

INDO-GERMAN ENERGY PROGRAMME

**Workshop on „Renovation &
Modernisation**

Rehabilitation of ENBW's Altbach and Heilbronn Power Station

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Rehabilitation & Modernisation Measures

Boiler Island

Turbine Island

Auxiliary Systems as Air & Flue Gas Duct

Modernization of Pulverisers

POWER Projects PP Heilbronn & PP Altbach

Rehabilitation & Modernisation Measures

Boiler Island

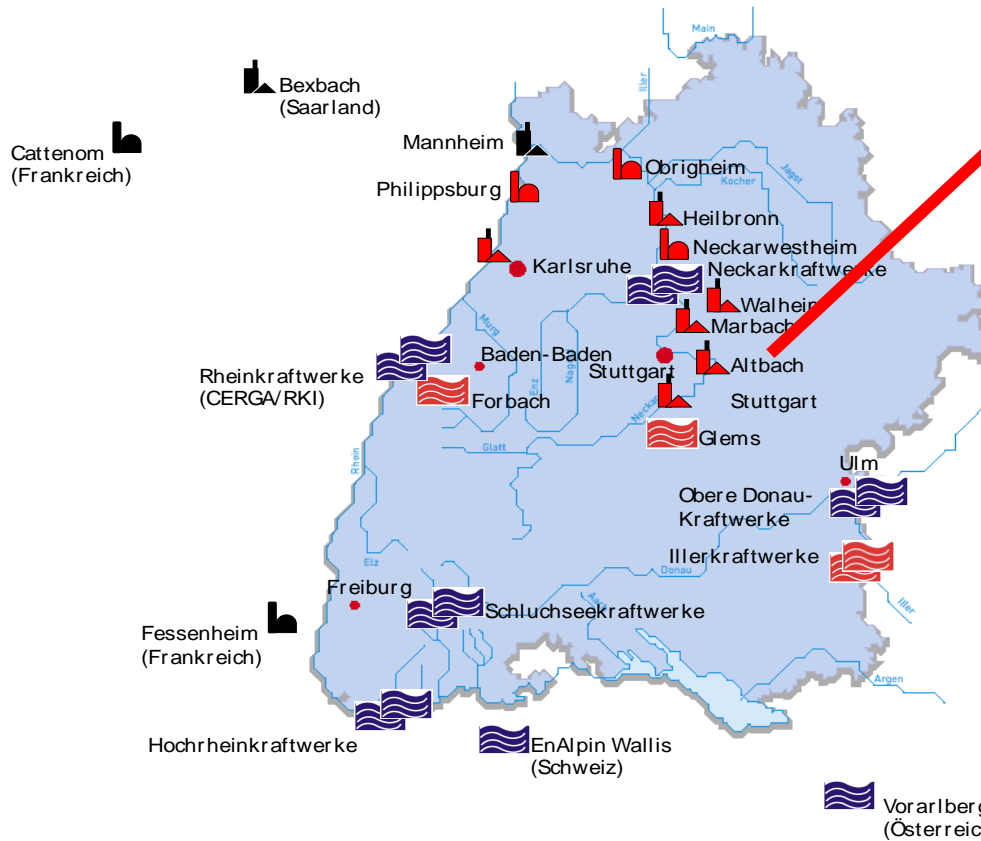
Turbine Island

Auxiliary Systems as Air & Flue Gas Duct

Modernization of Pulverisers

EnBW Kraftwerke AG

Power Plant Sites



Site Altbach/Deizisau
(420 MW/280 MJ/s)

- Wasserkraftwerk
- EnBW Eigenbetrieb
- EnBW Eigenbetrieb
- EnBW Eigenbetrieb

Coal, Oil, Gas:
6.600 MW
installed Capacity

Phase 1:

„Feasibility Study“

- **Reduction of Excess Air**
- **Reduction of primarily NOx Formation**
- **Unburned Carbon < 5 % in Ash**
- **Reduction of areas with reduced atmosphere (lack of oxygen)**
- **Retention of Outlet Temperature of Combustion Chamber**

Phase 1:

„Feasibility Study“

- Reduction of Excess Air
 - **get lower auxiliary consumption / have lower flue gas losses**
- Reduction of primarily NOx Formation
- Unburned Carbon < 5 % in Ash
- Reduction of areas with reduced atmosphere (lack of oxygen)
- Retention of Outlet Temperature of Combustion Chamber

Phase 1: „Feasibility Study“

- Reduction of Excess Air
- Reduction of primarily NOx Formation
 - **get lower costs for NH3 consumption**
- Unburned Carbon < 5 % in Ash
- Reduction of areas with reduced atmosphere (lack of oxygen)
- Retention of Outlet Temperature of Combustion Chamber

Phase 1:

„Feasibility Study“

- Reduction of Excess Air
- Reduction of primarily NO_x Formation
- Unburned Carbon < 5 % in Ash
 - **to produce a sellable product**
- Reduction of areas with reduced atmosphere (lack of oxygen)
- Retention of Outlet Temperature of Combustion Chamber

Phase 1:

„Feasibility Study“

- Reduction of Excess Air
- Reduction of primarily NO_x Formation
- Unburned Carbon < 5 % in Ash
- Reduction of areas with reduced atmosphere (lack of oxygen)
 - **to get lower erosion and longer life time of water walls**
- Retention of Outlet Temperature of Combustion Chamber

Phase 1:

„Feasibility Study“

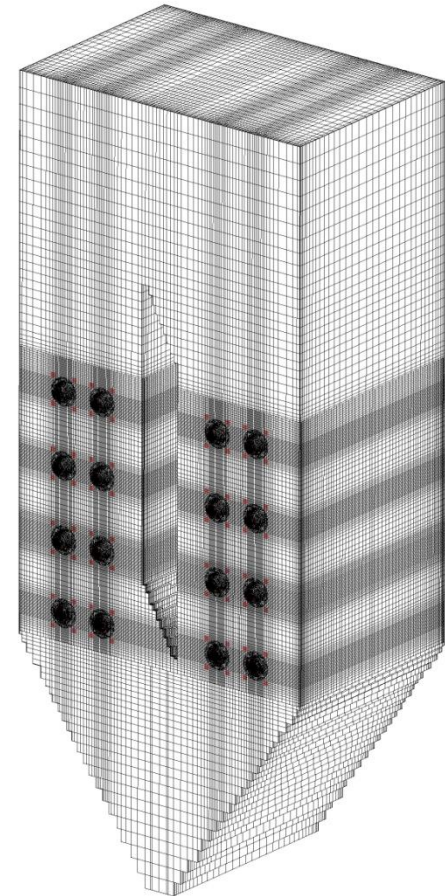
- Reduction of Excess Air
- Reduction of primarily NO_x Formation
- Unburned Carbon < 5 % in Ash
- Reduction of areas with reduced atmosphere (lack of oxygen)
- Retention of Outlet Temperature of Combustion Chamber
 - to avoid slaging and fouling

Procedure of Optimization- & Procurement Process

- 1. Simulation-based Pre-Engineering** => **Evaluation of the technical & economic Feasibility**
- 2. EU-Tendering Process incl. Requirement for detailed Specification of the Concept** => **Pre-requisite for simulation-based Evaluation**
- 3. Simulation-based Evaluation of different first Variants** => **Achieving the required specified Warranties?**
- 4. Offer of different Suppliers** => **Elaboration of the optimized Variant by possible supplier**
- 5. Simulation-based Evaluation of optimized Variant** => **Achieving the required specified Warranties?**
- 6. Decision**

HKW 1 in Altbach / Deizisau

Commiss. Year :	1985
Supplier:	L&C Steinmüller
Boiler Type:	Boxer Combustion
No. of Burnerl:	32
Burner Type:	SM I/SM IV Drallburner
P_{therm} :	ca. 1.100 MW
Fuel:	different Import Coal
$\text{NO}_{x,\text{Primär}}$:	850 mg/Nm ³ ,tr 6% O ₂ *)
Air Ratio:	1,23 *)

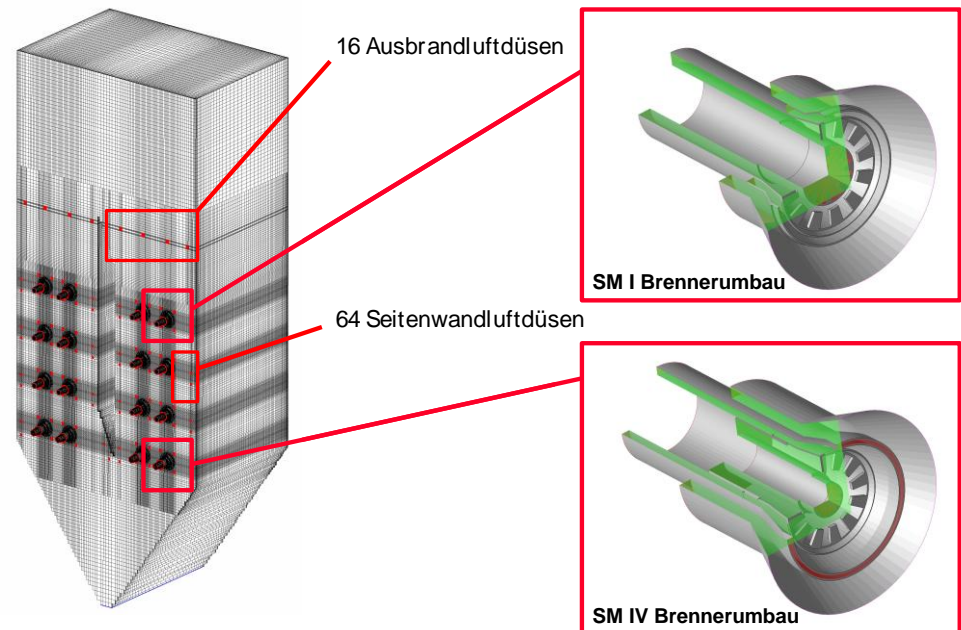


*) Status before Retrofit

Simulation-based Procurement Decisions

Comparison of Offers

- › Some Suppliers could be pre-qualified.
- › Concepts are comparable:
 - › Modification of the Burner
 - › Retrofit of Air Nozzles
 - › Retrofit of Air staging nozzles



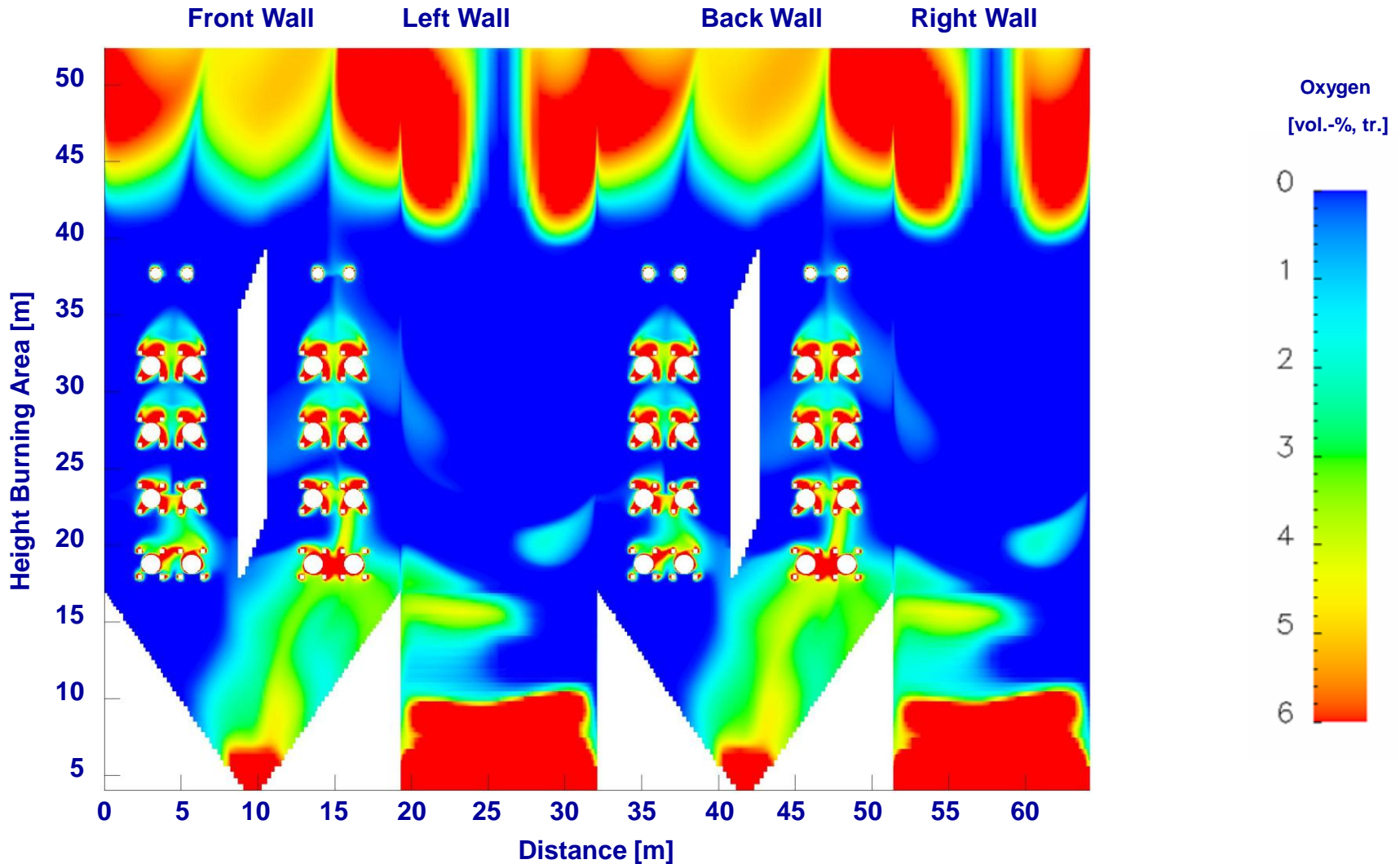
Procurement Decision Comparison of Offers

	Bid 1		Bid 2		Bid 3		Bid 4	
	V1	V2	V1	V2	V1	V2	V1	V2
Total Excess-Air	++	+	+	++	o		+	+
NOx* [mg/Nm ³ ,6% O ₂]	++	+	+	+	+		+	+
CO* [mg/Nm ³ ,6% O ₂]	+	+	+	+	+		+	+
Un-burned share in ash [weight.-%]	+	+	+	+	+		+	-
Outlet Temperature Combustion Area [°C]	o	o	-	-	+		+	+
Burner Slagging	+	+	-	+	+		+	+

Evaluation in Compliance with
given Specification and Targets

Detailed Analysis

Wall Atmosphere: without Air Nozzles



Optimization Potential of Combustion System

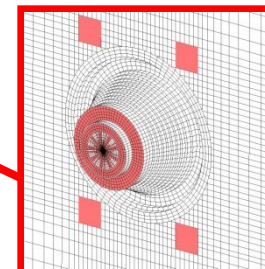
- Distribution of Combustion Air
- Modificationen at the Burner

Retrofit of Air Staging-Level

Burner Level 4
Burner Level 3
Burner Level 2
Burner Level 1



Retrofit of air nozzles



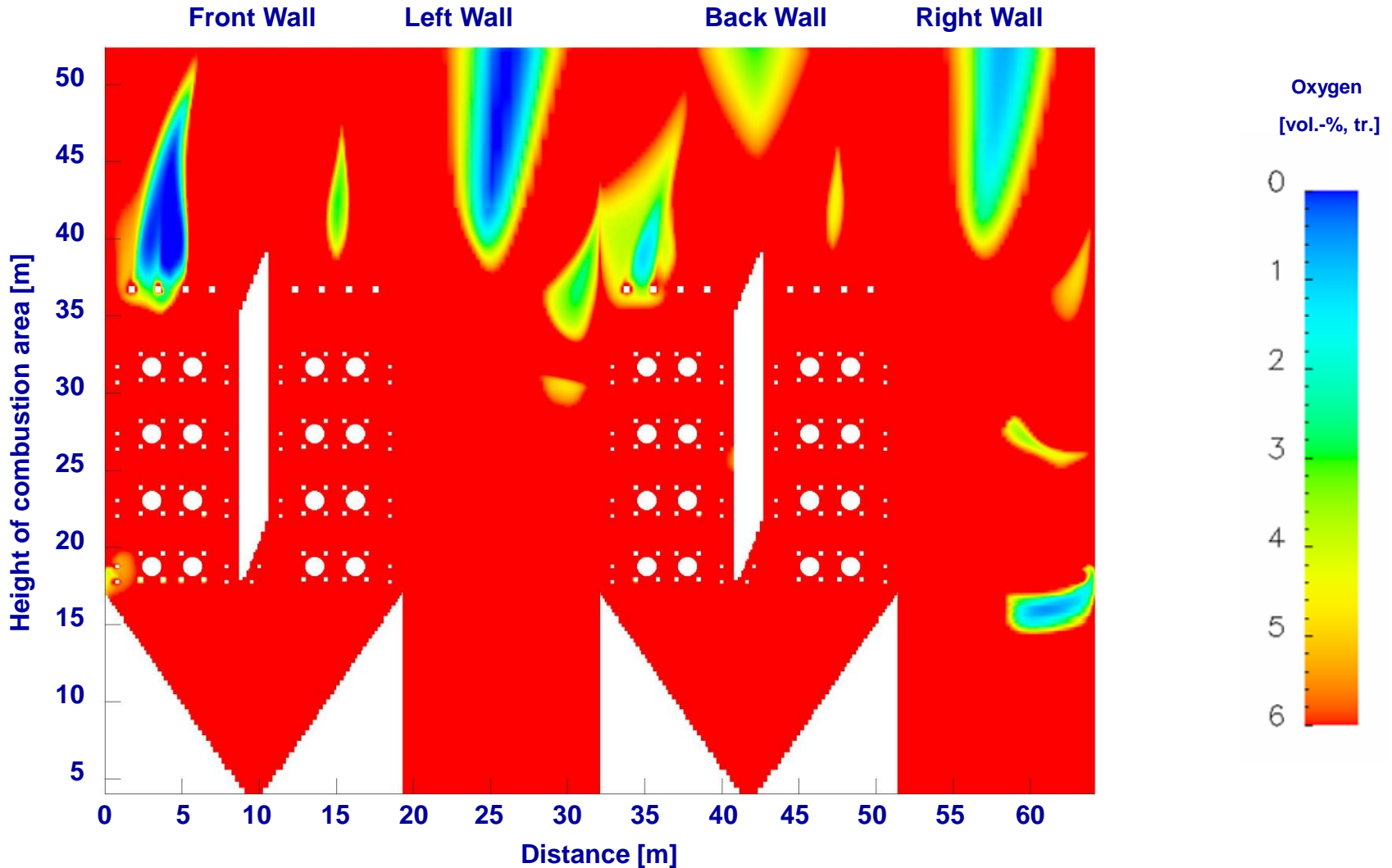
Modification of Burner Design & Construction

- › Functional Specification: clear Definitions of Warranty Conditions (according Feasibility Study: NO_x, Air Ratio, Wall Atmosphere, Burn-out)
- › Specific: Technical Checks on the basis of process simulation of the offered Variants also referring to the Compliance to Warranty Conditions

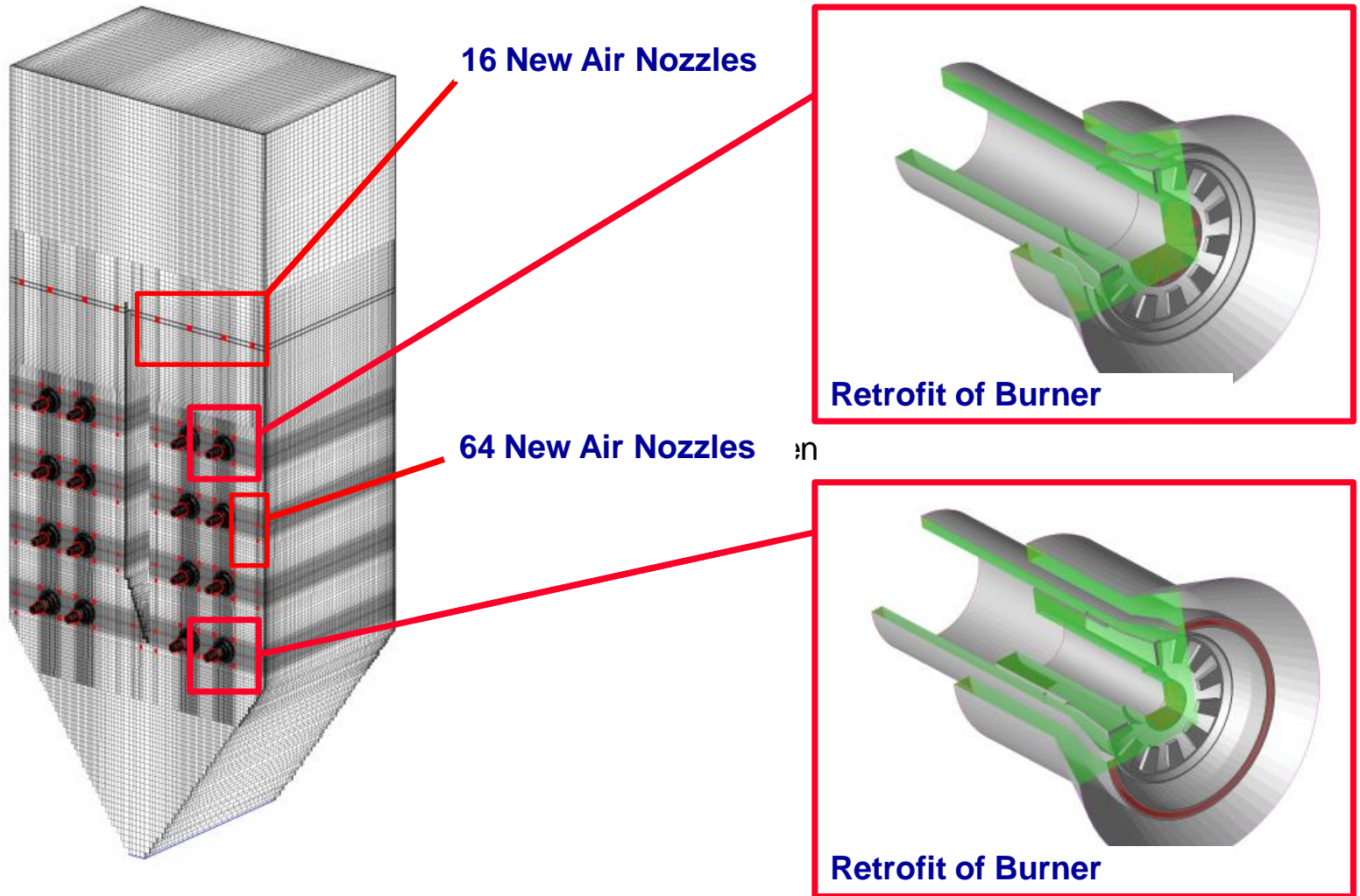
required Assumptions:

- › Amount of Air needed
- › Amount of Fuel needed
- › Position, Geometry of Air-staging Nozzles
- › Geometry of the Burner: => Outlet Cross Section
 => Swirl Angle
 => Muffle Geometry

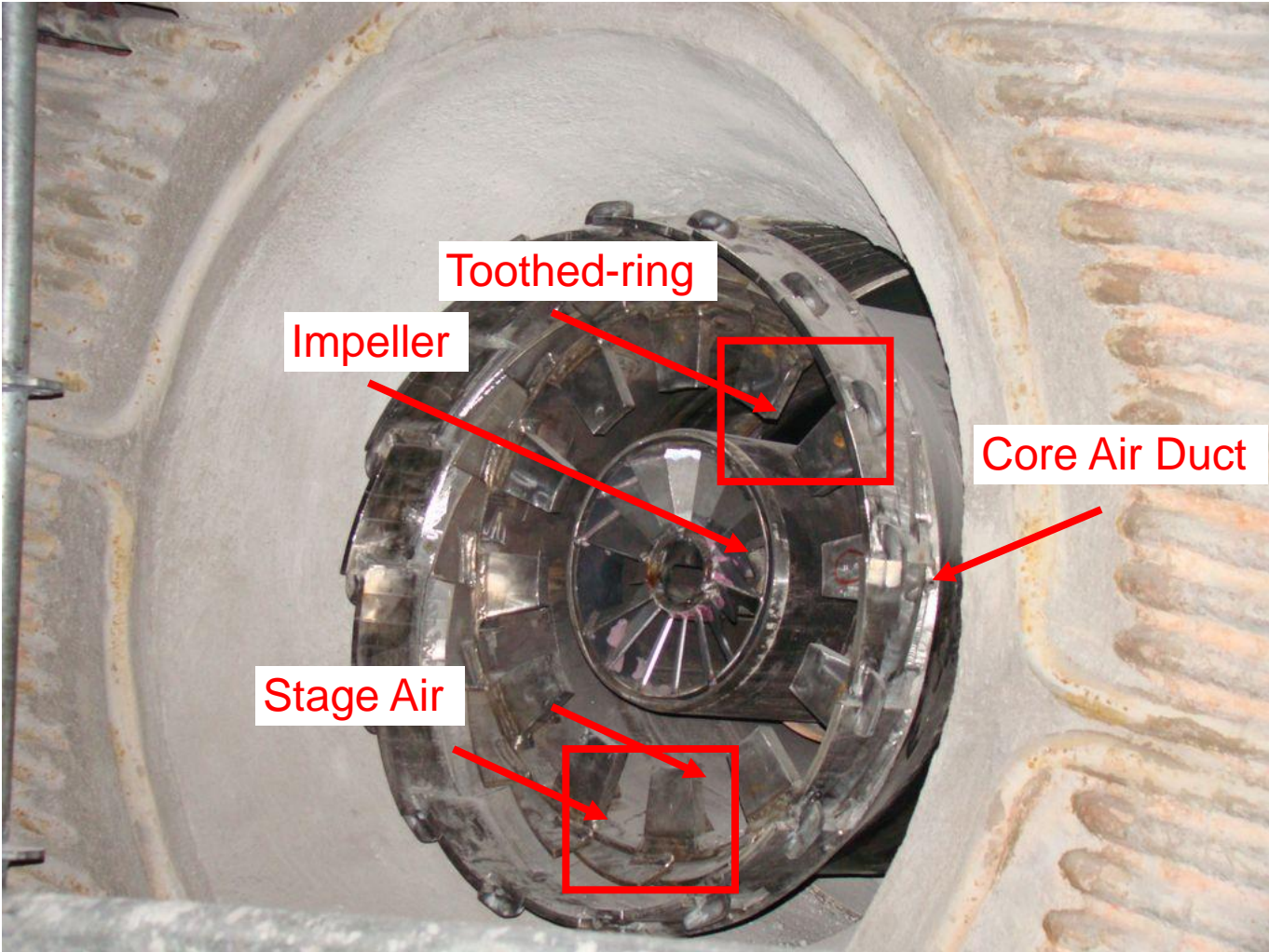
Simulation-based Procurement Decision Comparison of Offers Wall Atmosphere: Air Nozzles



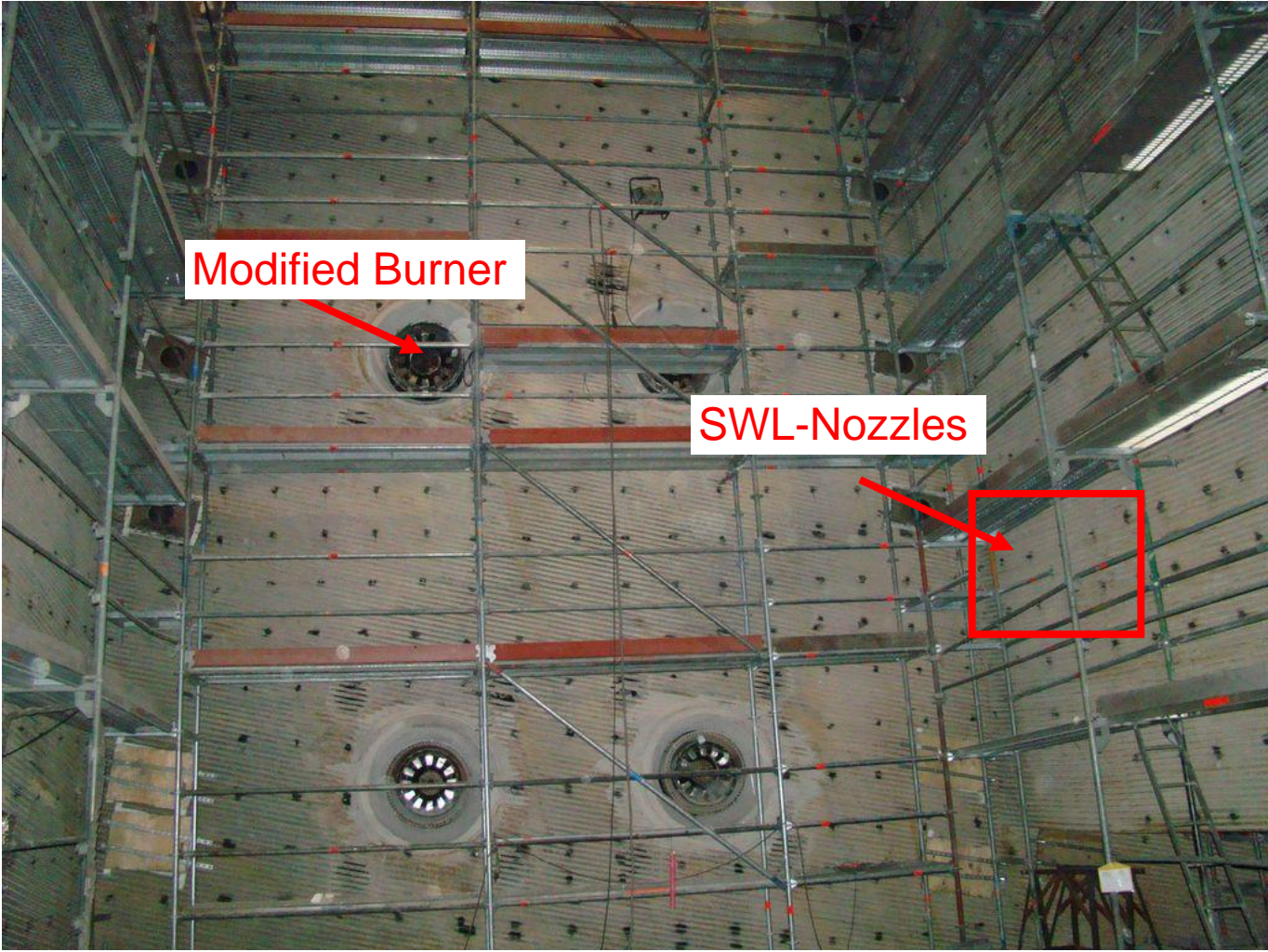
Selected Concept Modification of Burner, Retrofit SWL- and ABL- Nozzles



Refurbishment Burner Orifice



Boiler View



Results

	Status	Result
Total Air - Ratio	1,23	<= 1,18
NOx* [mg/Nm ³ ,6% O ₂]	Ø 852 (836 – 884)	450
CO* [mg/Nm ³ ,6% O ₂]	Ø 7 (7 – 8)	-
O2 before Luvo* [vol.-%, dry]	Ø 4,30 (4,09 – 4,40)	-
Un-burnt in the Ash [weight.-%]	2,2	< 5
WA-Measuring > 0,5% O ₂ [%]	98,6	100
WA-Measuring > 1% O ₂ [%]	95,8	90
Distribution of grinded Coal	< +/-10%	-
Combustion-Chamber Temper. [°C]	-	no change
Burner Slagging	no	no impact

Rehabilitation & Modernisation Measures

Boiler Island

Turbine Island

Auxiliary Systems as Air & Flue Gas Duct

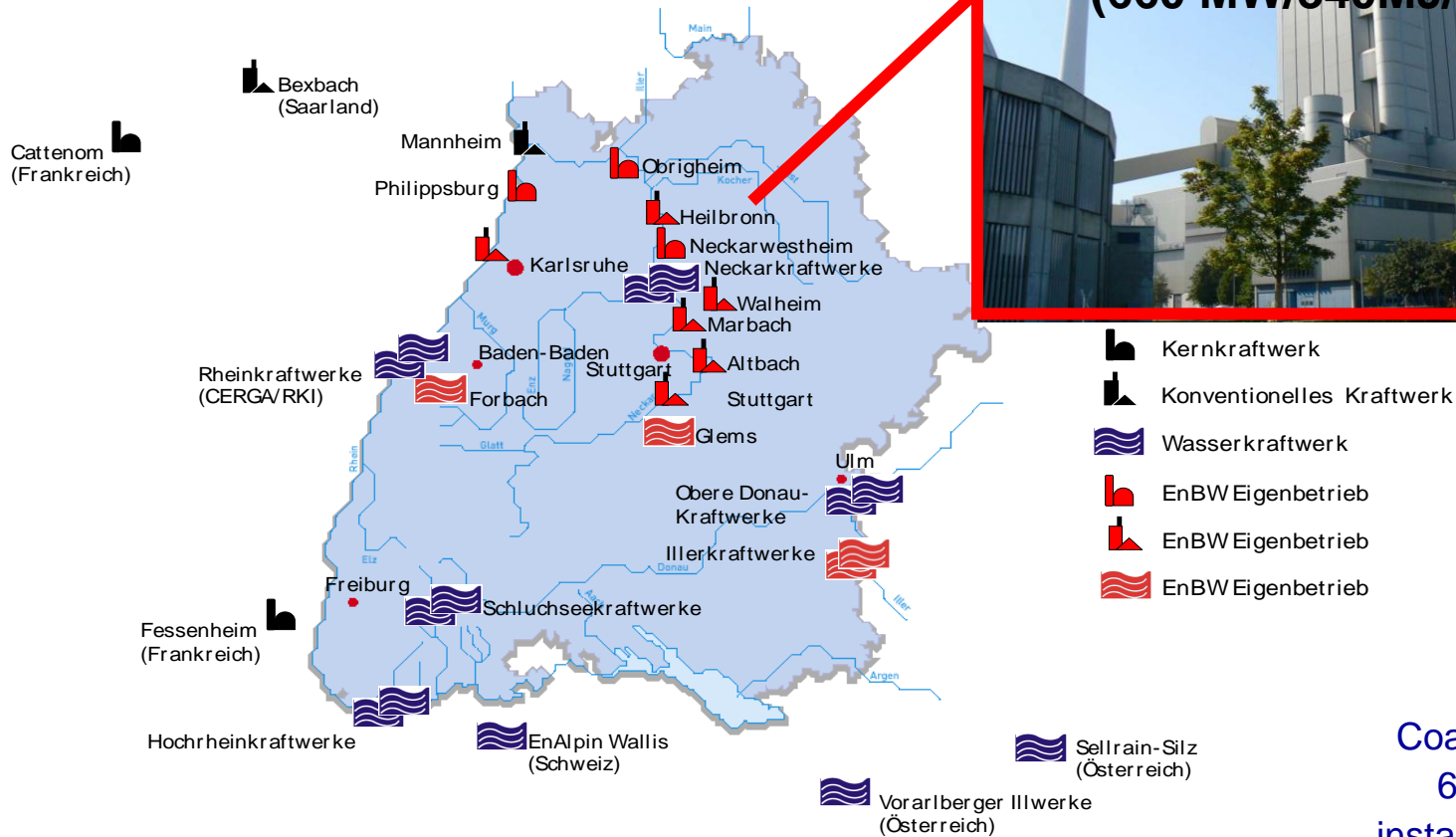
Modernization of Pulverisers

EnBW Kraftwerke AG

Power Plant Sites



Site Heilbronn (HLB 7)
(660 MW/340MJ/s)

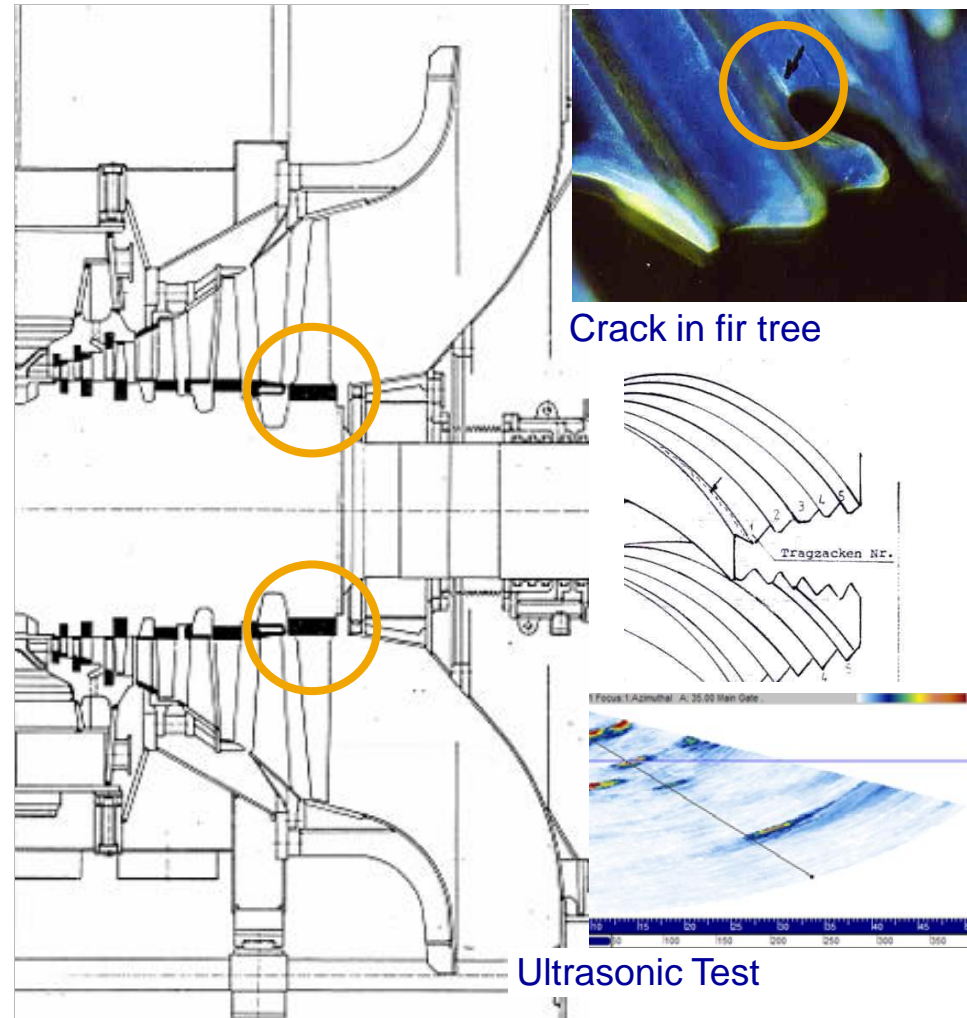


Coal, Oil, Gas:
6.600 MW
installed Capacity

Initial Situation

HLB 7 – Retrofit of Steam Turbine

- › Cracks in the Fir Trees of Rotor groove of the last row
- › Crack-size, -longitudinal and -number was increasing from 1994 until 2005



HLB 7 – Retrofit of Steam Turbine Island

Increase of Power Output of 19,5 MW was achieved by...

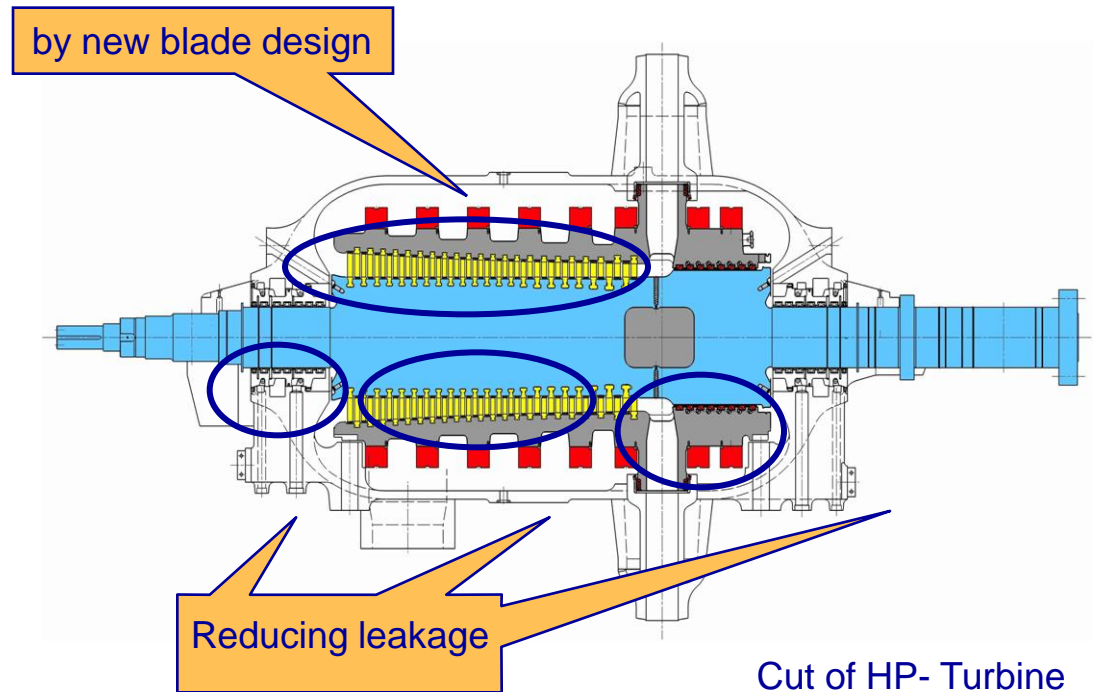


3D stator blade
and rotor blade

The measure has been performed during regular revision outage:

Duration 58 d

Retrofit ST 45 d



Rehabilitation & Modernisation Measures

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Modernization of Pulverisers

POWER Project

HLB 7 – Optimization of the Air/Flue Gas Duct System

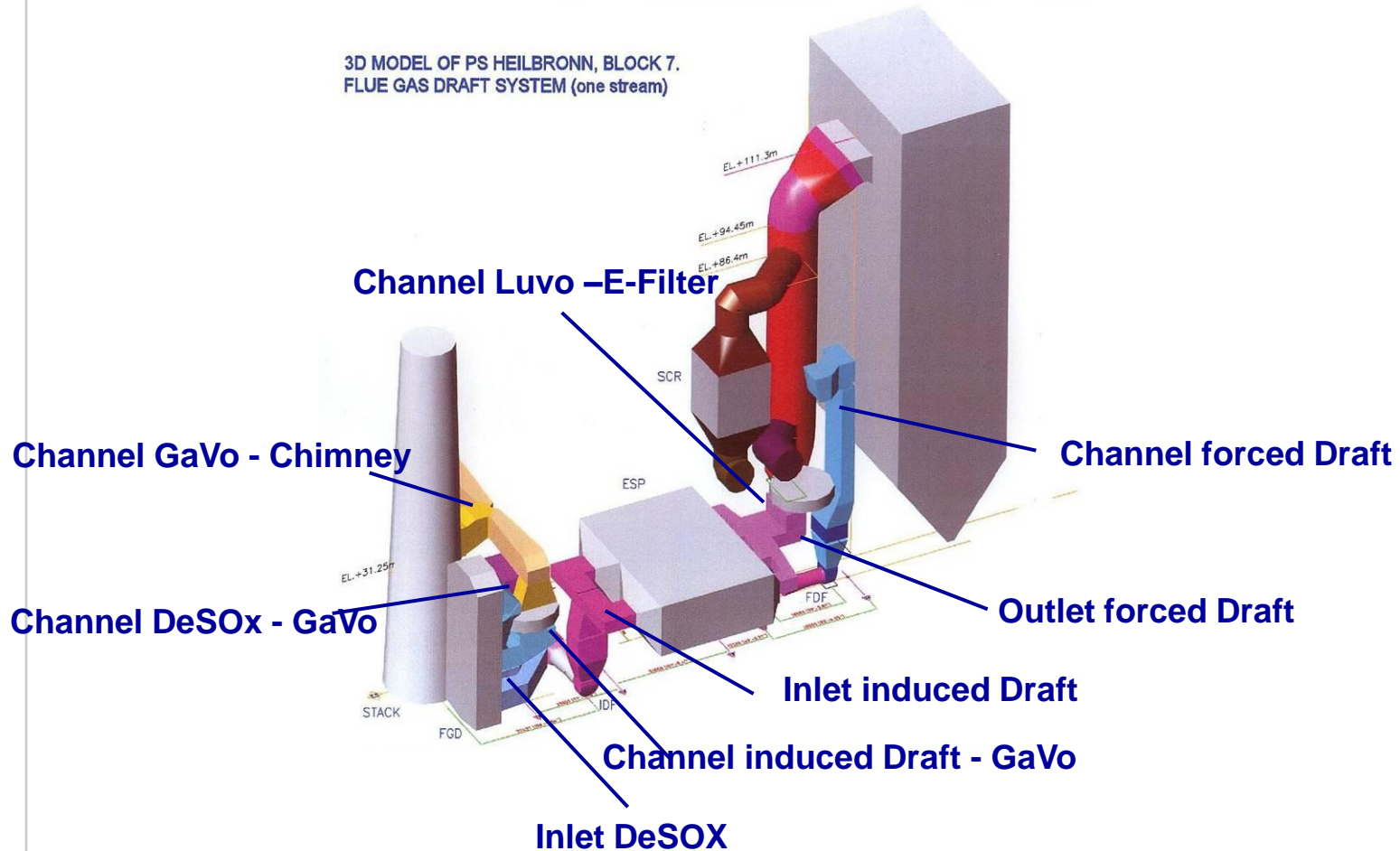
› Analysis

- › **Expectation: Optimisation of Flow in Air and Flue Gas Duct Parts might cause a Reduction of Pressure Loss and therefore reduces Auxiliary Consumption for forced and induced Draft Fan.**

3D Model

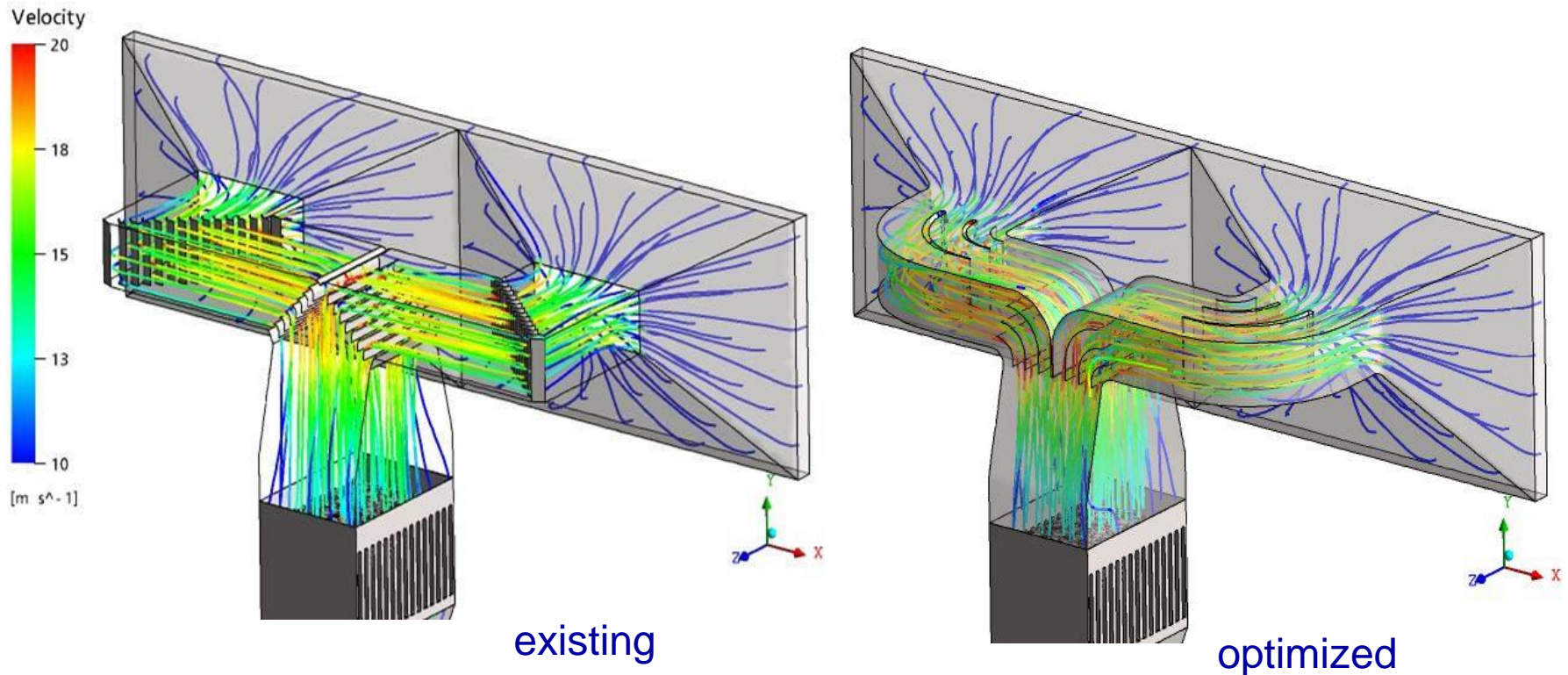
– Optimization of the Air/Flue Gas Duct System

3D MODEL OF PS HEILBRONN, BLOCK 7.
FLUE GAS DRAFT SYSTEM (one stream)



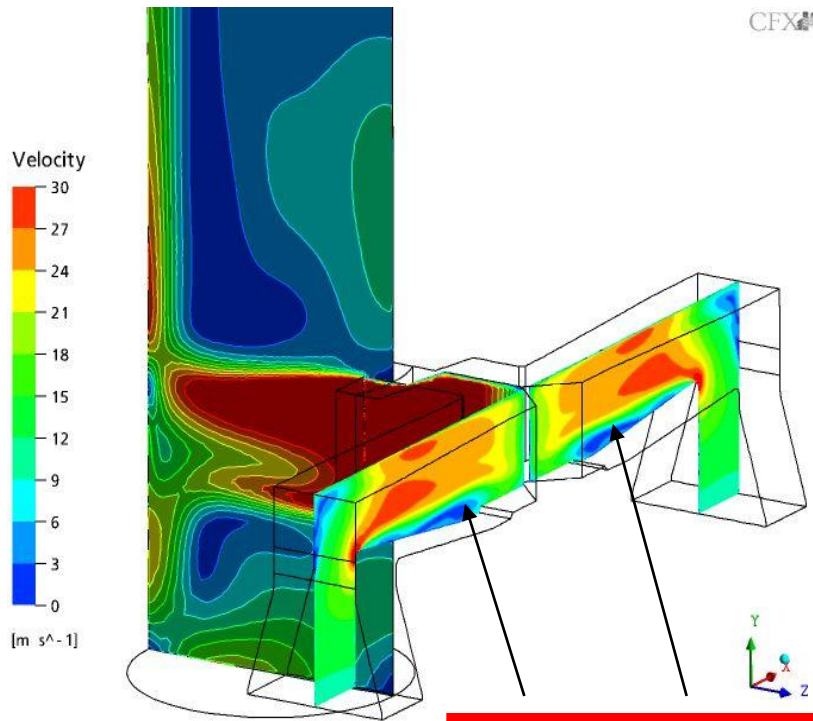
HLB 7 – Optimization of the Air/Flue Gas Duct System

Example CFD Analysis induced Draft Ducts



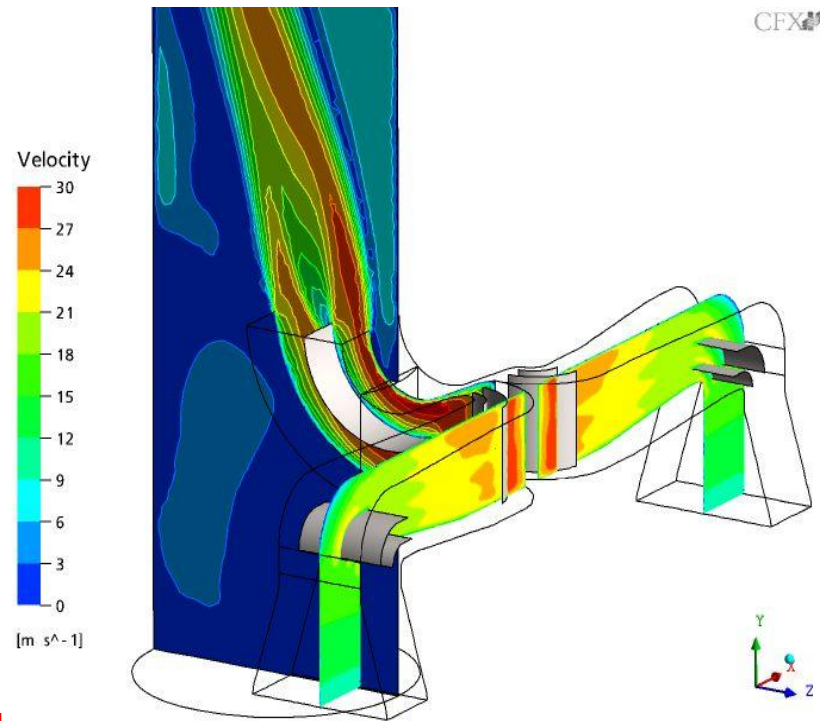
HLB 7 – Optimization of the Air/Flue Gas Duct System

Example CFD Analysis Chimney



existing

Unsteady flow

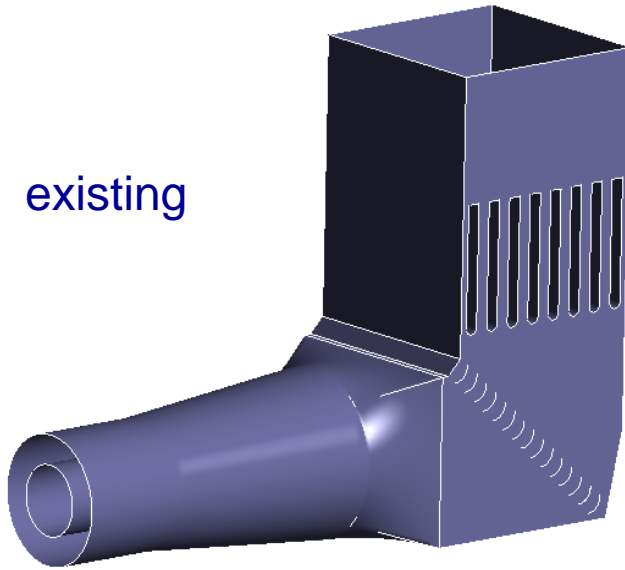


optimized
Arrangements

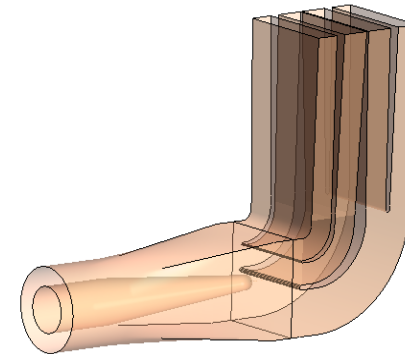
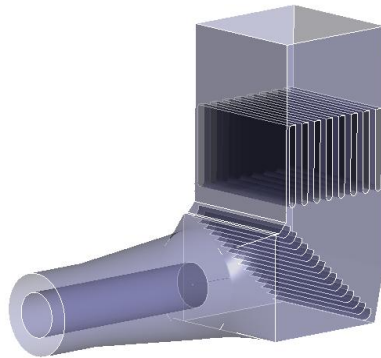
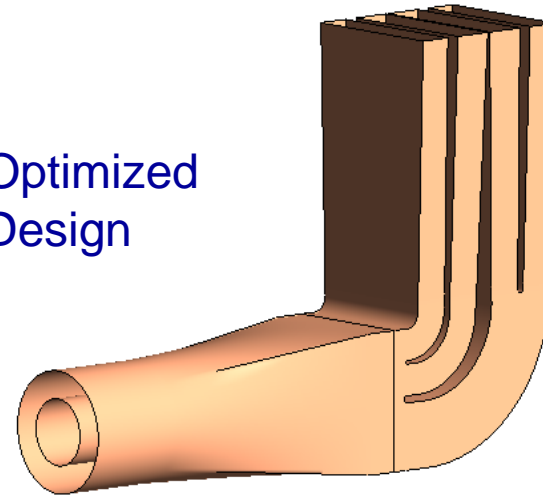
HLB 7 – Optimization of the Air/Flue Gas Duct System

Example CFD Analysis forced Draft Ducts

existing



Optimized Design



HLB 7 – Optimization of the Air/Flue Gas Duct System

Results → Reduction Pressure Loss

Savings in Auxiliary Consumption

Nr.	Bezeichnung	Presseure Loss existing (mbar)	M&I Approach (mbar)	achieved Reduction Pressure Loss (mbar)	Power Savings (both Lines) [kW]**
1	Inlet induced Draft Fan	4,93	3,92	1,01	130
2	Outlet induced Draft System Fan - Gavo-Inlet	11,17	6,07	5,10	650
3	Gavo-Outlet – Chimney Inlett	6,70	3,30	3,40	440
4	Inlet- forced Draft Fan	7,84	4,93	2,91	240
5	Outlet – forced Draft Fan	6,20	2,70	3,50	290
6	Outlet Luvo - Inlet ESP-Filter	19,31	17,27	2,04	260

2010 kW

* Reduction of Pressure Loss/Drop in GaVo by more homogenized Flow

** Auxiliary Power Savings related to existing and future Status on the Basis of the Fan Characteristic, Savings of the single Measures are not addable independently.

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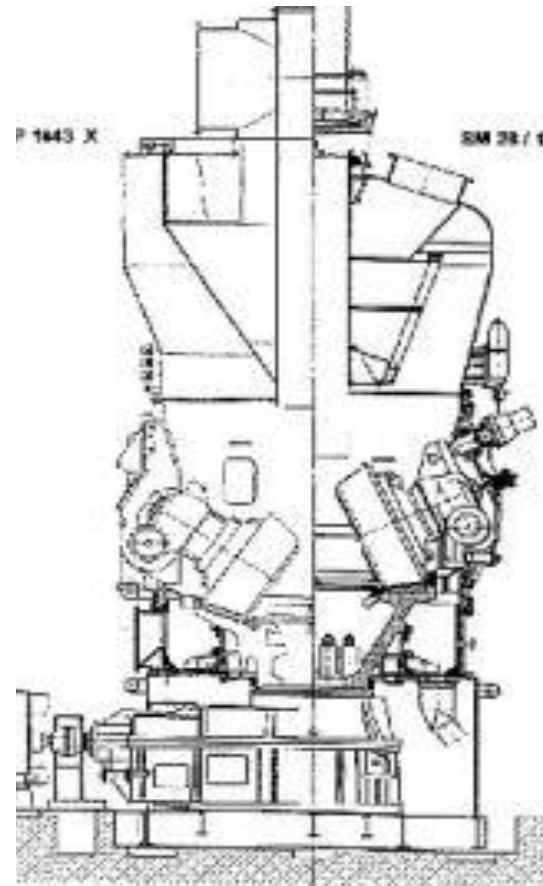
Modernization of Pulverisers

Results:

All Measures of Optimization 'Balance of Plant' enables an Increase of the Power Output of about 19 MW in HLB 7 and the new Pulverisers allowed an wider spread of used Coal

new

Ident. Number:	RP 1043
Classifier:	static
Grinding Figure R 90 µm	20 %
Milling Capacity [t/h]	ca. 77
Consump. Primary Air [m ³ /s]	< 21
Diameter of Rolls/Balls [mm]	1430
Diameter of Bowl [mm]	2670



SM 28/17

dynamic

10..25 %

ca. 105

> 22,5

1730

2800

VCEB

POWERTECH