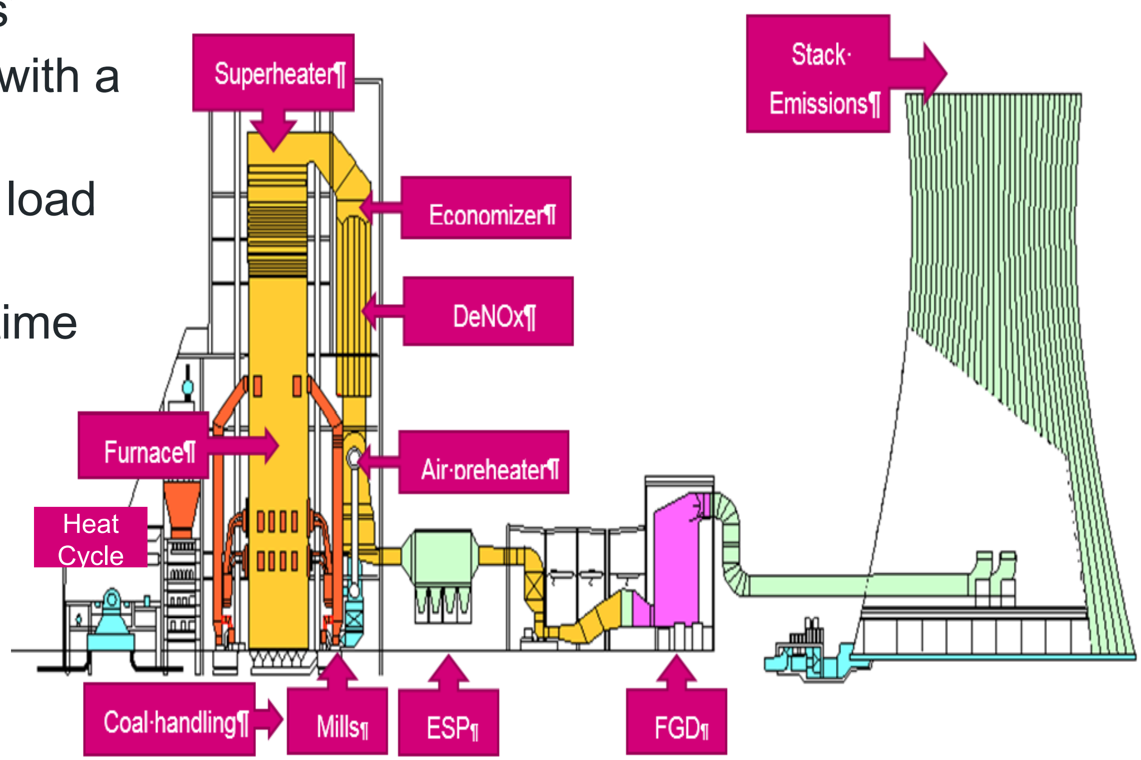
Objective → Increased flexibility of Power plants

Background – Impact on plant components

Requirements on power plants:

- Increasing number of start-up and shut down process
- Speed of load change with a still high efficiency
- Reduction of minimum load without fuel oil support
- Shortening of start up time

Impact on components



Moorburg Thermal Power Plant

Construction period	2008 – 2012
Continuous operation	28.02. / 30.08.2015

Technical data:

Live steam temperature	°C	600
Live steam pressure	bar	276
Reheat steam temp.	°C	610
Live steam delivery	kg/s	574
Preheating stages		9
Feed-water temperature	°C	293
Exhaust steam pressure	mbar	25 (abs.)
Generator output	MW	2 x 827
Net efficiency (condens. mode)	%	46.5
CHP efficiency:	%	58
Fuel		bituminous coal (LHV: 26 MJ/kg)
Heat extraction	MW_{th}	designed for 450, actual 30
Commissioning year		2014

Source: Vattenfall

MoorFlex - Reduction of technical minimum load

Objective:

- reduction from 35% (related to live steam quantity) to 26%
- plant operation must be ensured in pure coal operation, i.e. without additional oil firing or the use of auxiliary steam generators.

Measures:

- Control system adjustments
- Retrofit of automated NH_4OH dosing of SCR DeNOx
- Reduction of the temperatures (live and RH) in the steam lines already during the shutdown process
- Adjustment of water-steam cycle diagram
- Adjustment of classification of emission data

➔ 9 minimum load tests have been undertaken
➔ 24% minimum load has been achieved, tests down to 20%
➔ Definition of new minimum load with OEM confirmation

MoorFlex - Increasing load gradients & shortening start-up times

Objective:

- check possibilities for increasing the load gradients during load operation
- shortening the start-up and shutdown times

Measures:

- Electrical heating of thick-walled components (not realized)
- Optimization of the individual step chains and parallelization of sequences (50 minutes during the start-up process were saved)
- Optimization of starting fire performance
- Air-side bypass of mill air heat exchanger

➔ Definition and implementation of test programs
➔ Optimization of individual step chains and parallelization of sequences
➔ Shortened start up time warm-start by 30 min (104 to 78 min)
➔ 35% (49 to 32 t) fuel oil reduction achieved

MoorFlex - Expansion of warm start capability

Objective:

- Extend the warm start capability to a standstill period of > 48 hours to approx. 60 hours.

Measures:

- Installation of flue gas isolation valves with heated locking air system
- Installation of gas isolation valve at combustion air system with lock air system
- Pressure control with external steam load (not realized due to T24 material)
- Expansion of water level measurement bottle (not realized due to cost-benefit analysis)
- Retrofitting of automated butterfly valves at pulveriser locking air to avoid pressurizing the combustion chamber

Source: Vattenfall

MoorFlex – Electric ignition of burners

Objective:

- Retrofit of electric ignition at the burners of the level 30 to reduce the required fuel oil quantity during the start-up process as well as to save the necessary start-up times
- Avoid fuel oil ignition of 3rd burner level during minimum load operation with 2 burner levels

Measures:

- Design engineering is fully completed and prepared for implementation and includes exchange of oil ignition lances in favor of electric ignition
- Implementation of the measures was not undertaken due to a lack of practicability in accordance with the testing experience in existing plants (overheating of ignition parts)
- Ignition system must be further developed before applied in Moorburg

MoorFlex – online information

Source: Vattenfall

Agenda

About VPC & Encotec

Moorburg Flexibilisation

flexGen Jaenschwalde

Power Station Jaenschwalde (6 x 500 MW)

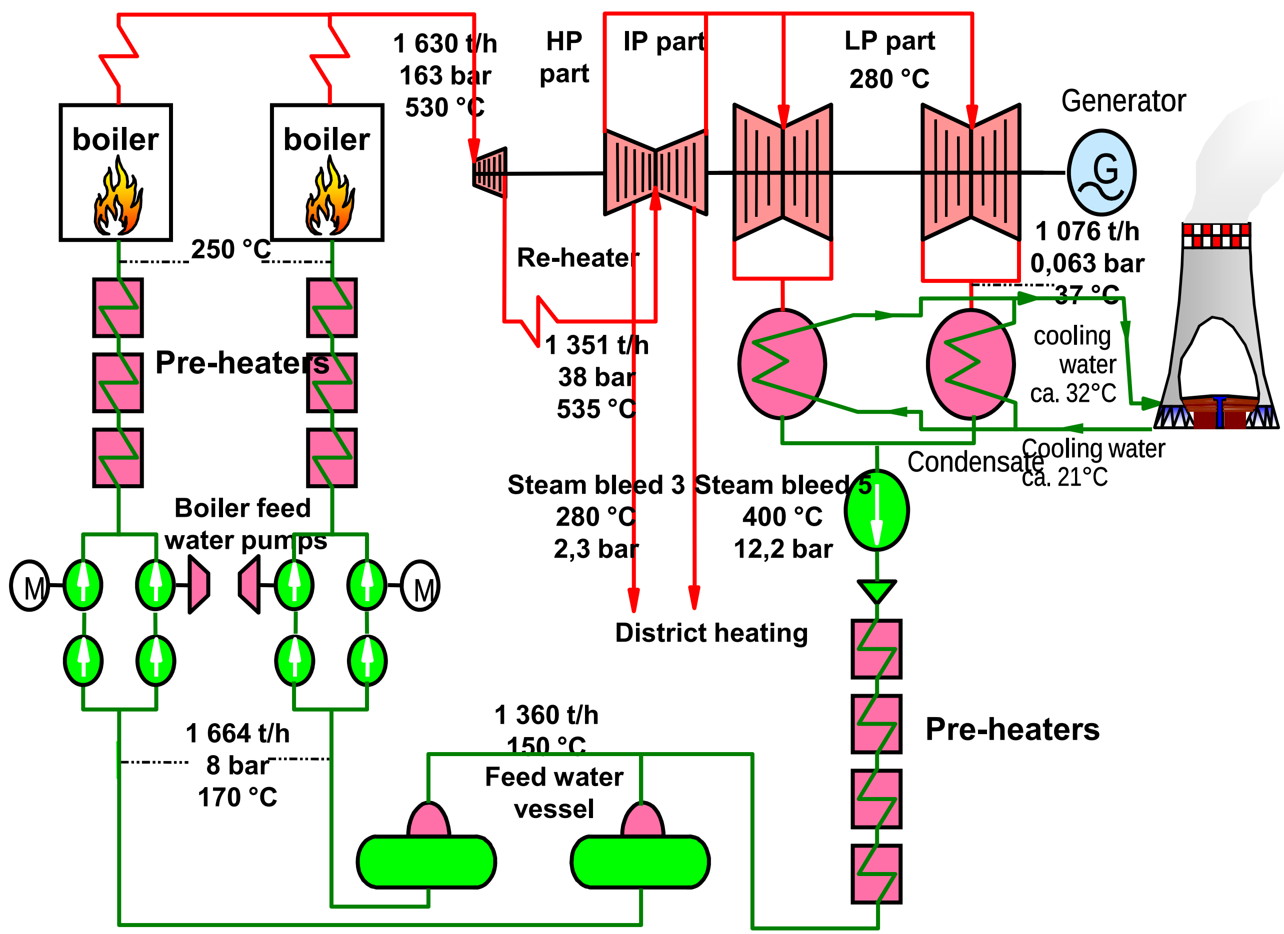
Construction period	1977–1988
Continuous operation	1982/1985/1988

Technical data:

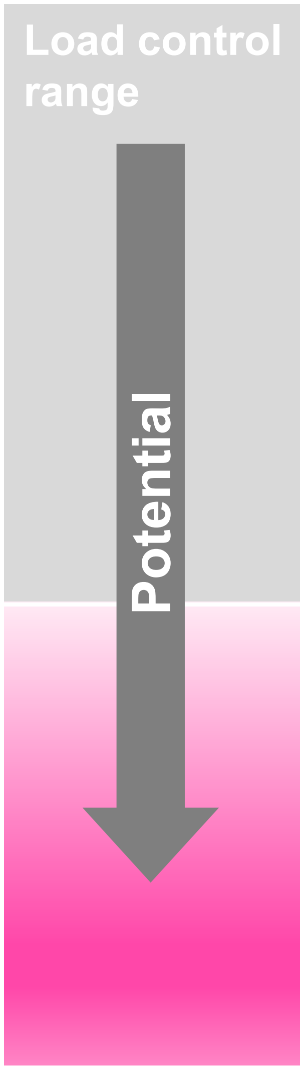
Live steam temperature	°C	535
Live steam pressure	bar	172
Intermediate steam temp.	°C	540
Live steam delivery	kg/s	2 x 226
Preheating stages		7
Feed-water temperature	°C	245
Cooling water temp.	°C	20
Exhaust steam pressure	mbar	50
Generator output	MW	530
Fuel		lignite, RDF
Heat extraction	MW_{th}	348
Commissioning year		1981/82 / 1983/85 / 1987/88

Simplified flow scheme of a 500 MW unit

Jänschwalde Power Plant



Dried lignite fuelled ignition and support firing system for steam generator F2 at Jänschwalde Power Plant



max. load

Technical minimum load (minimum load without fuel oil support firing)

Schematic diagram

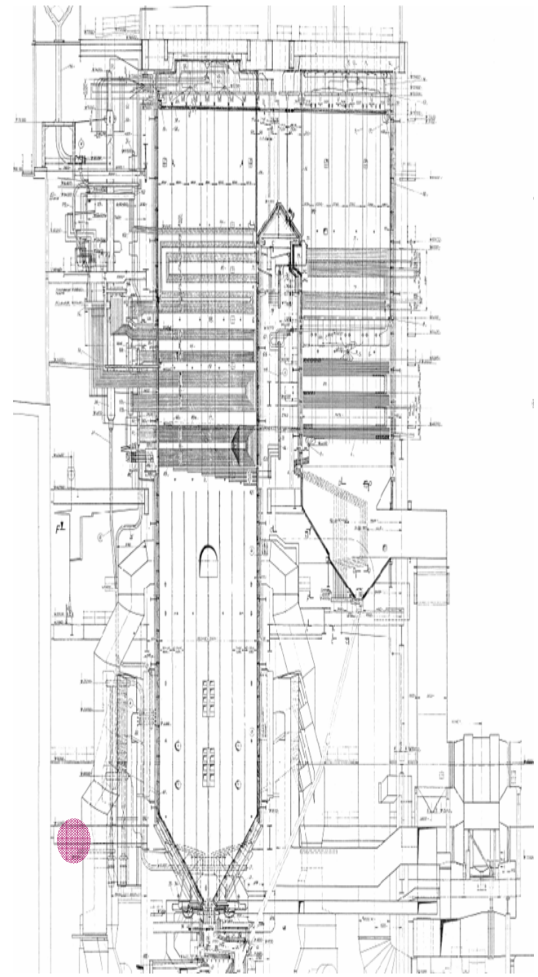
- Increase in the effective control range of a 815 t/h steam generator at the Jänschwalde Power Plant by halving its technical minimum load from
  - currently 180 MW
  - to 90 MW (=32 % of boiler load / 18% of unit load).
- Prevention of grid-related shut-down and start-up processes and therefore avoidance of lifetime consumption and higher maintenance costs.
- Replacement of heavy fuel oil support firing by dried lignite.
- Increase of load gradients.

Tasks & Requirements

- Organization of dried lignite supply
- Establishment of dried lignite storage at JPP
- Replacement of the oil burner/oil supply systems in the steam generator area by a dried lignite fuelled ignition and support firing system (dried lignite burner with dosing, conveying and combustion air supply systems)

....

- Use of existing oil burner openings on the steam generator
- Use of electrical direct ignition
- Functional integration of the controller and safety circuit in the power plant's I&C system
- Optimization of the water-steam and air-flue gas systems in the new minimum load range

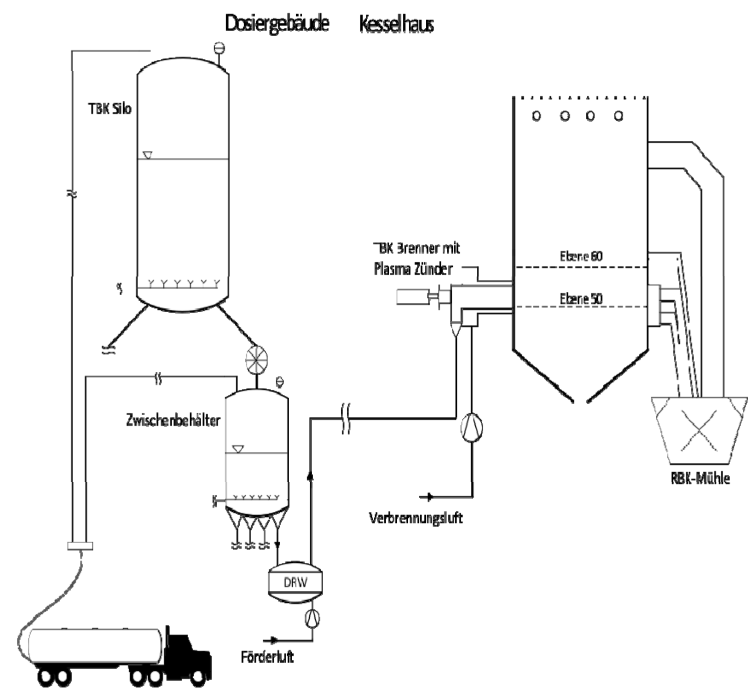


Operating requirements

- Low load operation with mixed fuel (raw lignite + dried lignite) up to 270 t/h boiler output (33%)
- Improvement of the dynamics of boiler operation
- Improvement in the provisions of secondary control power
- Total firing system's thermal output with dried lignite: 240 MWth
- Rating for 100 boiler start-ups per year, unlimited auxiliary burner operation
- Low CO and NOx emissions, main emission limits down to a minimum boiler output of 270 t/h
- Non-slagging operation
- Auxiliary burner use with low quality raw lignite
- Short start-up time
- Mixed fuel operation with various combinations of coal pulverisers
- Low wear and tear of the system

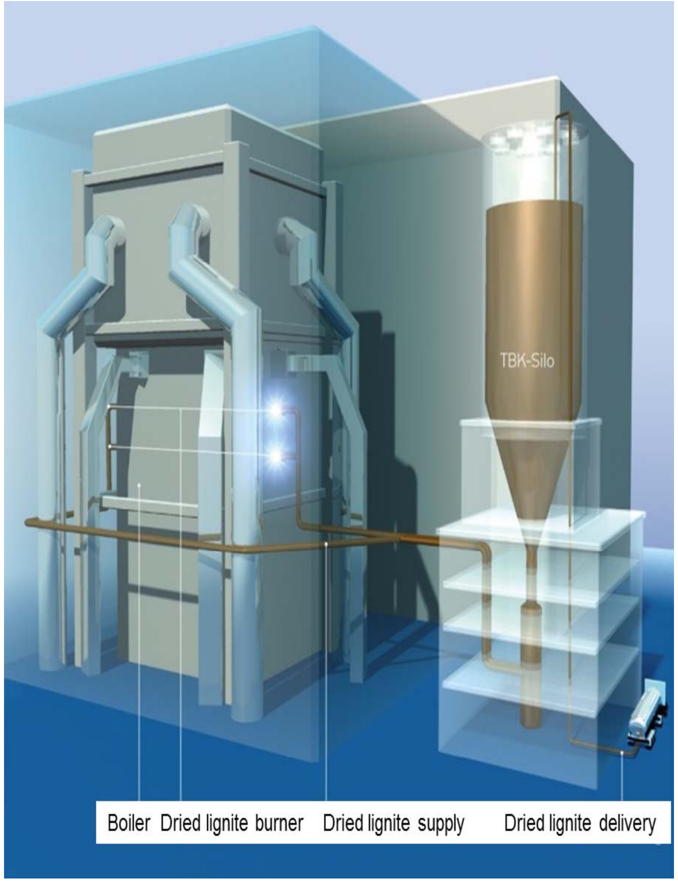
System Engineering

- Fuels used: pulverized lignite from refining and dried lignite from the pressurized steam fluidized-bed drying (DDWT) system; quality parameters: LHV=21 MJ/kg, W=10.5%, A=6.0%
- Dried lignite silo with a storage capacity of 650 t, protection criteria CO, CH4 and max. temperature in the silo
- Two dosing tanks with a storage capacity of 8 t each
- One dosing tank is fitted with an additional filling connector for filling with dried lignite



Dried lignite fuelled ignition and support firing system for steam generator F2 at Jänschwalde Power Plant

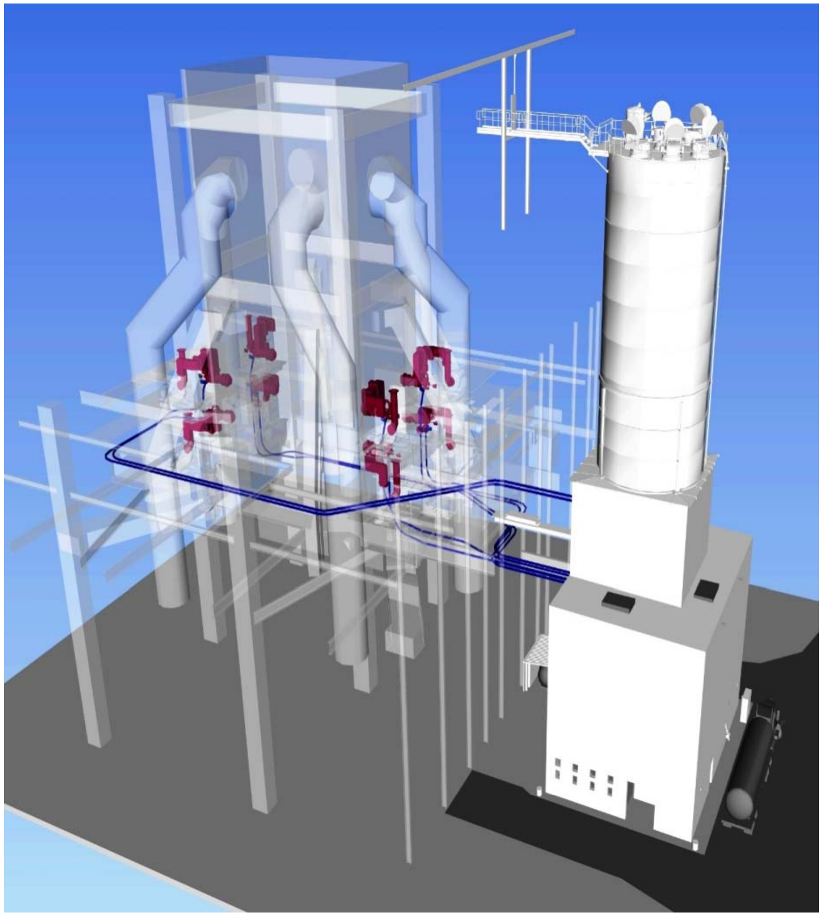
- Replacement of oil burners by 8 dried lignite burners
- One dosing tank supplies the 4 lignite burners on each level
- Each burner has a rotary weigh feeder, conveyor air blower, dust line, combustion air fan and ignition system (plasma ignition)
- The thermal output of each burner is infinitely variable between 7.5 and 30 MWth, controlled by the rotary weigh feeder
- CO_2 inertization system, tank capacity 5.4 t, with liquid CO_2



Source: Vattenfall

Special plasma burner for dried lignite

First fire



3D Model of dried lignite silo building, fuel piping and burners arranged at the 815 t/h boiler no. F2

Source: Vattenfall

VPC
Sustainable Engineering & Consulting

encotec
A member of VPC Group

... FOR BETTER RESULTS.