



Experience in Online Performance Monitoring and Optimization in German Power Plants

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EVONIK
INDUSTRIES

PADOs in Germany

Evonik Energy Services

Eon (5), RWE (8), Vattenfall (5), EnBW (1)

PADOs ...

PADOs ...

Evonik



Walsum

600 MW



Lünen

500 MW



Herne

950 MW



Voerde

2,222 MW



Weiher

707 MW



Bergkamen

747 MW



Bexbach

773 MW



Fenne

502 MW



Walsum

750 MW



Termopaipa

165 MW



Iskenderun

1,320 MW



Köln-Godorf

211 MW



Mindanao

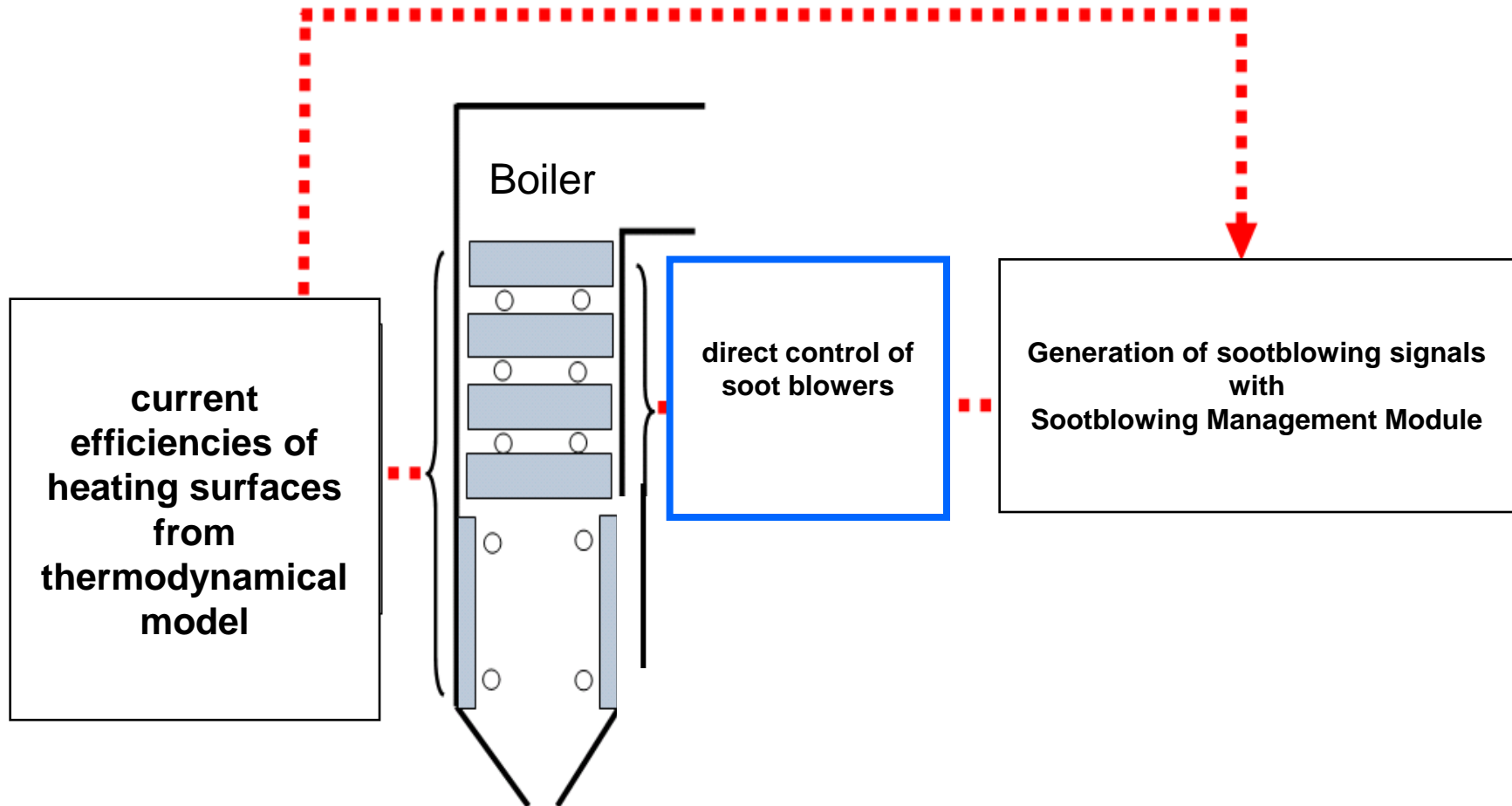
232 MW



Leuna

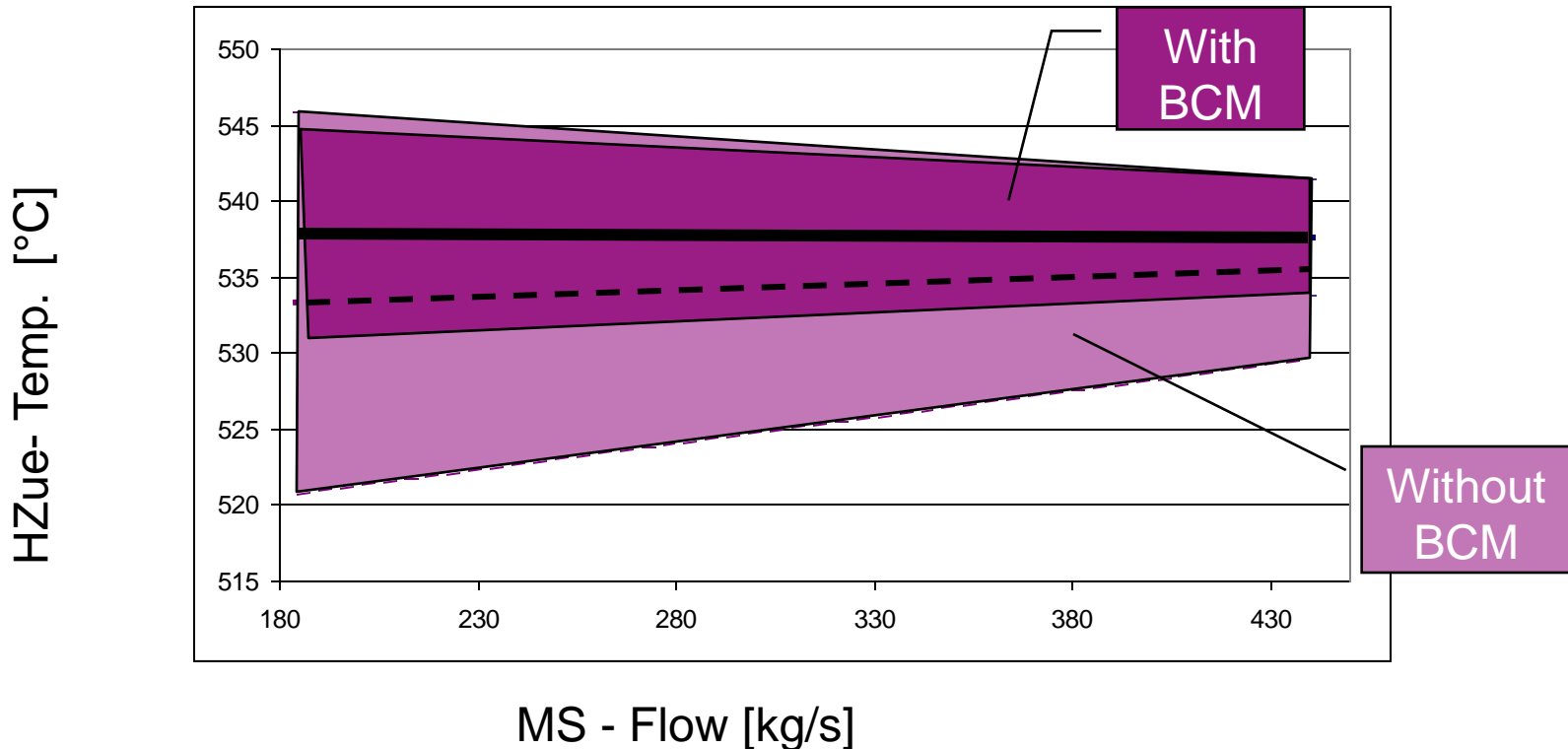
158 MW

Sootblowing in PADO



Case Study: Improving RH temperatur in a 500MW coal fired unit

→ Intelligent sootblowing can help to maintain hot RH temperature. It avoids cleaning the superheater surfaces in case of strong fouling of the reheater and thus avoids further reduction of heat input to the superheater



Case Study: reducing sootblowing steam consumption in a 350MW coal fired unit

- ➔ Intelligent sootblowing can help to reduce sootblowing steam . By taking into account the fouling conditions of the heating surfaces it activates the sootblowers if and only it is necessary to maintain the required operational conditions

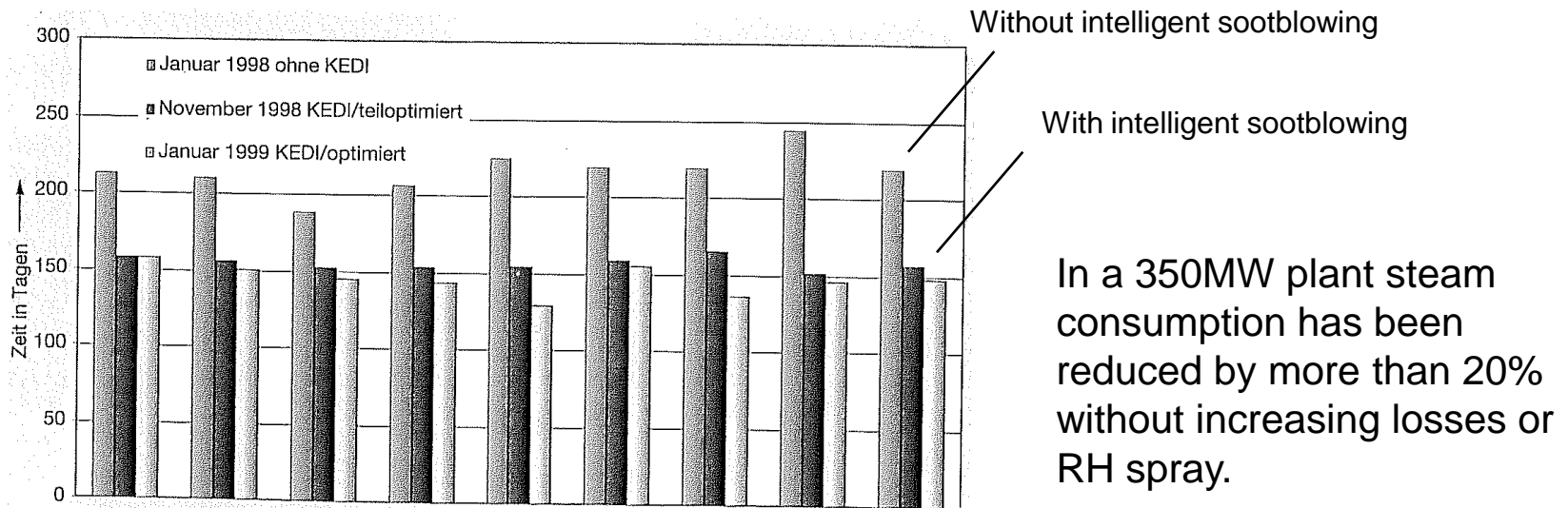
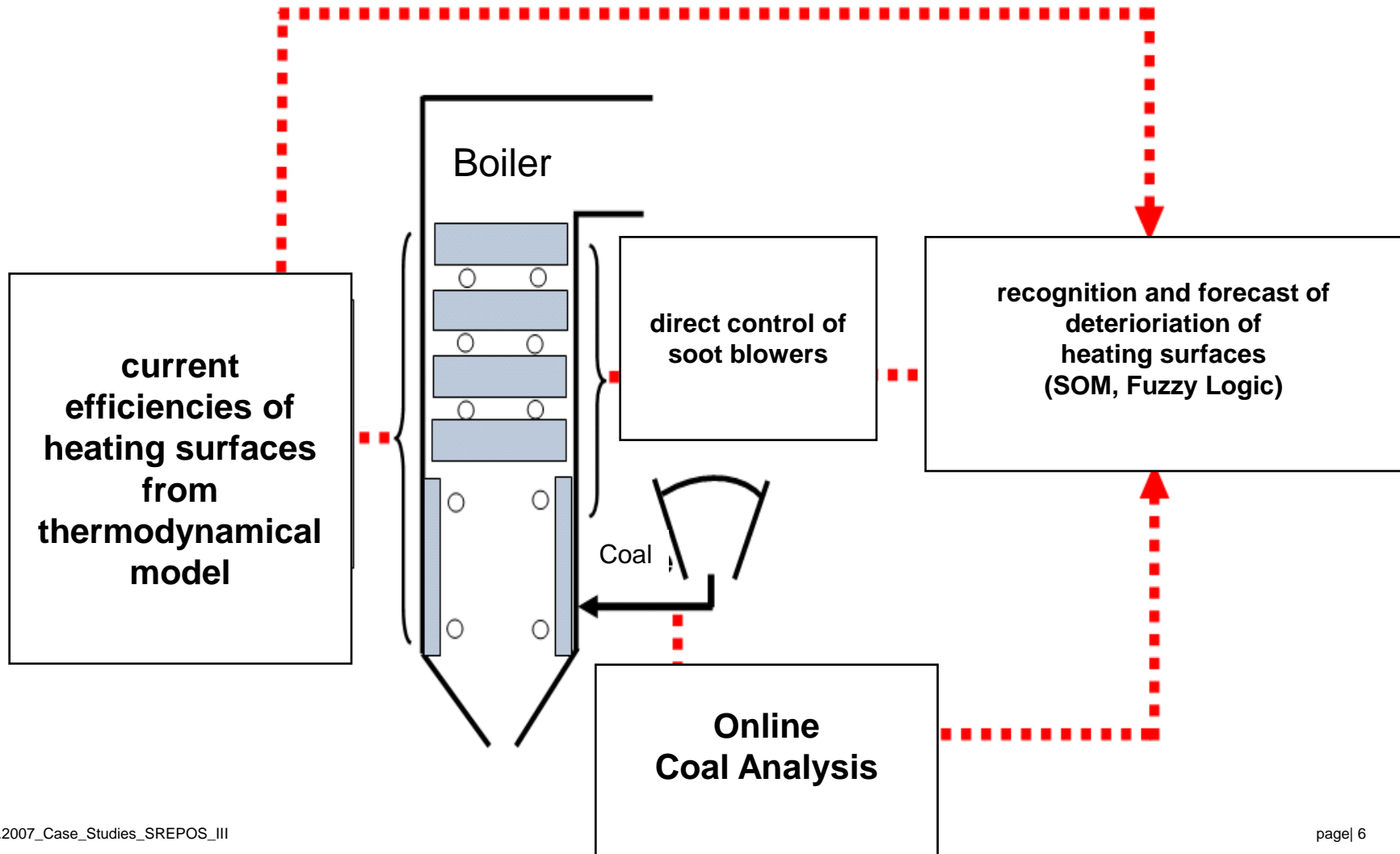


Bild 10. Vergleich der Rußblasedampfmenge mit/ohne KEDI für Zeiträume mit vergleichbaren Lastverläufen.

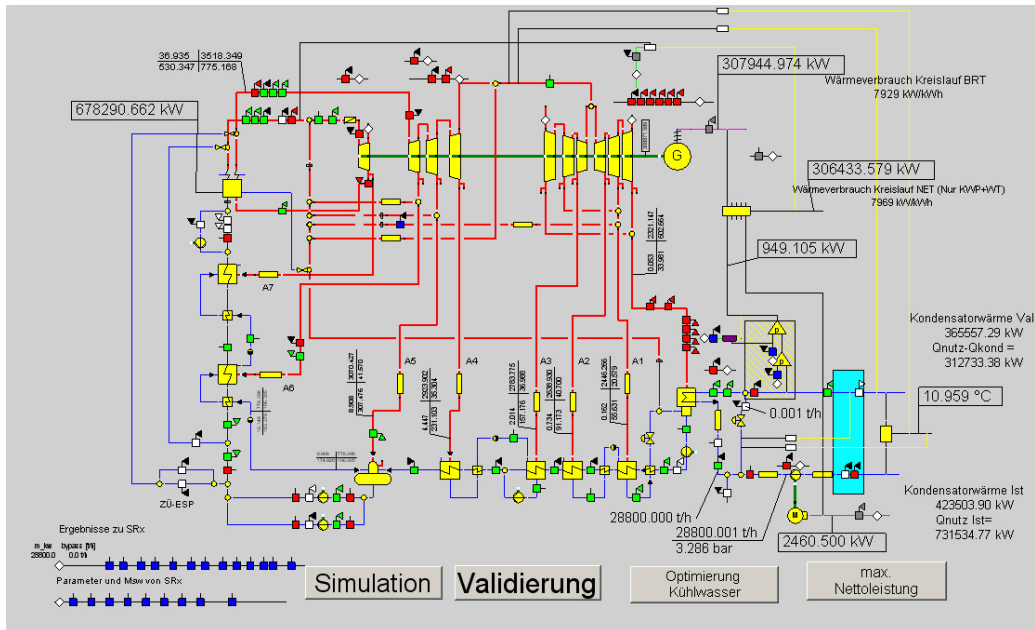
PADO in Lignite Power Plants e.g. RWE



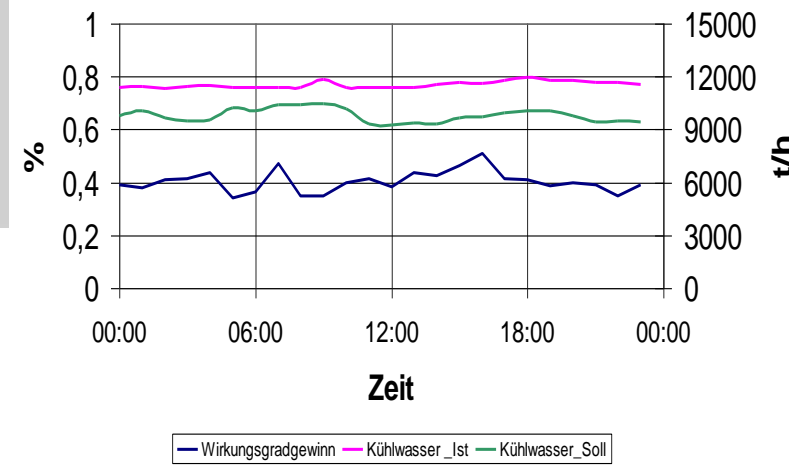
Optimization of Cooling Water Mass Flow considering:

- **Cost of**
 - Fuel**
 - water**
- **Energy Consumption of CW Pumps**
- **Energy Generation of Francis Turbines**
- **Envirometal Restrictions (monitored by authority)**
 - CW temperature increase**
 - CW outlet temperature**
- **maximum CW Flow**

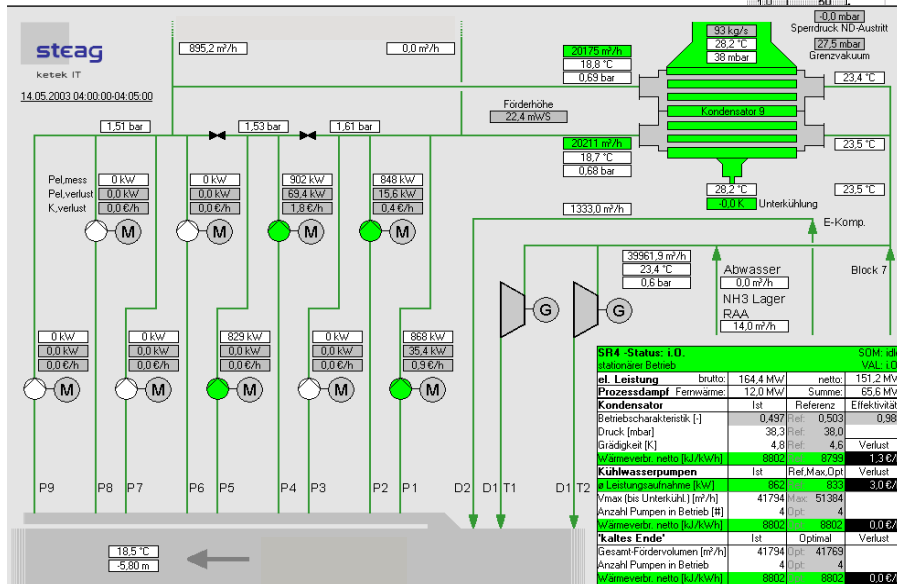
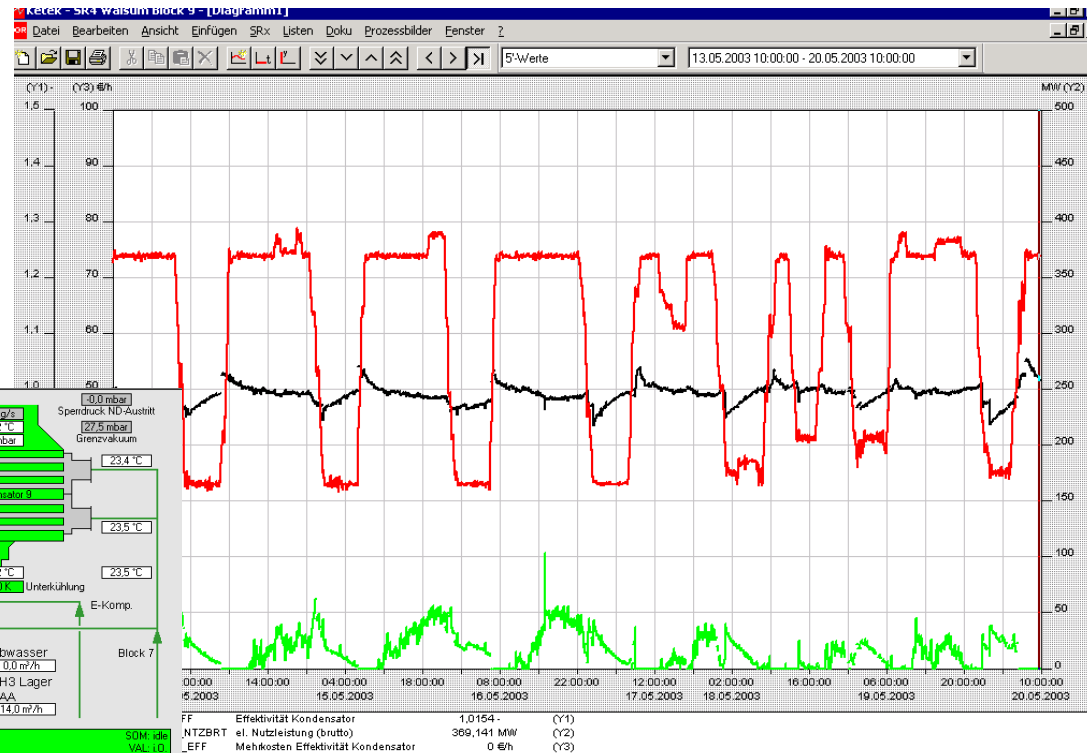
Cold End Optimization



- Restrictions for max. temperature increase of fresh water
- Upto 0.5% gain in total efficiency
- 70T€ savings per annum



Monitoring of Condenser Quality

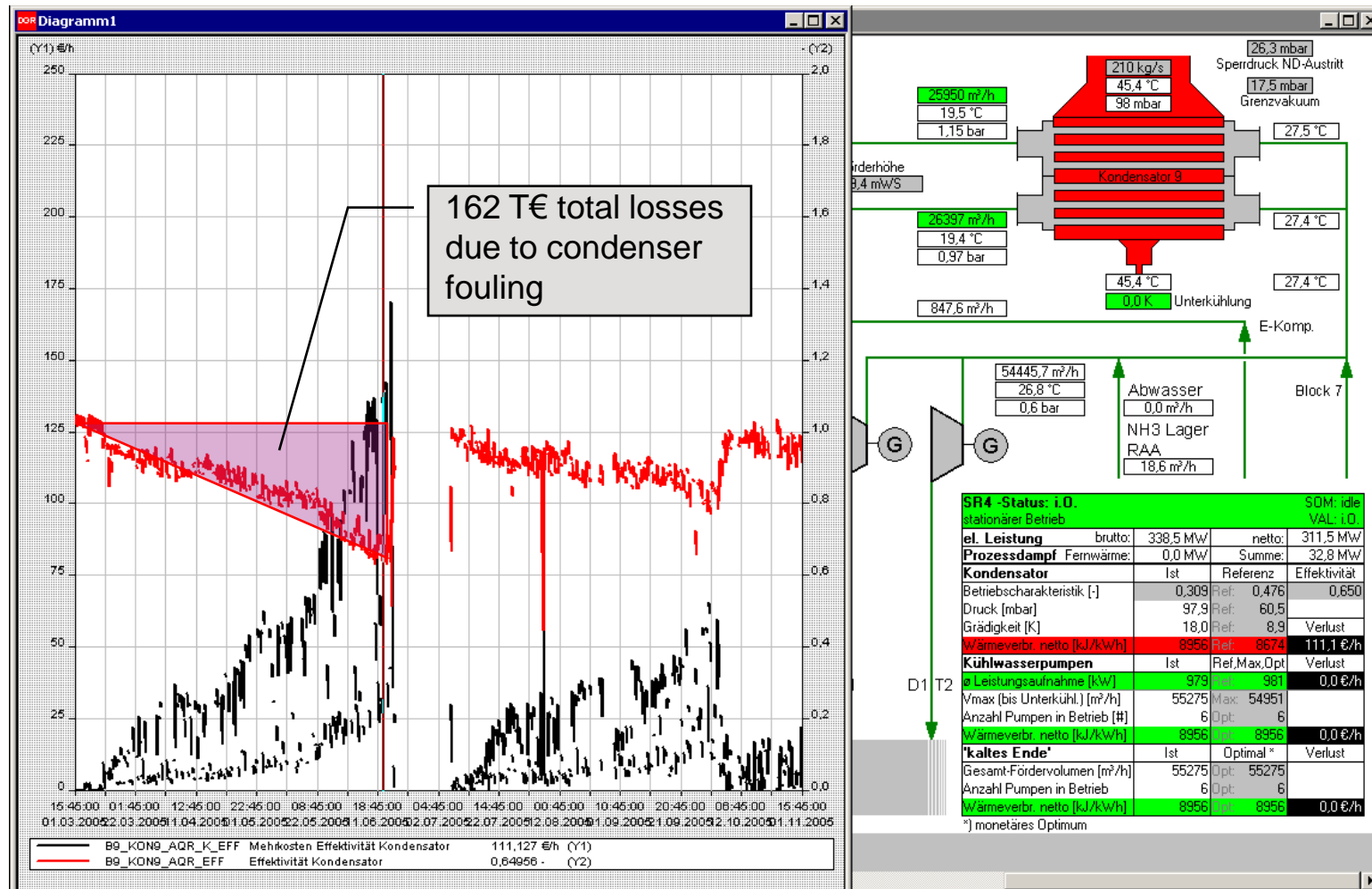


SR4 Status: 1.0 SOM: alle stationärer Betrieb VAL: 1.0

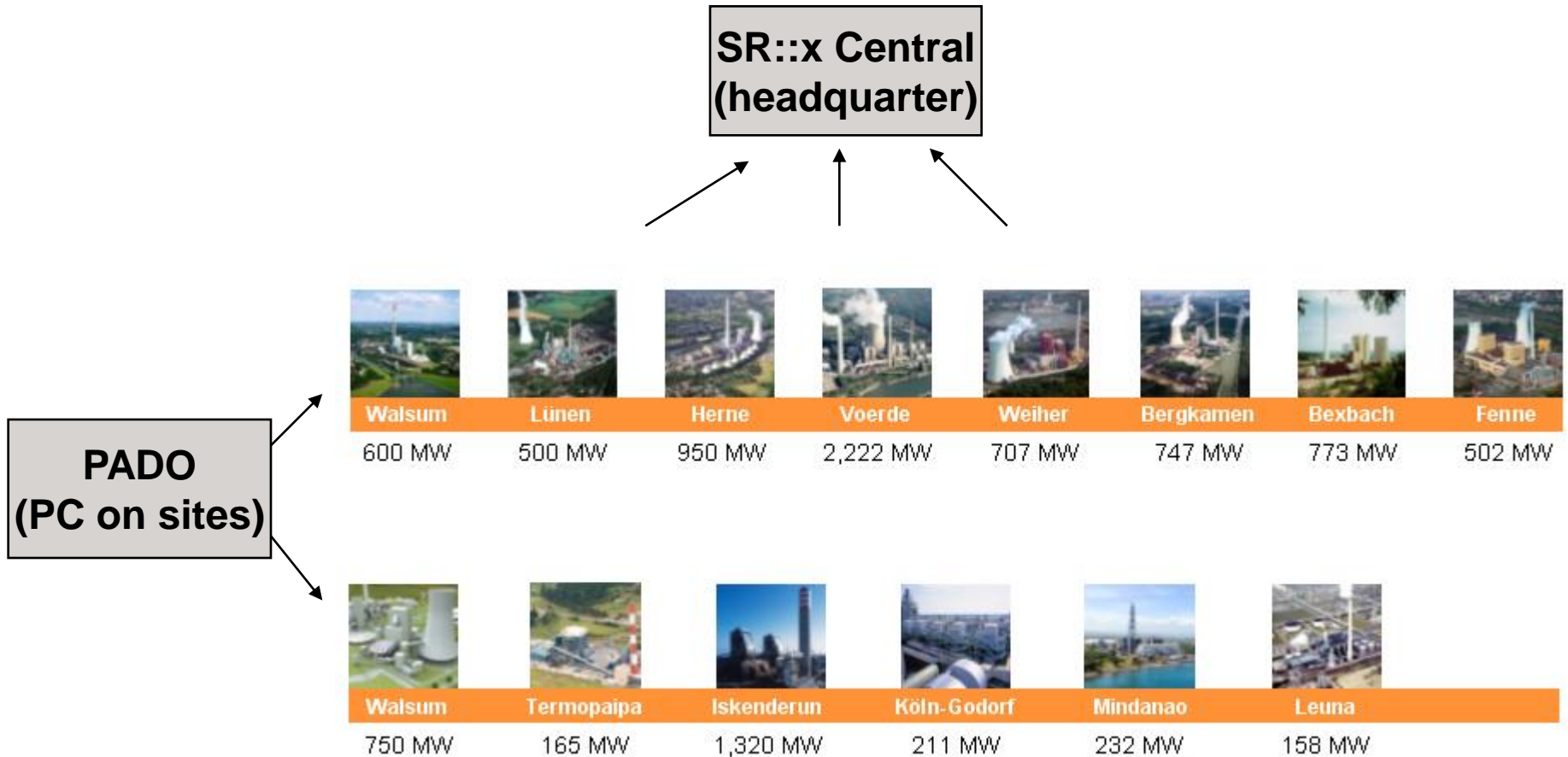
el. Leistung	brutto: 164.4 MWh	netto: 151.2 MWh
Prozessdampf	Ferrowärme: 12.0 MWh	Summe: 65.6 MWh
Kondensator	Ist: 0.497	Referenz: 0.503
Betriebscharakteristik [-]	Ist: 38.3	Ref: 38.0
Druck [mbar]	Ist: 4.8	Ref: 4.6
Gradigkeit [K]	Ist: 8802	Ref: 8799
Wärmeverl. netto [kJ/kWh]	Ist: 33961.9	Ref: 33961.9
Abwasser	Ist: 23.4 °C	Ref: 23.4 °C
NH3 Lager RAA	Ist: 14.0 m³/h	Ref: 14.0 m³/h
E-Komp.	Ist: 0.0 m³/h	Ref: 0.0 m³/h
Block 7	Ist: 0.0 m³/h	Ref: 0.0 m³/h

FF	Effektivität Kondensator	1.0154	(Y1)
NTZBRT	el. Nutzleistung (brutto)	369,141 MW	(Y2)
EFF	Mehrkosten Effektivität Kondensator	0 €/h	(Y3)

Cost of condenser fouling



SR::x Central



SR::x Central Performance Monitoring



- Fleetwide real time tracking of CO₂ emissions
- Data reconciliation of coal consumption data
- Consistent determination of characteristic plant data for the Evonik Steag fleet

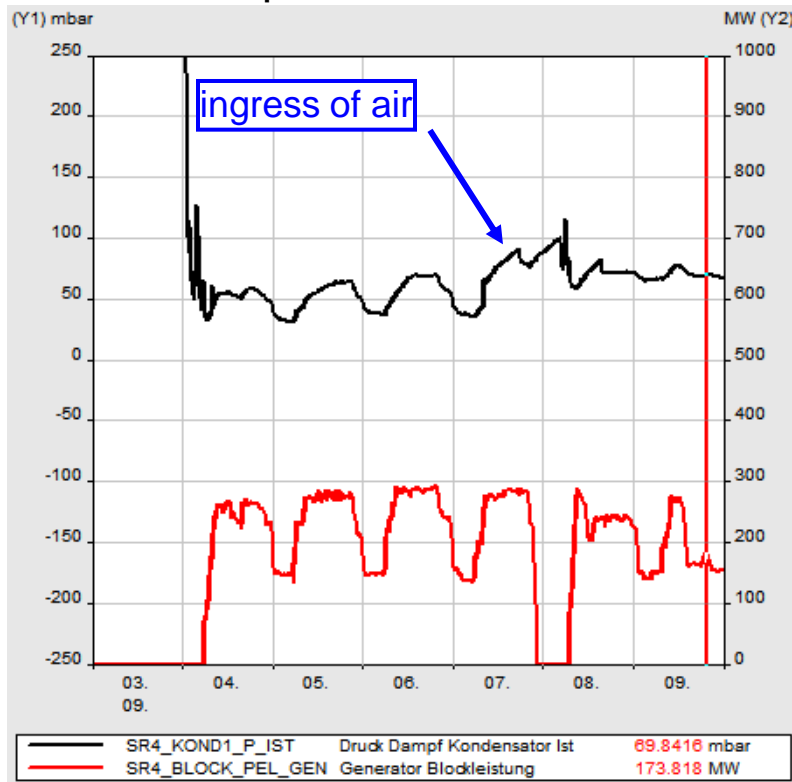
12.07.2006 18:00:00-18:05:00 Zentrales Erfassungssystem für Blockkennzahlen und Emissionen 1σ = 68% Konfidenzintervall (x2 = 96%)
 0: keine Berechnung; E: Ersatzwertrechnung
 B: Bilanzrechnung; K: Kennwertrechnung

steag ketek IT	in Planung					Σ STEAG, aktuell aktuelle Summe aller Blöcke
	Bergkamen	Herne 3	Herne 4	Lünen 6	Lünen 7	
Betriebsart (nach VGB)	Beharrung stationär	Beharrung stationär	Beharrung stationär	Beharrung stationär	Beharrung stationär	
Berechnungsstatus* (OEBK)	stationär -> B+K	stationär -> B+K	stationär -> B+K	stationär -> B+K	stationär -> B+K	
Klemmenleistung	185 MW	166 MW	185 MW	185 MW	35 MW	1228,2 MW
Ferwärme	0 MJ/s	0 MJ/s	0 MJ/s	0 MJ/s	16 MJ/s	2,6 MJ/s
spez. Block-WV netto	83 J/Wh ± 204	38 J/Wh ± 415	83 J/Wh ± 204	110 J/Wh ± 185	163 J/Wh ± 271	
spez. Turbine-WV brutto	52 J/Wh ± 146	30 J/Wh ± 335	52 J/Wh ± 146	90 J/Wh ± 150	58 J/Wh ± 230	
Kesselwirkungsgrad (DIN)	1,9 ± 0,007	1,9 ± 0,004	1,9 ± 0,007	1,9 ± 0,004	1,9 ± 0,003	
Stromverlust (anteilig)	1,0 MW ± 0,00	1,0 MW ± 0,00	1,0 MW ± 0,00	0,0 MW ± 0,00	1,5 MW ± 0,06	1σ
Kohlemassenstrom	13,3 t/h ± 4,1	6,2 t/h ± 4,2	13,3 t/h ± 4,1	18,8 t/h ± 1,3	13,0 t/h ± 4,2	471,3 t/h ± 13,8
Sekundärbrennstoff	0 kg/s	0 kg/s	0 kg/s	0 kg/s	0 m ³ /h	0,00 t/h
Heizöl	0 kg/s	0 kg/s	0 kg/s	0 kg/s	0 m ³ /h	0,00 t/h
Gas	1 kg/s	1 kg/s	1 kg/s	0,0 kg/s	0 m ³ /h	0,00 t/h
Brennstoff Hilfskessel						
CO ₂ (Online*f(korr))	415,8 t/h ± 9,1	198,9 t/h ± 20,4	415,8 t/h ± 9,1	135,6 t/h ± 3,2	302,1 t/h ± 10,1	1052,3 t/h ± 42,8
f(korr) = MBS/Online-Kohle	0,9844 ± 0,0898	1,0465 ± 0,1198	0,9844 ± 0,0898	0,9988 ± 0,0165	1,0098 ± 0,0199	
Datenbasis	endgültige Tagesrech. 3	endgültige Tagesrech. 3	endgültige Tagesrech. 3	endgültige Tagesrech. 3	vorläufige Tagesrech. 2	
	in Planung					Σ kumuliert, Jahr kumulierte Summe aller Blöcke*** ***) bis Jan'07 nur Lünen
	Voerde A	Voerde B	Walsum	West I	West II	
Betriebsart (nach VGB)	Beharrung stationär	Beharrung stationär	Beharrung stationär	Beharrung stationär	Beharrung stationär	
Berechnungsstatus* (OEBK)	stationär -> B+K	stationär -> B+K	stationär -> B+K	stationär -> B+K	stationär -> B+K	
Klemmenleistung	185 MW	166 MW	185 MW	185 MW	35 MW	2063,1 GWh
Ferwärme	0 MJ/s	0 MJ/s	0 MJ/s	0 MJ/s	16 MJ/s	144,0 GWh
spez. Block-WV netto	83 J/Wh ± 204	38 J/Wh ± 415	83 J/Wh ± 204	110 J/Wh ± 185	163 J/Wh ± 271	
spez. Turbine-WV brutto	52 J/Wh ± 146	30 J/Wh ± 335	52 J/Wh ± 146	90 J/Wh ± 150	58 J/Wh ± 230	
Kesselwirkungsgrad (DIN)	1,9 ± 0,007	1,9 ± 0,004	1,9 ± 0,007	1,9 ± 0,004	1,9 ± 0,003	
Stromverlust	1,0 MW ± 0,00	1,0 MW ± 0,00	1,0 MW ± 0,00	0,0 MW ± 0,00	1,5 MW ± 0,06	1σ
Kohlemassenstrom	13,3 t/h ± 4,1	6,2 t/h ± 4,2	13,3 t/h ± 4,1	18,8 t/h ± 1,3	13,0 t/h ± 4,2	789,1 kt ± 39,1
Sekundärbrennstoff	0 kg/s	0 kg/s	0 kg/s	0 kg/s	0 m ³ /h	0,00 t/h
Heizöl	0 kg/s	0 kg/s	0 kg/s	0 kg/s	0 m ³ /h	0,00 t/h
Gas	1 kg/s	1 kg/s	1 kg/s	0,0 kg/s	0 m ³ /h	0,00 t/h
Brennstoff Hilfskessel						
CO ₂ (Online*f(korr))	415,8 t/h ± 9,1	198,9 t/h ± 20,4	415,8 t/h ± 9,1	135,6 t/h ± 3,2	302,1 t/h ± 10,1	1960,1 kt ± 110,3
f(korr) = MBS/Online-Kohle	0,9844 ± 0,0898	1,0465 ± 0,1198	0,9844 ± 0,0898	0,9988 ± 0,0165	1,0098 ± 0,0199	Prognose Jahr: Qbr / CO ₂
Datenbasis	endgültige Tagesrech. 3	endgültige Tagesrech. 3	endgültige Tagesrech. 3	endgültige Tagesrech. 3	vorläufige Tagesrech. 2	6692 GWh 2286 kt

SR::SPC Statistical Process Control

Semi-automatic, early and reliable recognition of process changes

Control room visualization of condenser pressure



SR::SPC module



During Implementation

- Impact of Headquarter / Site
- Sensors / Interfaces to DCS and PLCs

During Commissioning and Test Run

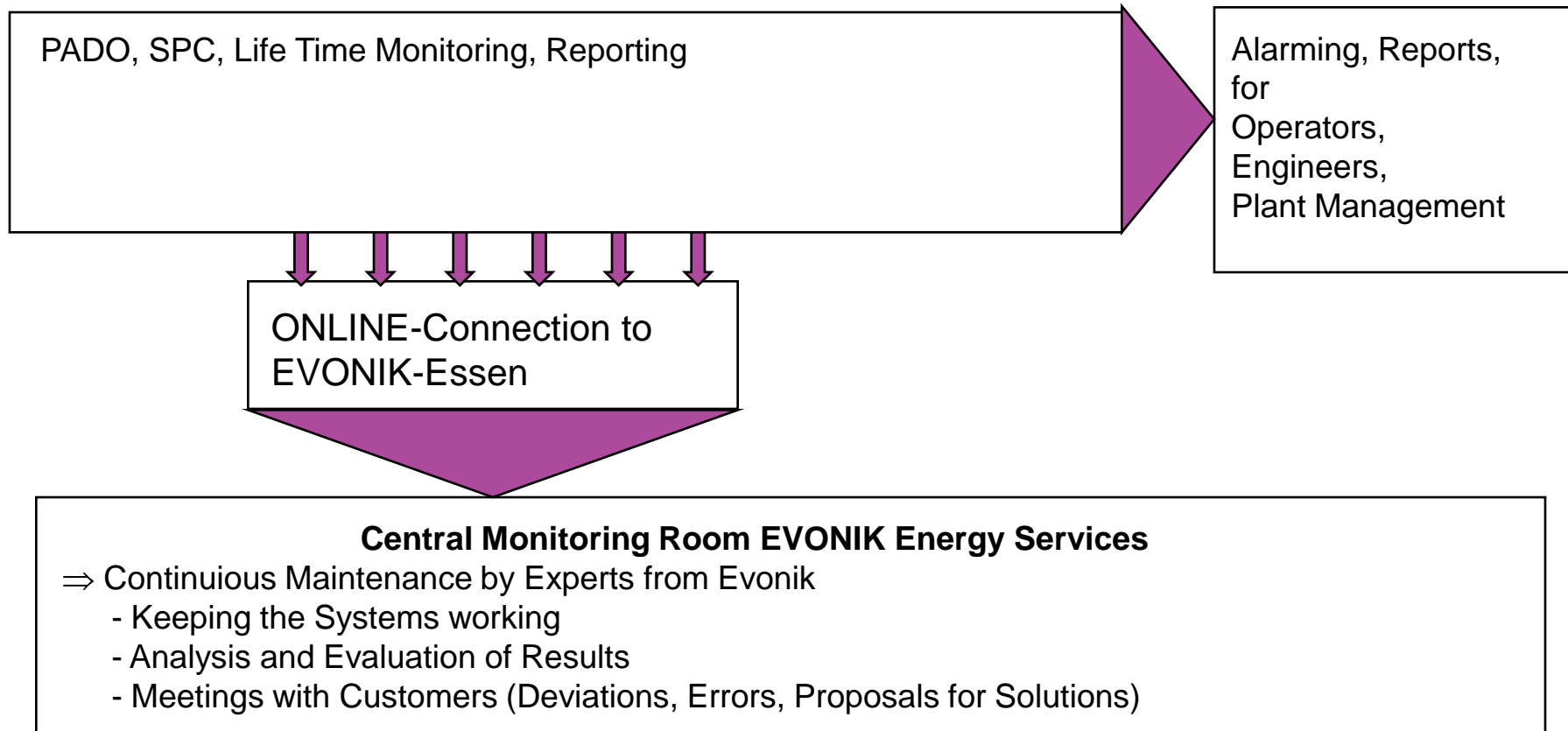
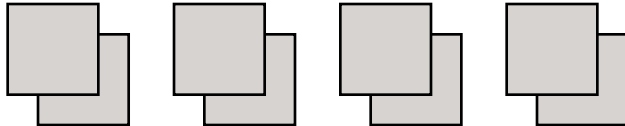
- Accuracy Aspects
- Support from Site

During Operation

- Closed Loop Vs. Advisory Mode
- AMC

Evonik Service Concept 2009

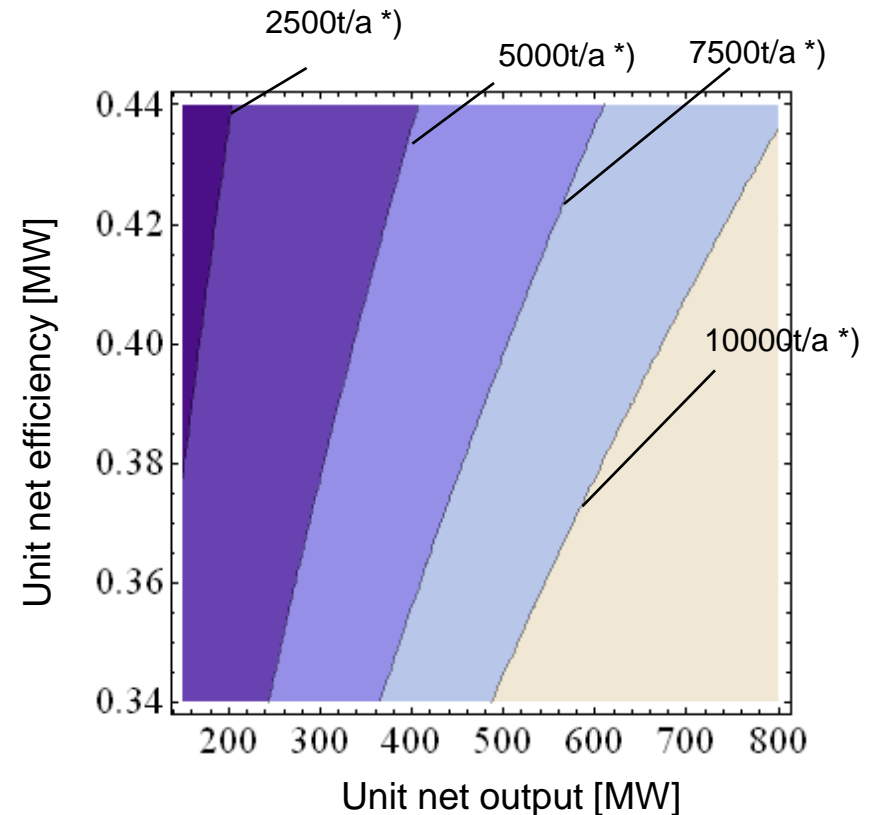
Customers



Potential coal savings by PADO technology

Usually a special unit does not have all of these benefits, but typically an overall improvement of 0.3% in unit net efficiency is achieved

- Coal savings per year depend on unit size, unit efficiency, full load equivalent operation hours and net calorific value of the coal:
- **250MW**, 38% efficiency, NCV= 29.3MJ/kg, 6000h/a full load equivalent: **3800t/a**
- **500MW**, 40% efficiency, NCV= 29.3MJ/kg, 6500h/a full load equivalent: **7500t/a**



*) calculated for 6500h/a and NCV = 29.3MJ/kgK



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