

Adaptions of Polish Coal Fired Power Plants to Meet Existing IED and Future Regulatory Emission Limits (BAT/BREF) (based on Patnow Power Plant Modernization Experiences)

Robert Żmuda, B.Higgins, E.Pozzobon,
D.Reutowicz, S.Mandrela, W. Adamczyk

1. Introduction
2. SBB Energy S.A.
3. ZEPAK Group
4. Patnow Power Plant – Retrofitting boilers 1 and 2
5. Patnow Power Plant – Projects results
6. Mercury reduction
7. Summary

2017 – Ratifying of the BAT/BREF for Large Combustion Plants with respect to Hg, SO₂, NO_x, HCl, HF and PM (dust) emission reduction



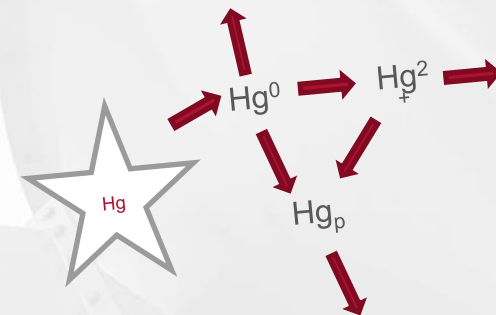
Circular economy with respect to coal power generation – *Sustainable Development*



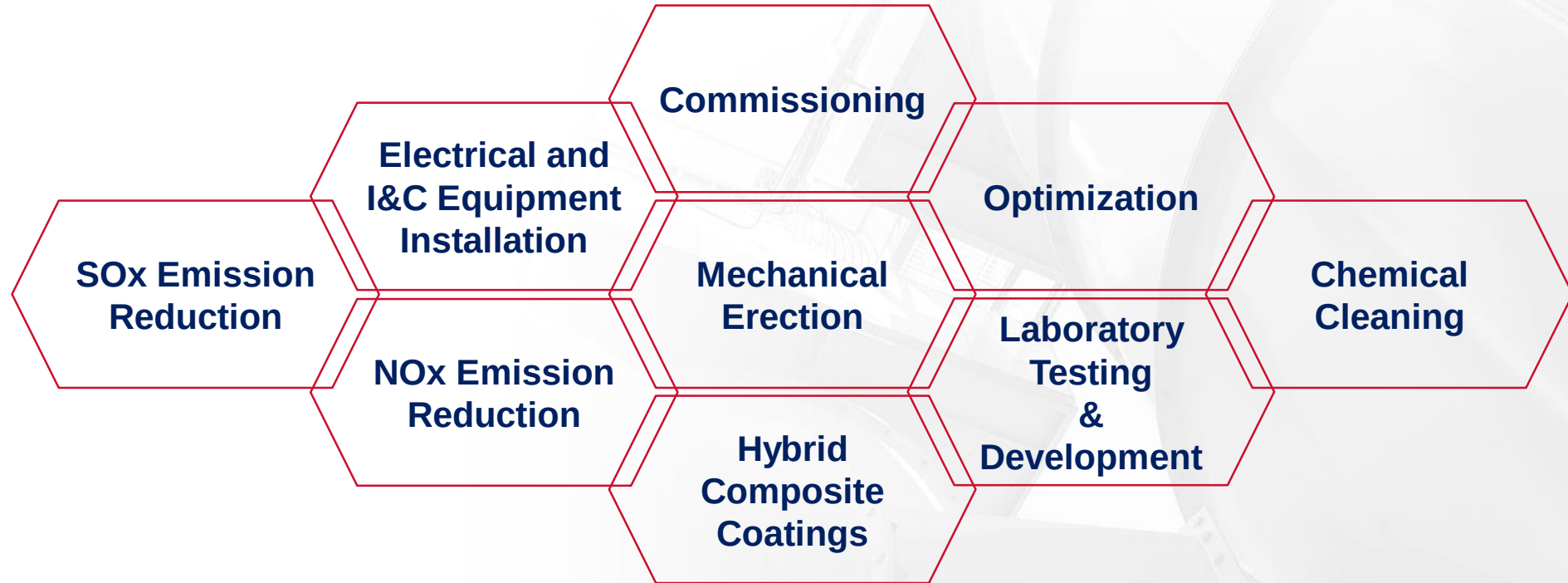
- **Reduction of mercury emissions**
- **Improvement of SO₂ capture**
- **Reduction of mercury content in fly ash as an anthropogenic mineral (product)**

	Lignite Coal
NO _x , mg/dNm ³	175
SO ₂ , mg/dNm ³	130
Hg, µg/dNm ³	7
HCl, mg/dNm ³	5
HF, mg/dNm ³	3
PM, mg/dNm ³	12

Environmental impact



SBB ENERGY S.A. has been operating in the power engineering industry for more than 20 years providing commissioning, erection, installation services and various other specialized works.



Primary technique ROFA

 **35-50%** of NOx emission reduction

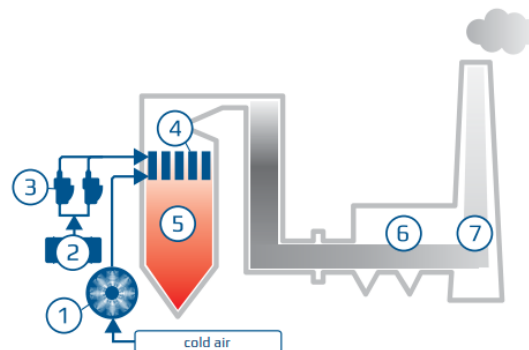
- Reduction of CO, SOx, unburned carbon in ash and particulate matter
- Improvement of combustion efficiency



1. Hot secondary air fan
2. Boiler
3. Secondary air nozzle system
4. ESP or Fabric Filter
5. Stack

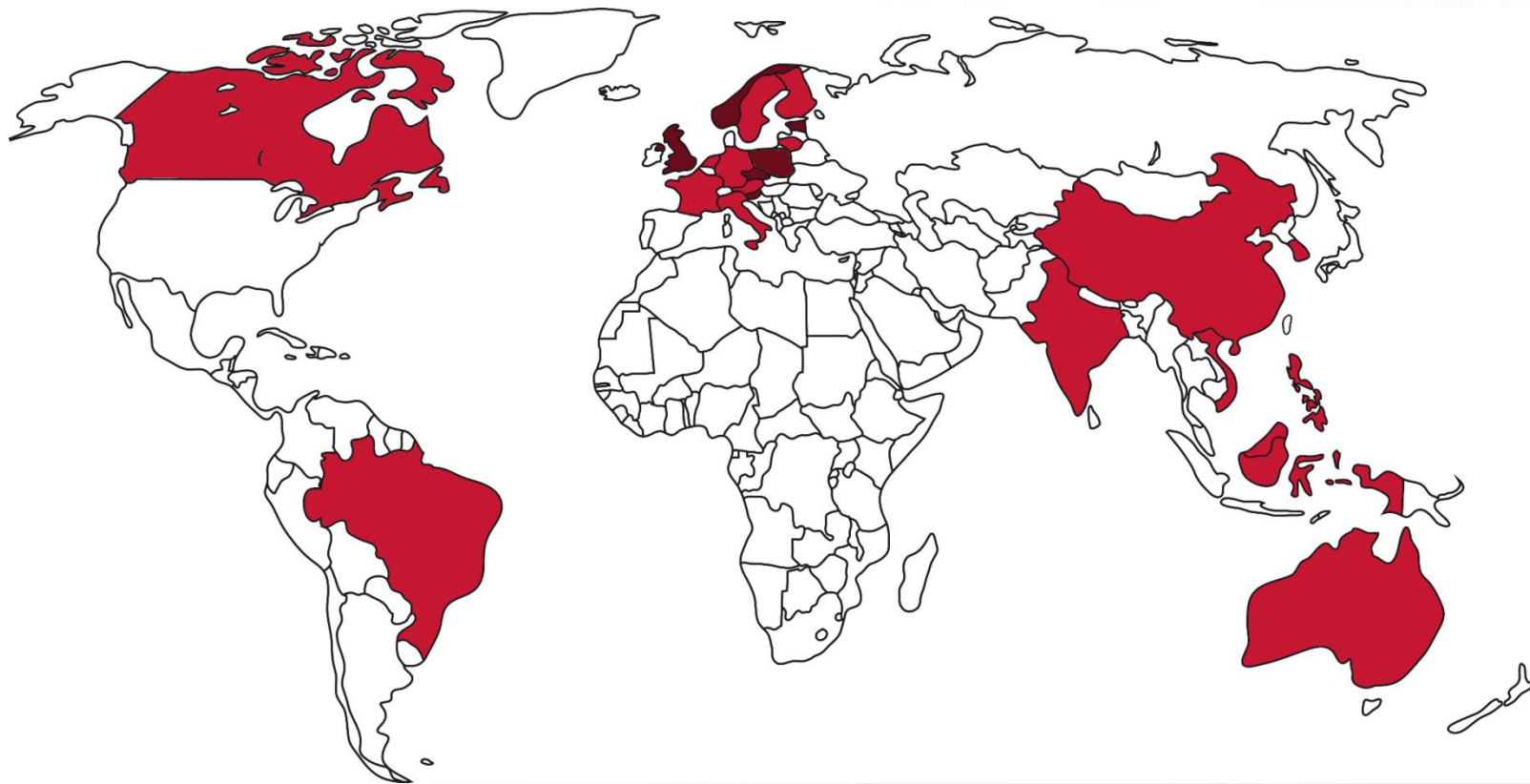
SNCR Rotamix

 **40-60%** of the baseline NOx emission level



1. Fan
2. Urea or ammonia water tank
3. Ammonia water or urea pumps
4. RRMIX injection nozzles
5. Boiler
6. ESP or Fabric Filter
7. Stack

Total NOx reduction >80%







K1

Year of origin
1967

K2

Year of origin
1967

■ **Key dates**

- Contract signing: - 31.07.2013
- Unit K1 – start-up - 07.05.2015
- Unit K2 – start-up - 22.09.2015

■ **Rehabilitation scope**

All necessary components' upgrade and existing systems modification

■ **Compliant with IED Directive**

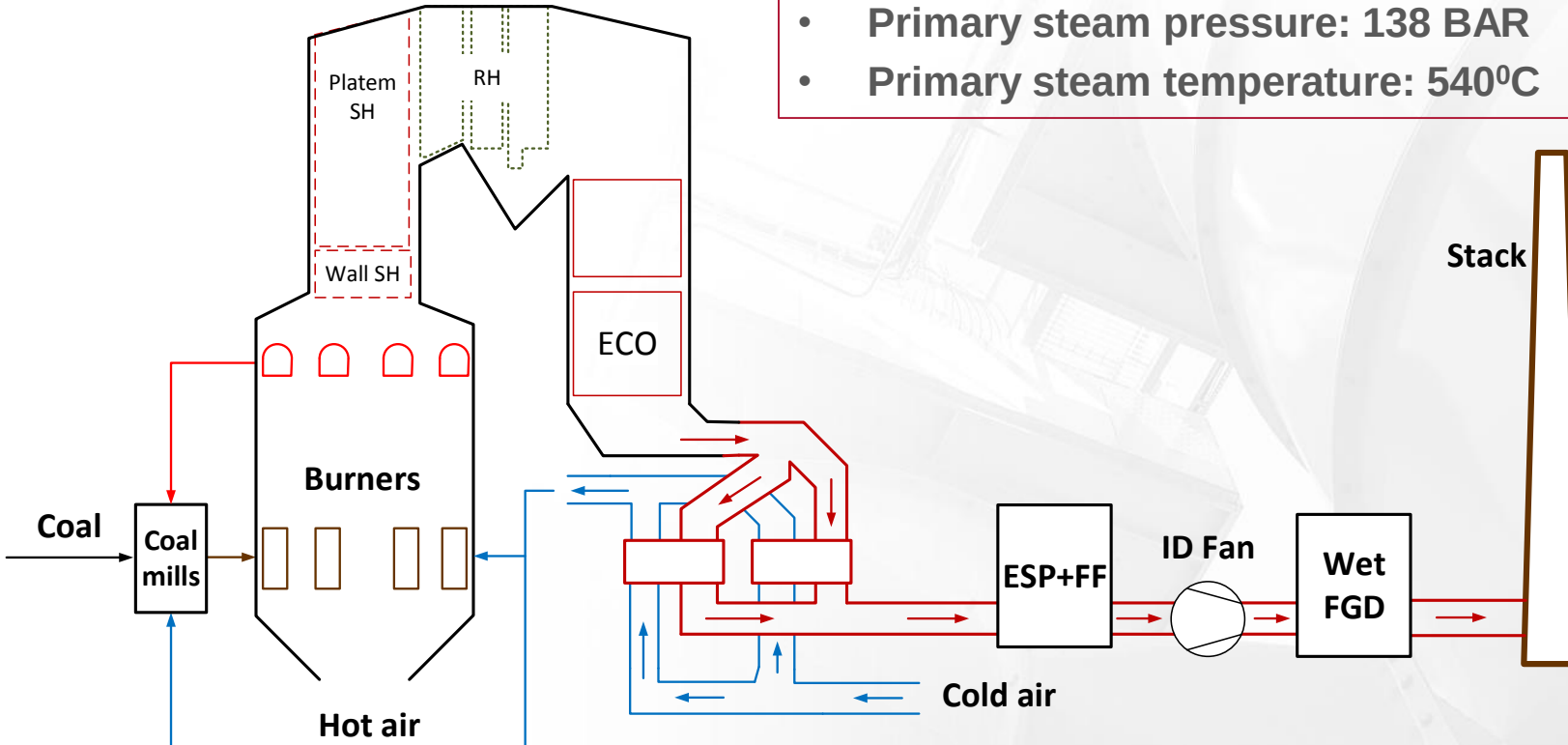
Adaptation to NOx emission as per IED

■ **Inventory of existing infrastructure**

A necessity to match the existing infrastructure and local conditions

- Fuel: lignite coal
- Steam generation: 650 t/h
- Primary steam pressure: 138 BAR
- Primary steam temperature: 540°C

OP-655b

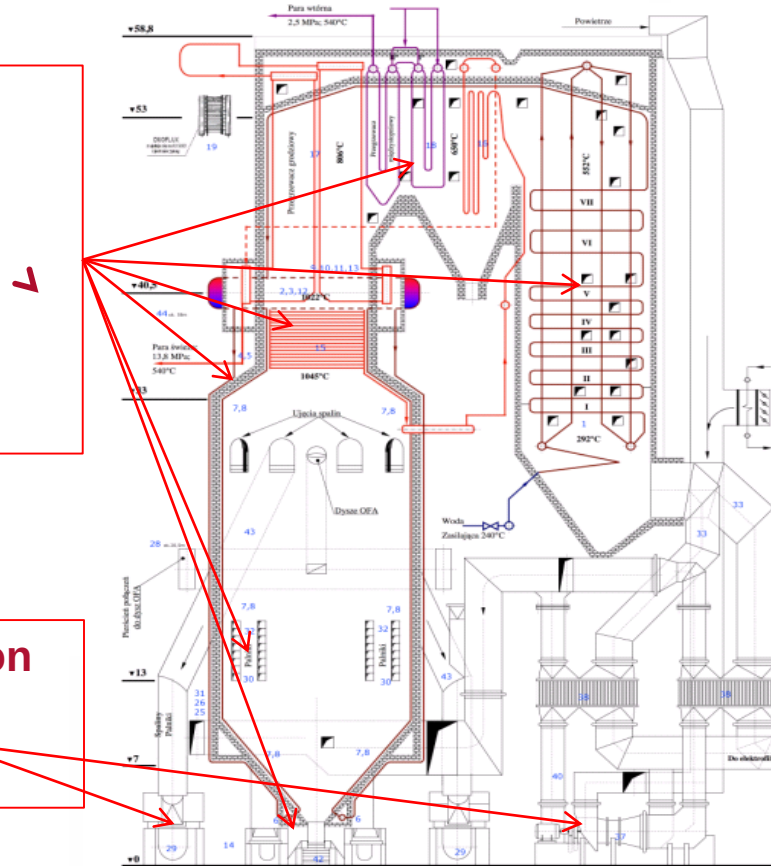


Boiler retrofitting

- Pressure Parts
- Drums
- Boiler Steel Structure
- New Low NOx Burners
- New Ignition Burners
- New Reburning Grate
- New deNOx Systems (ROFA, Rotamix)

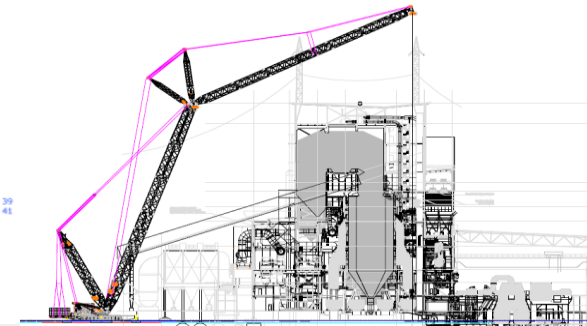
Repair and Modification

- Coal Mills
- FD & ID Fans
- Coal System

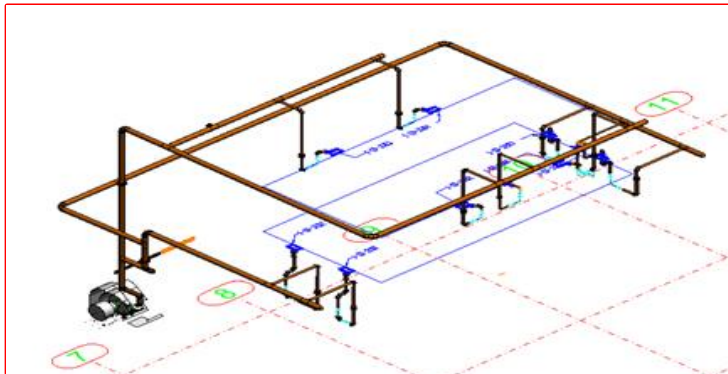


Repair

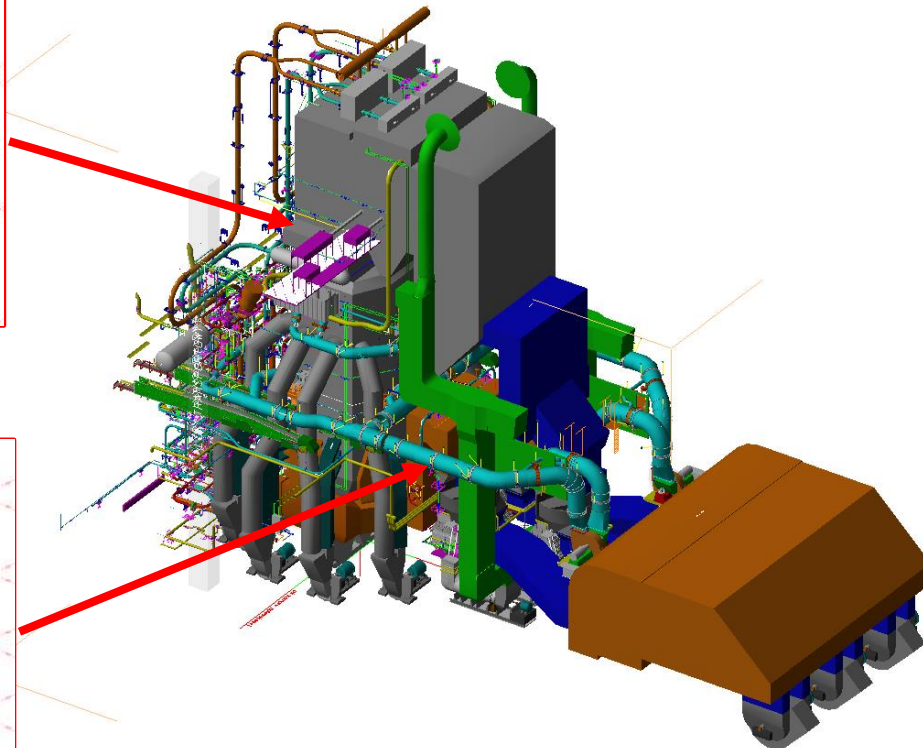
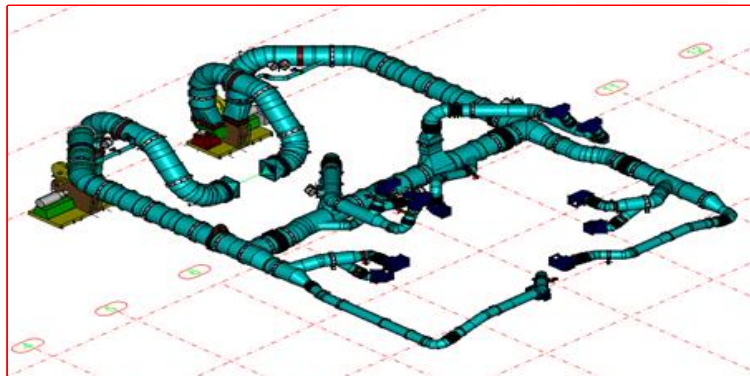
- Air and Flue Gas Systems



Rotamix

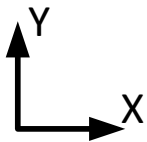
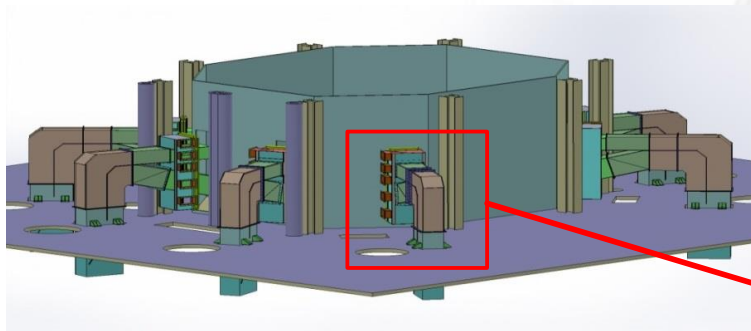


ROFA

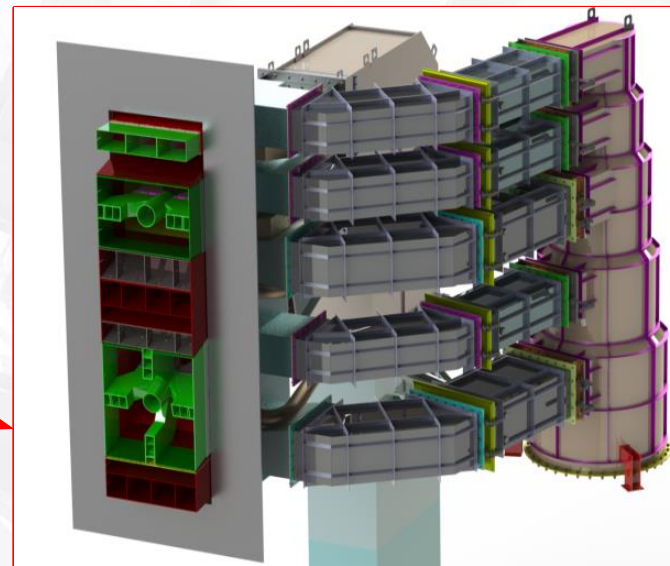


New Burners

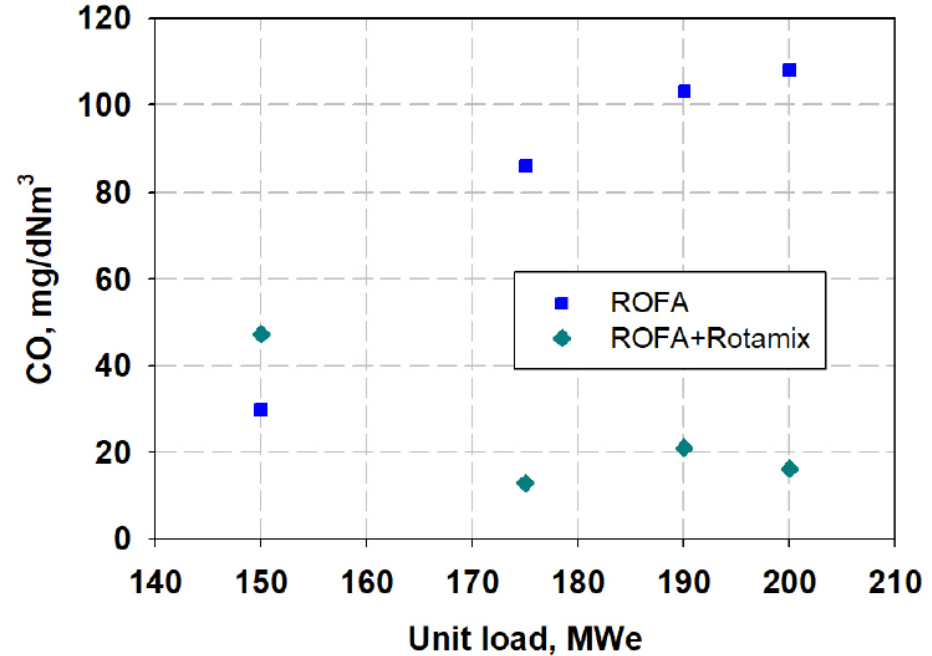
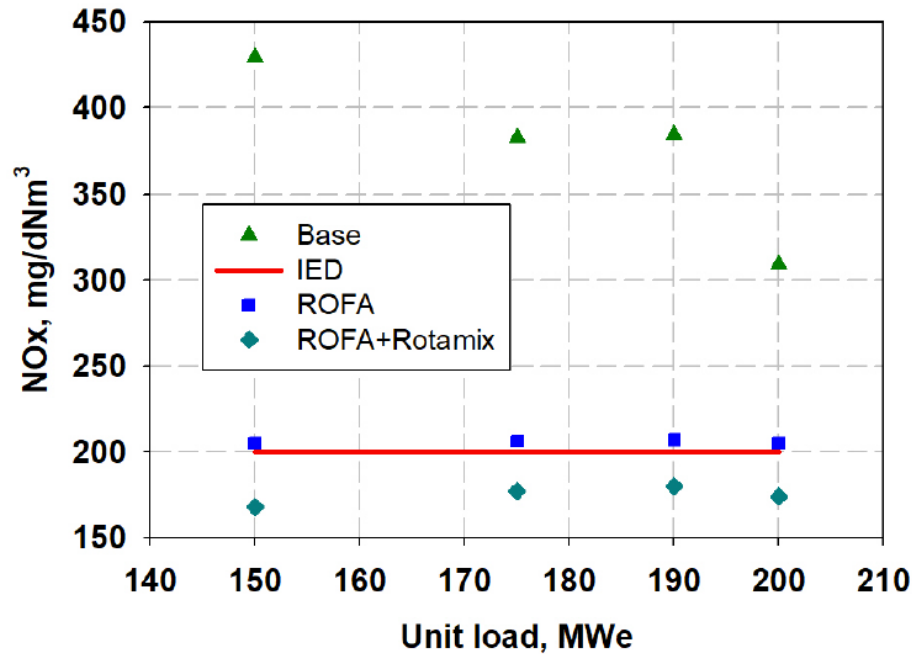
Burners configuration



Burner tips construction



NOx and CO data versus load for baseline, burner mods, and ROFA/ Rotamix conditions



ZE PAK S.A. - Modernization of boilers of units K1&K2 at Patnow Power Plant

Field Tests

		Guar. A	Guar. B	Guar. C	Guar. D	
	Electrical power, MWe	220.5	200	170	150	
	Firing rate, MWth	565.2	518.2	447.2	403.2	
	Delivered coal, t/h	214.4	212.3	182.2	160.1	
	Air heater					
	FG OUT	°C	169.3	165.9	159.7	160.0
		O ₂ , % (dFG)	5.10	5.23	5.58	5.82
		Λ	1.32	1.33	1.36	1.38
	Emissions					
	ROFA ON – SNCR OFF					
	NOx, mg/dNm ³	196	203	195	190	
	CO, mg/dNm ³	108	103	86	29	
	ROFA ON – SNCR ON					
	NOx, mg/dNm ³	162	171	156	153	
	CO, mg/dNm ³	16	21	12	47	
	NH ₃ , dppm	0.295	1.470	0.730	1.330	

Boiler Performance Conditions After Modernization

- The boiler efficiency increased (*>5% increase*)
- Boiler operational flexibility improved (*from a range of 150-200MW to 130-220MW*)
- Electrical energy generated by each unit has increased by approximately 10% (*from 200 MW to 220 MW*)
- NOx reduction below 180 mg/dNm³ for all boiler loads (*possibility to reach NOx emission below 150 mg/dNm³*)

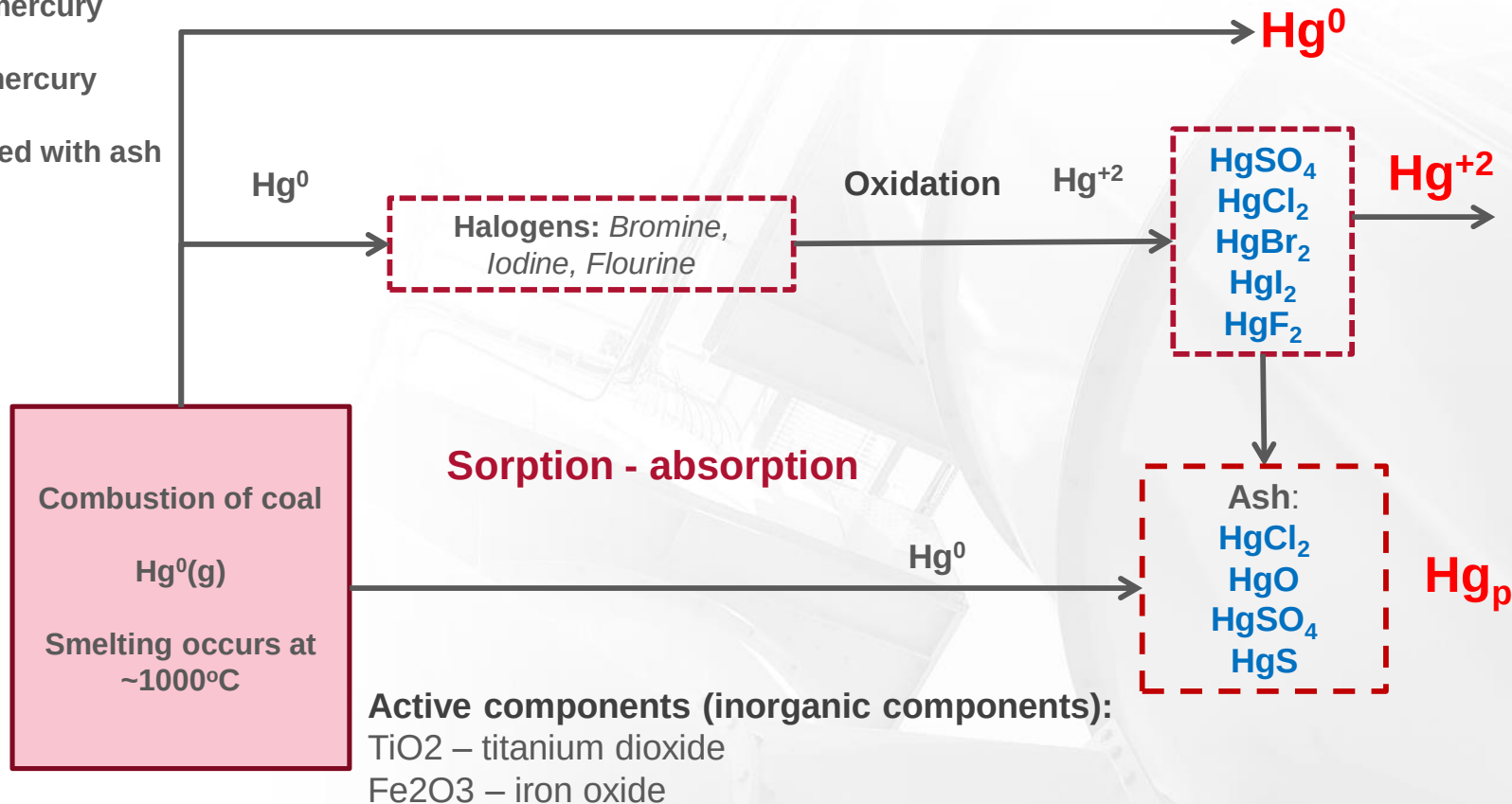
BAT/BREF – what is to be done,

1. Mercury control installation
2. de-SOx efficiency improvment
3. PM – ESP's improvment

Hg^0 – elemental mercury

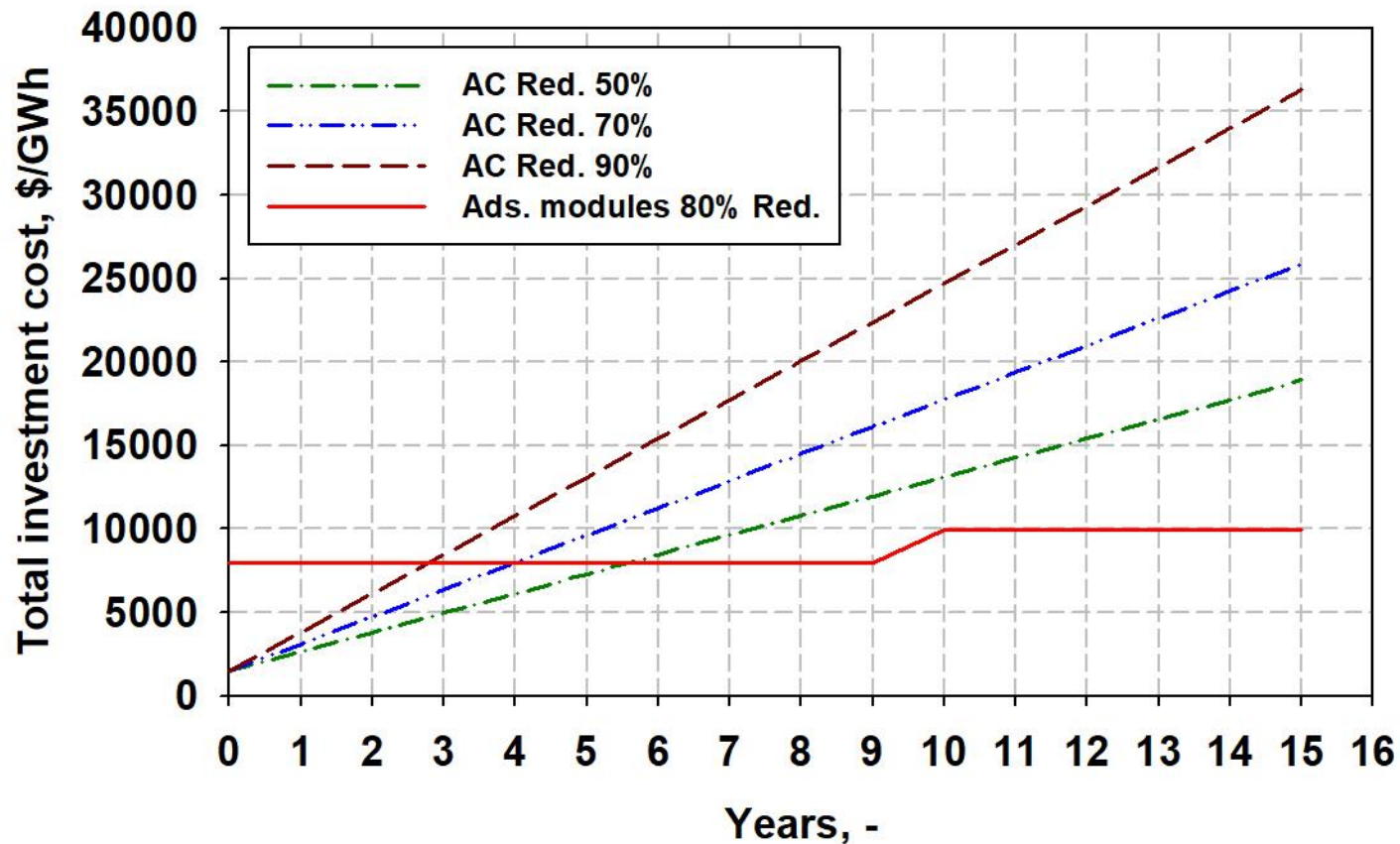
Hg^{+2} – oxidized mercury

Hg_p - mercury fixed with ash



Available Technologies for Mercury Emission Control

- Fuel Additives
- Injection of Activated Carbon
- Chemical Additives Introduced to Desulphurization Installations
- **Installation of Sorbent Polymer Catalyst (SPC) Composite**



New Approach for Flue Gas Mercury Removal

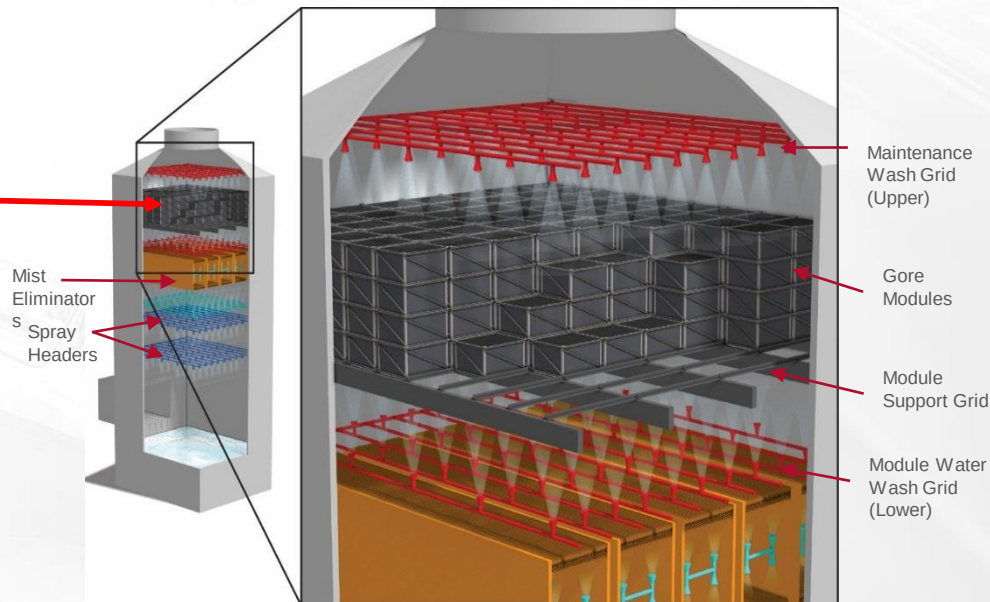
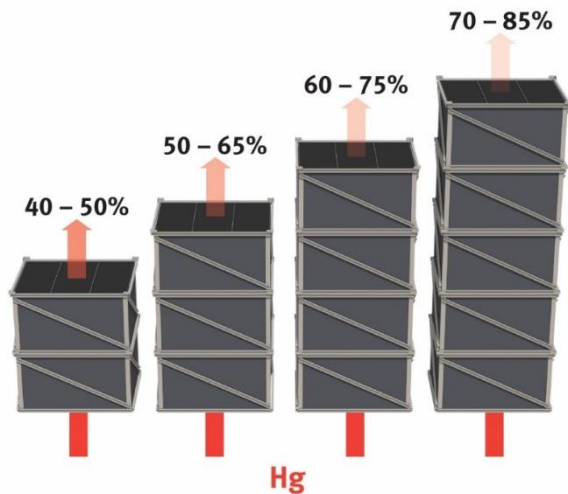
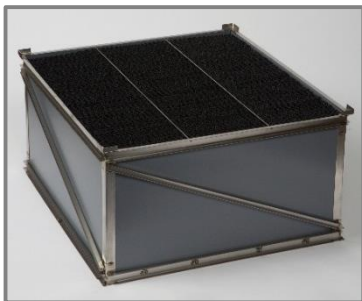
Fixed sorbent technology

- An alternative to sorbent injection
 - ✓ No contamination of fly ash
 - ✓ No additional PM introduced
 - ✓ Insensitive to SO_3 level
 - ✓ Simple system, no moving parts
 - ✓ Low operating cost
- An alternative to oxidizing chemicals
 - ✓ No risk of upstream process corrosion
 - ✓ No concerns with downstream Waste Water Treatment
- An alternative to re-emissions additives
 - ✓ No impact on gypsum quality
 - ✓ Minimal impact on scrubber chemistry



Installation Approaches

GORE® MSC Module



Inside Wet Flue Gas Desulfurizer (WFGD)

2100 MW Installed

Installation Approaches

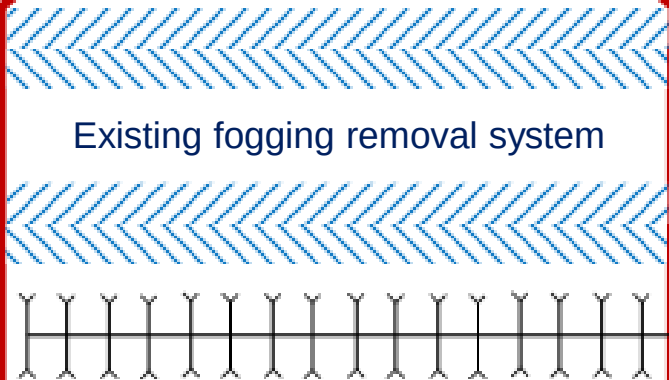
Mist Eliminators

Base

Hg: 20 $\mu\text{g}/\text{Nm}^3$

SO₂: 250 mg/Nm^3

Existing fogging removal system



Hg: 20 $\mu\text{g}/\text{Nm}^3$
SO₂: 250 mg/Nm^3

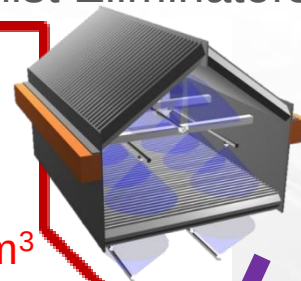
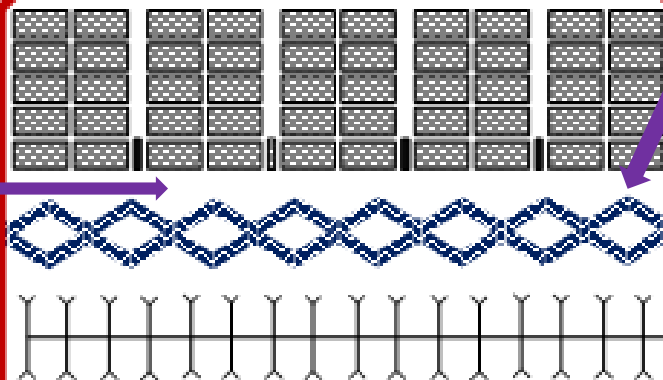
Spray nozzle
arrangement

FGD Modernization

Hg: <7 $\mu\text{g}/\text{Nm}^3$

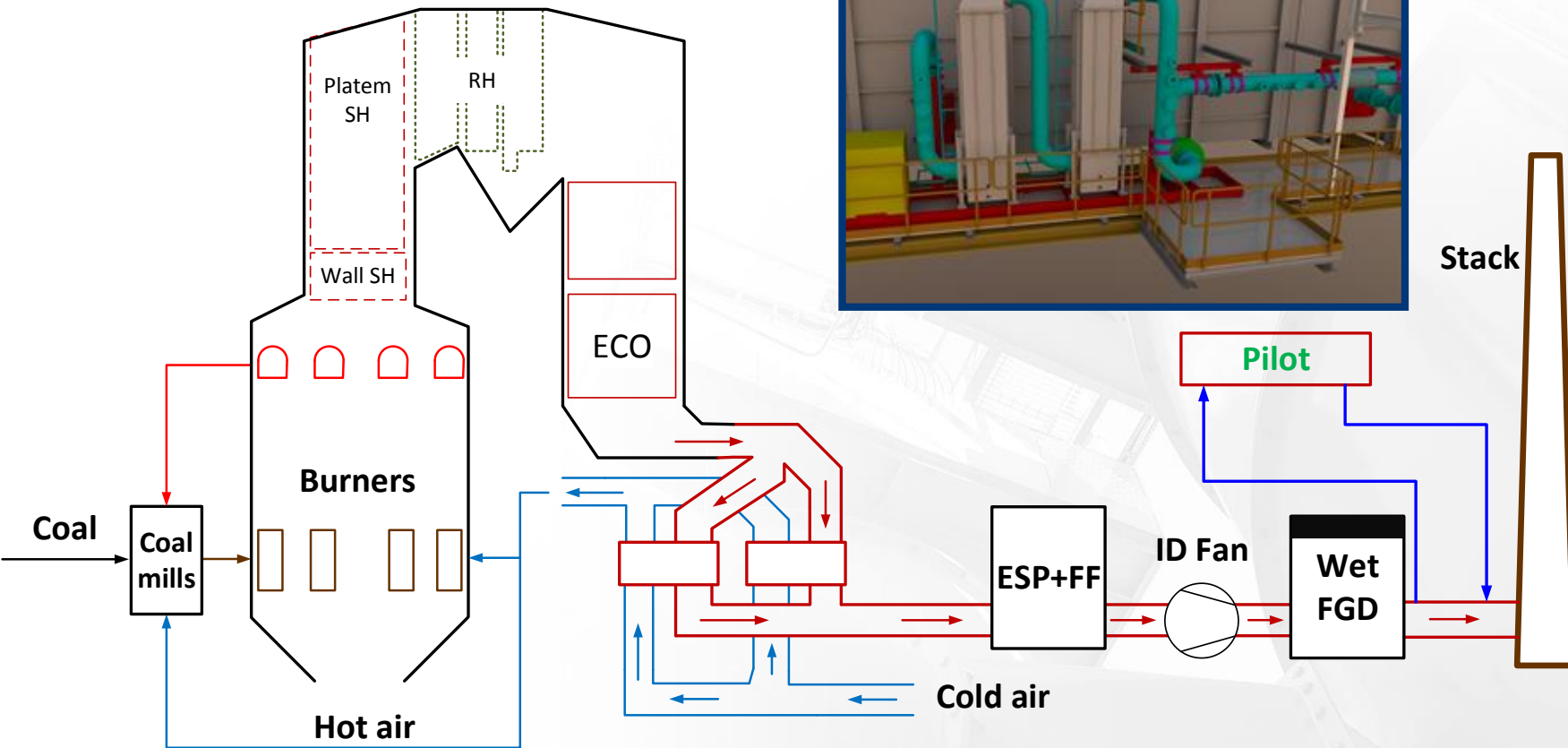
SO₂: <130 mg/Nm^3

GORE® Modules



But there is one question...

How to convince a client that polymer modules will solve their problem of mercury control and also assist in SO₂ reduction?



- **Boiler modernization allows achievement of defined emission limits in IED**
- **Field test shown that with relatively minor boiler retrofitting, Units 1 and 2 can be easily be adapted to forthcoming emission limits of BAT/BREF document (additional Rotamix nozzles, slight modification of ROFA boxes, inserts for secondary air nozzles)**
- **SPC mercury reduction technology is considered to be a very good alternative to activated carbon and other chemical additives**
- **Pilot installation will be used for SPC modules field testing**

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Thank you

Robert Żmuda, r.zmuda@sbbenergy.com

SBB ENERGY S.A.
Lowicka 1 Str., Opole, Poland