Improving the flexibility of hard-coal fired power plants by means of APC

Dr. Kaminski

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Outline

1	Introduction
2	Minimum load reduction
3	Start-up optimization
4	Frequency control
5	Combustion Optimization
6	Summary

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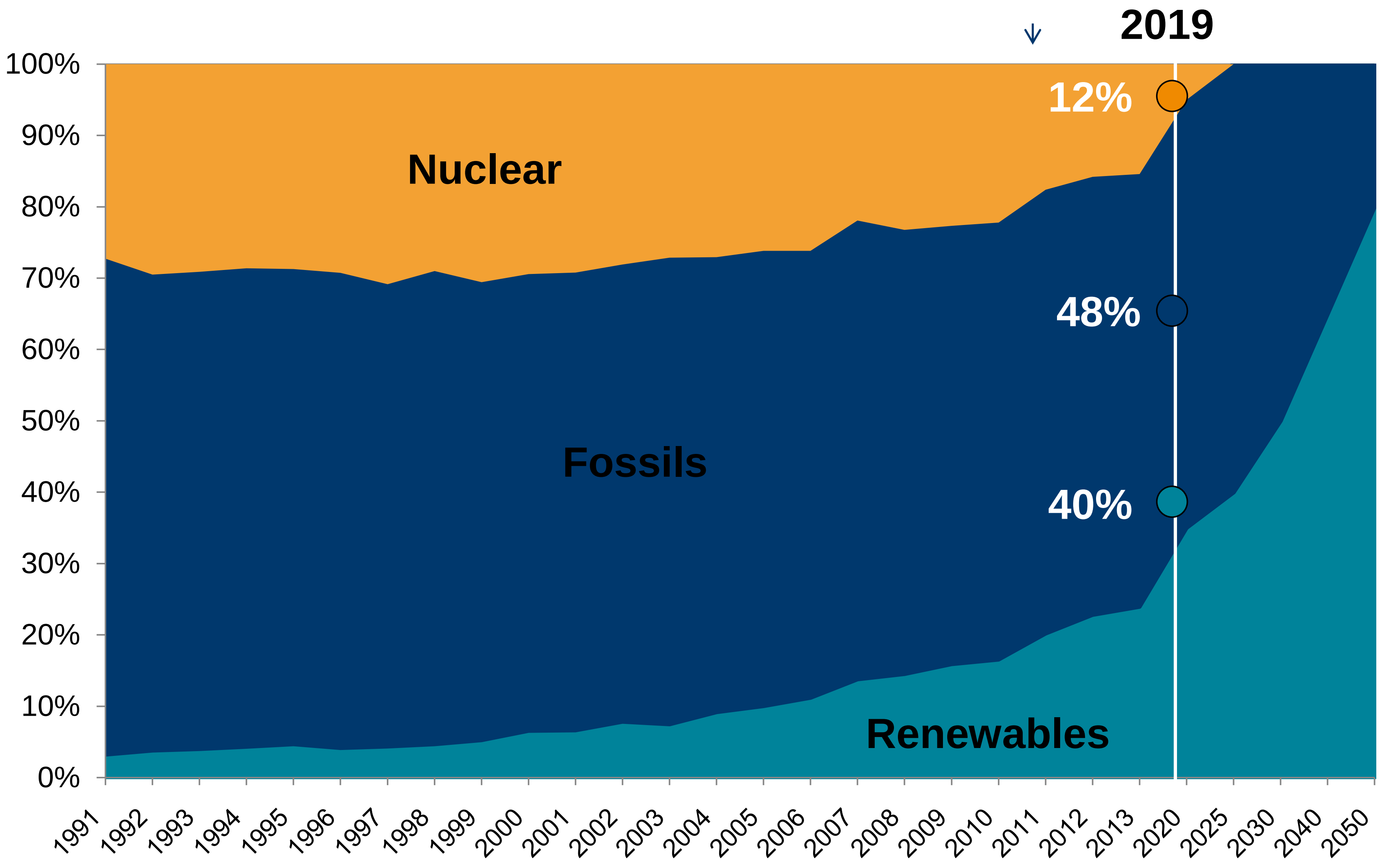
Development and Outlook of Renewable and Conventional Power Generation in Germany



Renewables and Conventional Power Plants feeding into the German Grid

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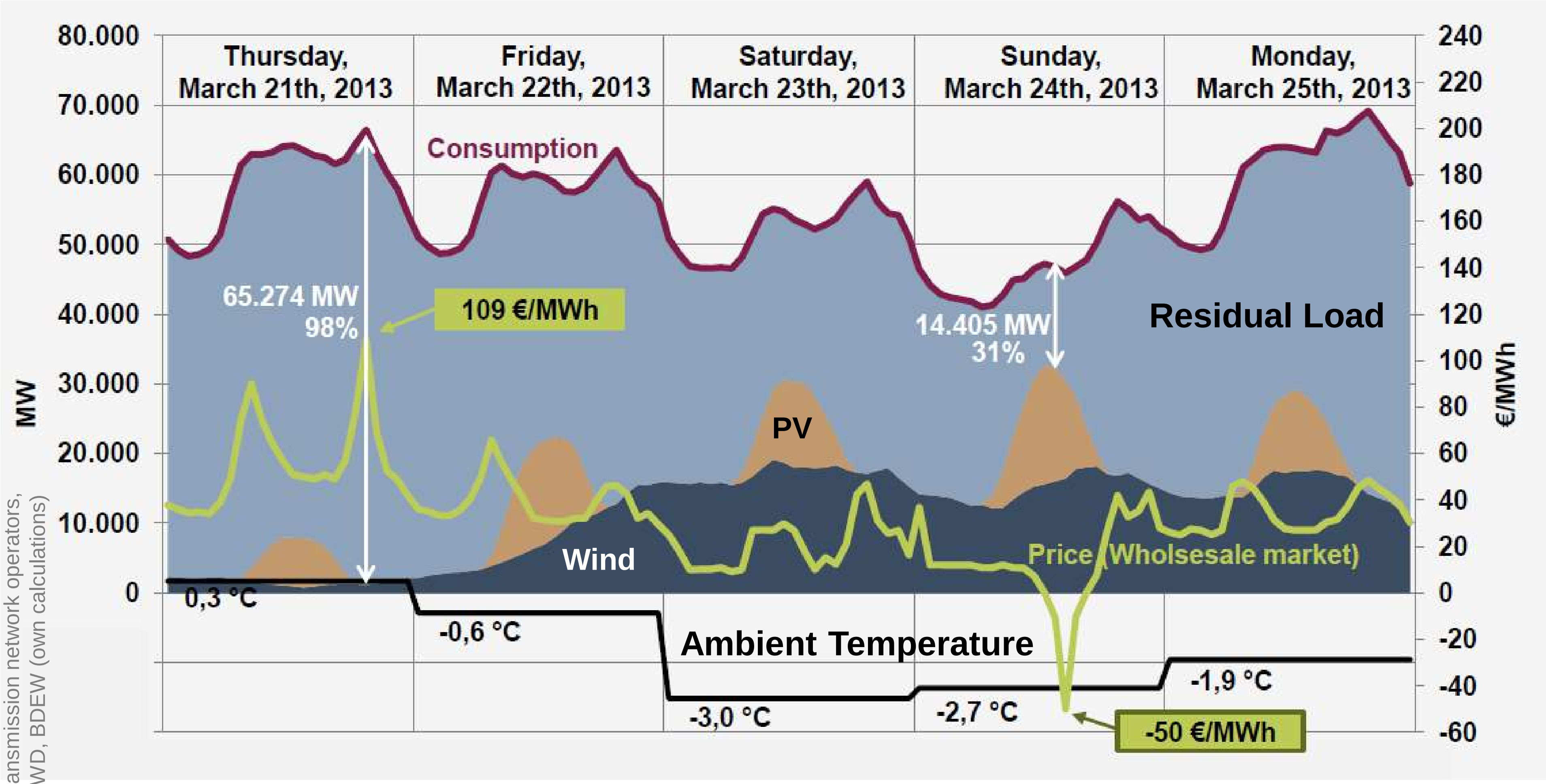

Ref.: Transmission network operators, EEX, DWD, BDEW (own calculations)

What will be the situation in 2030?

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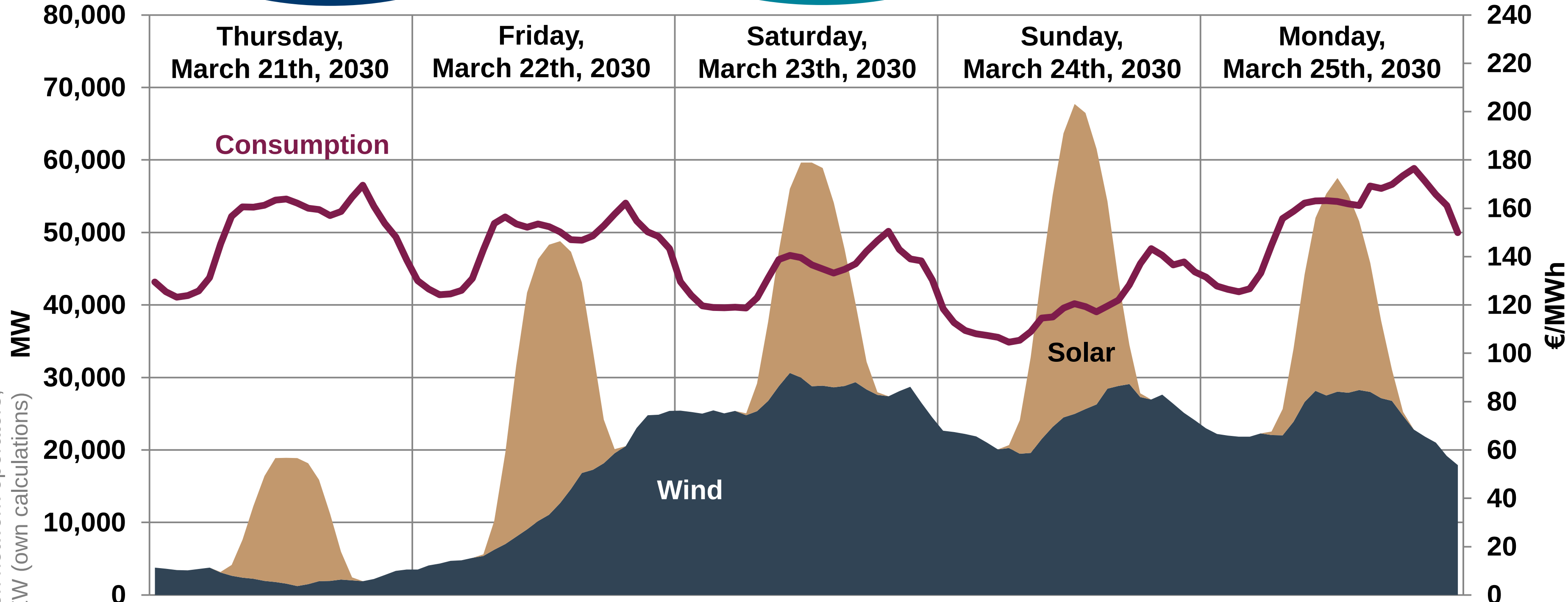
① flexible, conventional power plant in operation and as back-up

② Market integration of and system services by renewables

③ Energy Storage?



Ref.: Transmission network operators, EEX, DWD, BDEW (own calculations)

④ Back-up by UTCE ?

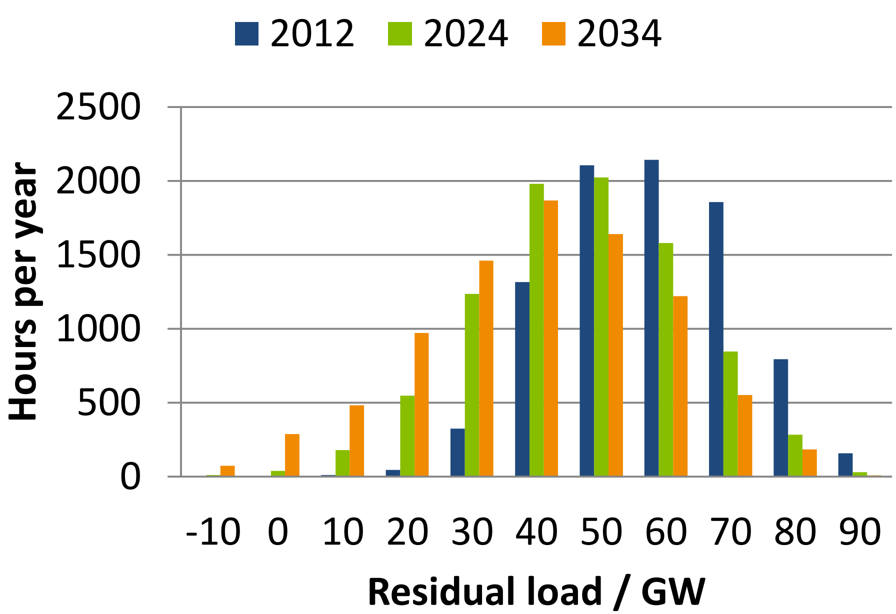
⑤ Demand Side Management??

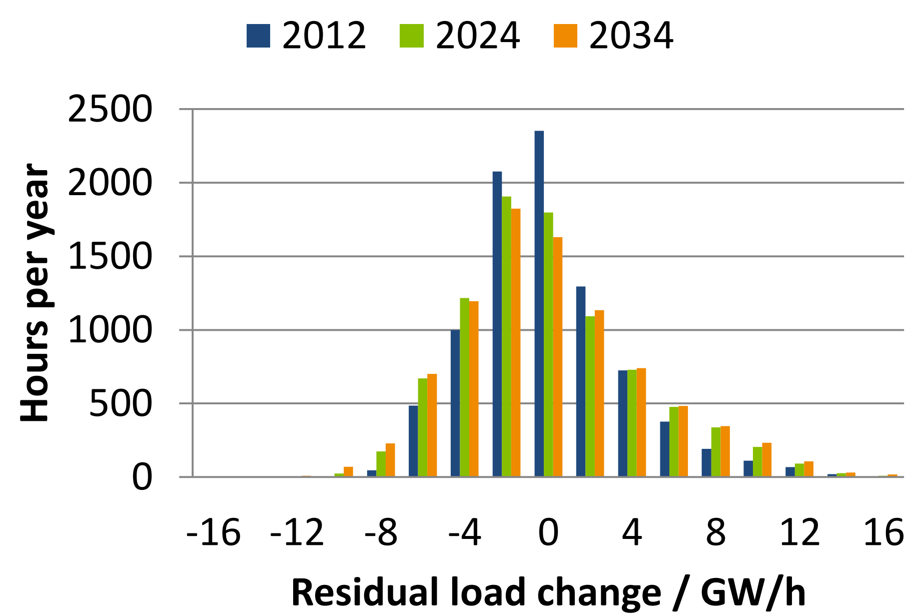
⑥ Smart Grids???

Residual load in Germany

- **Dispatchable energy sources cover the residual load**

$$P_{\text{Residual}} = P_{\text{Total}} - P_{\text{PV}} - P_{\text{Wind, onshore}} - P_{\text{Wind, offshore}}$$





- **Flexible capacity (reduced minimum load and optimized start-up) by thermal power plants are still necessary**

Flexible, conventional power plant in operation and as back-up

- **Conventional power plants can be optimized.**
- **Optimisation done:**
  - Reduction of minimum load
  - Optimisation of start-up
  - Optimisation of load-ramps
- **Financial situation of power plants is very tight:**
  - Low prices on the electricity market
  - Unadequate reimbursement for system services like redispatch etc

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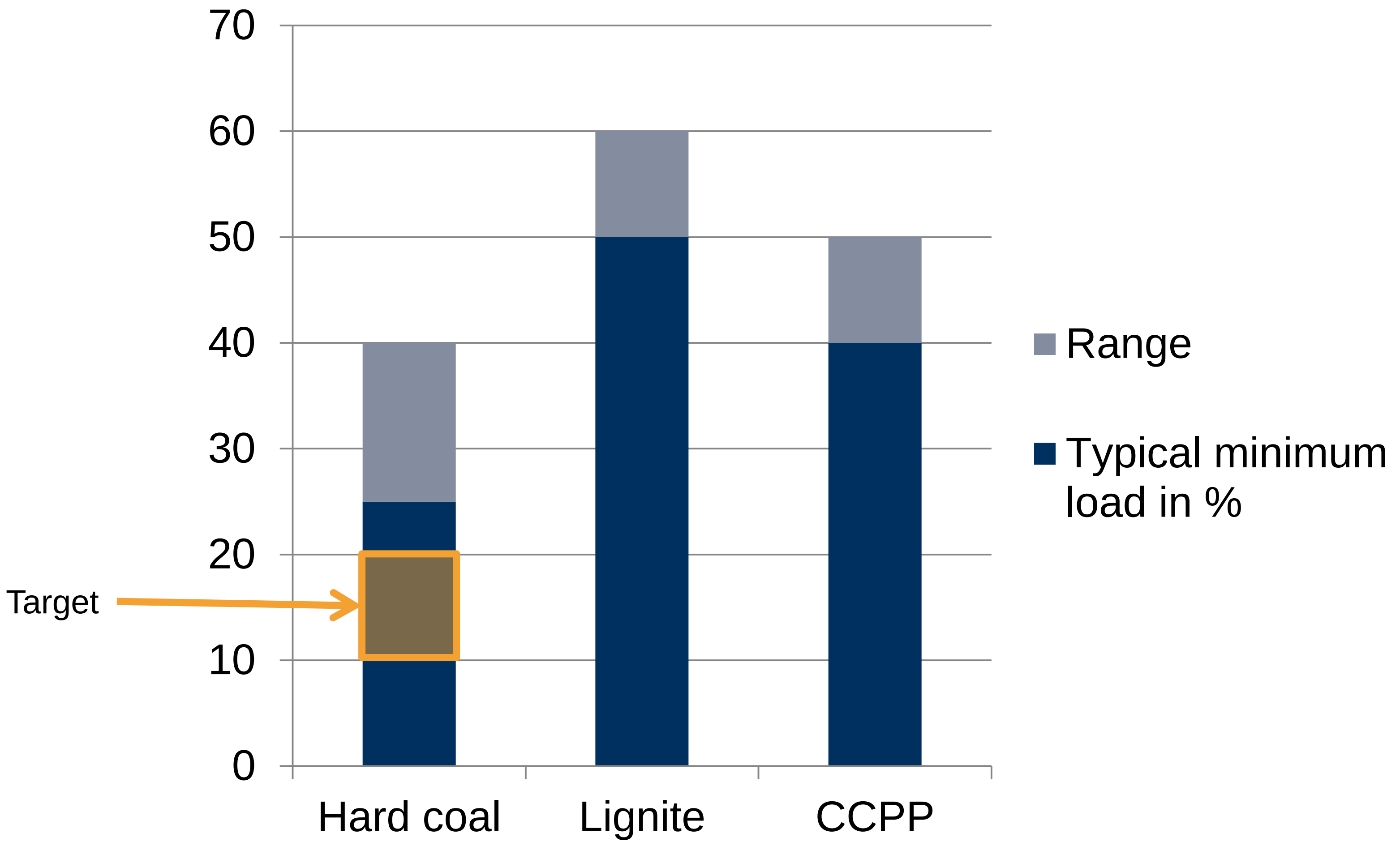
Target load


70
60
50
40
30
20
10
0
Target
Hard coal
Lignite
CCPP
Range
Typical minimum load in %

Some limiting factors for minimum load

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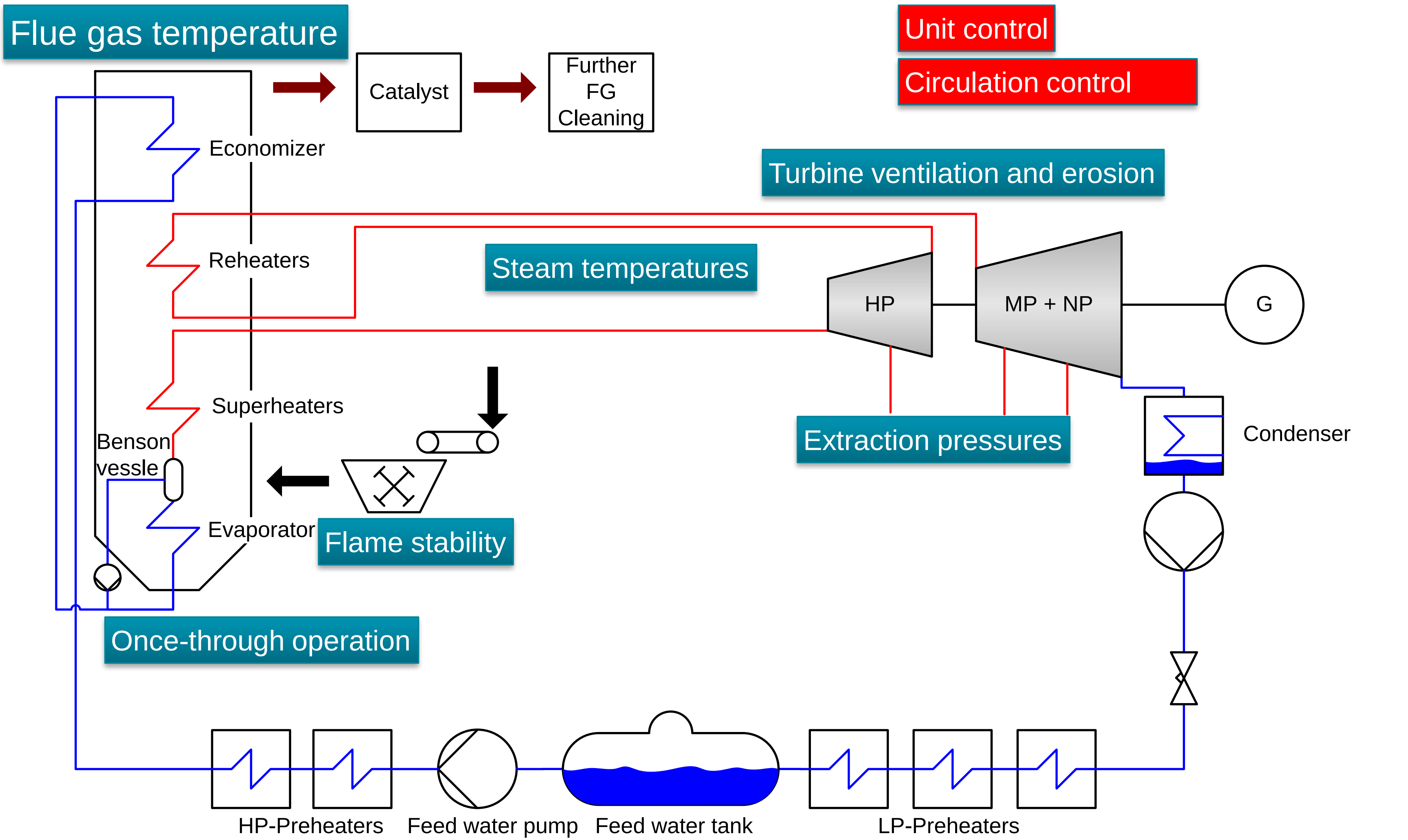
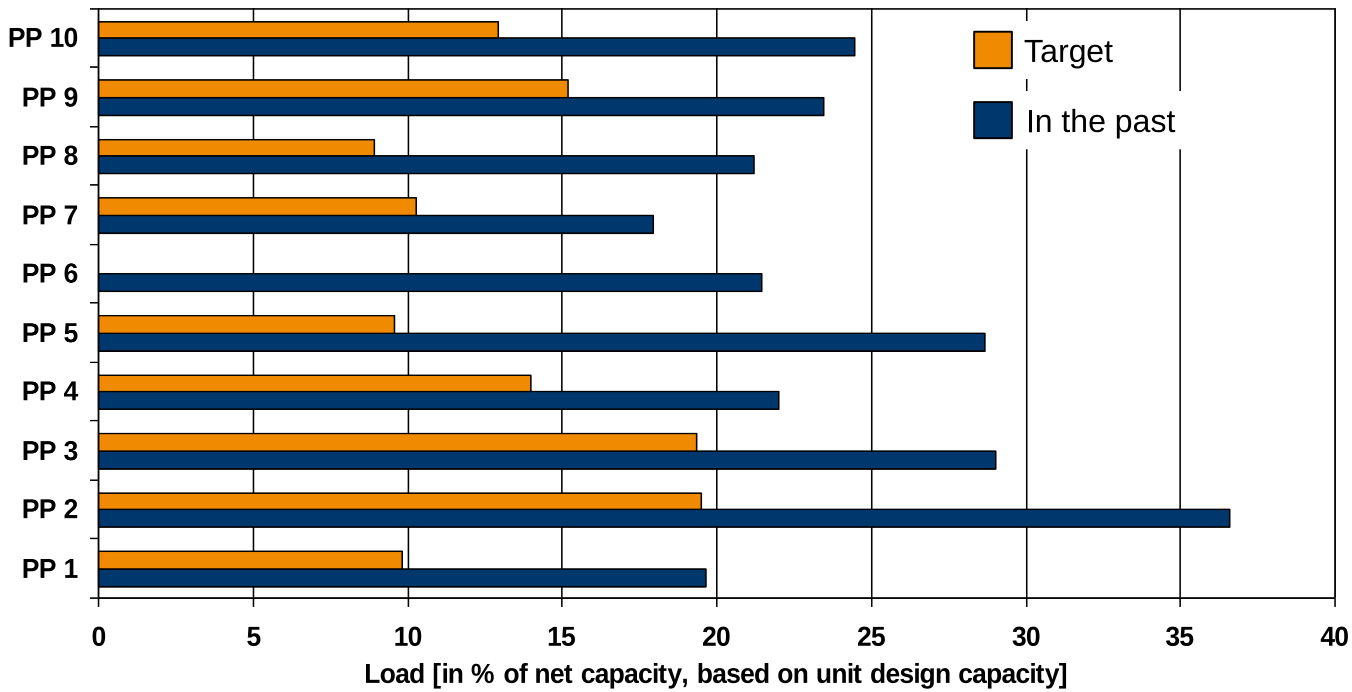
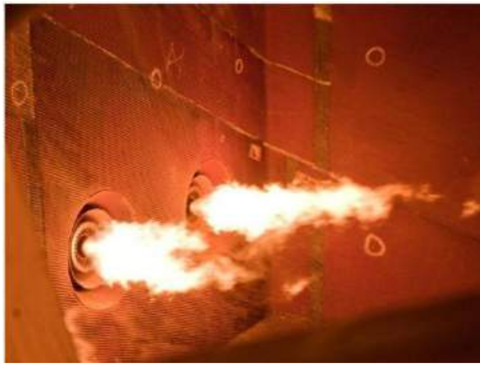
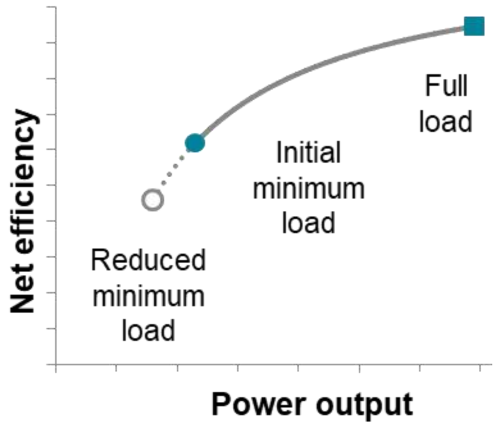


Potential for Minimum Load Reduction

- Big potential beyond the initial design

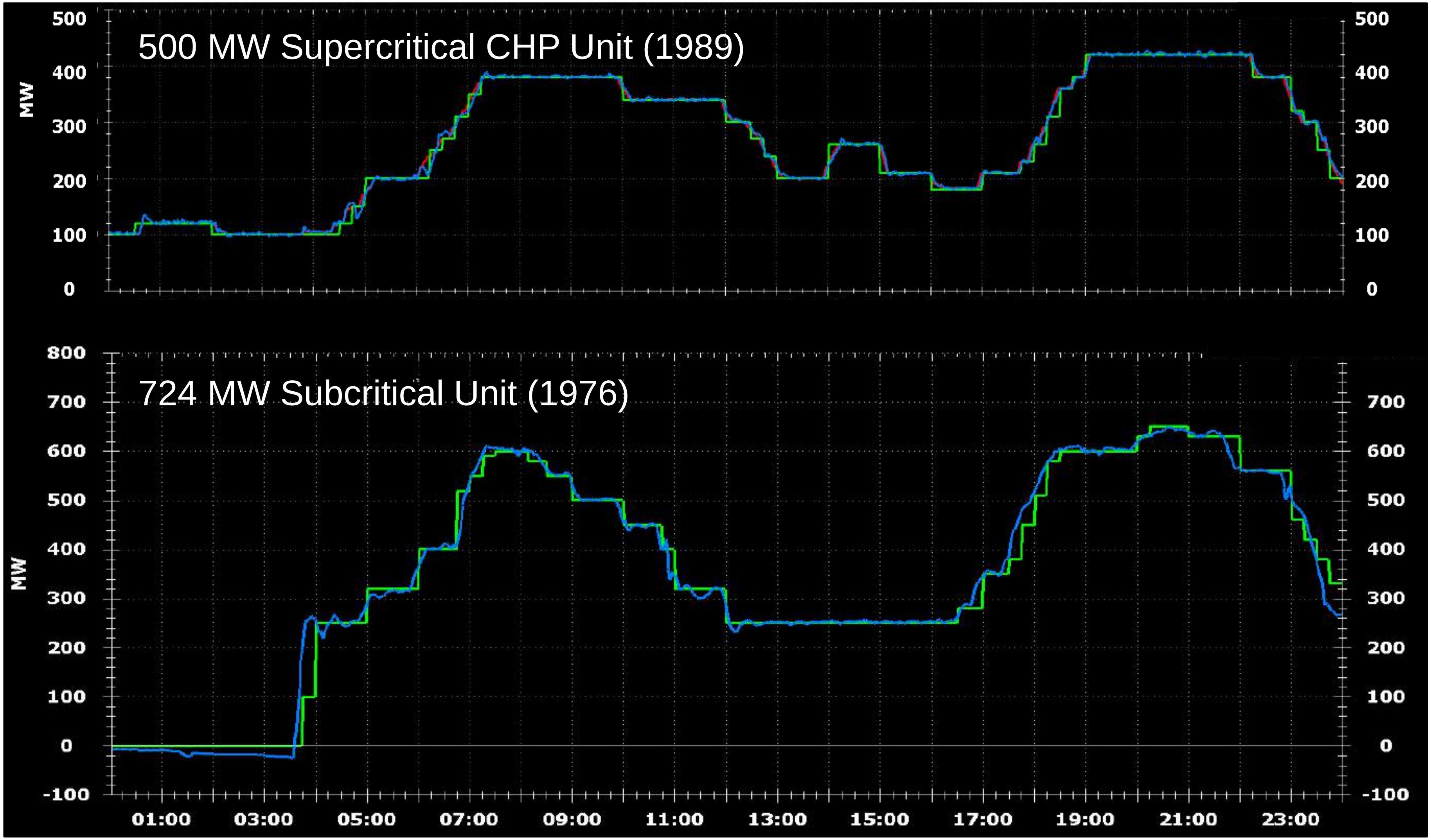




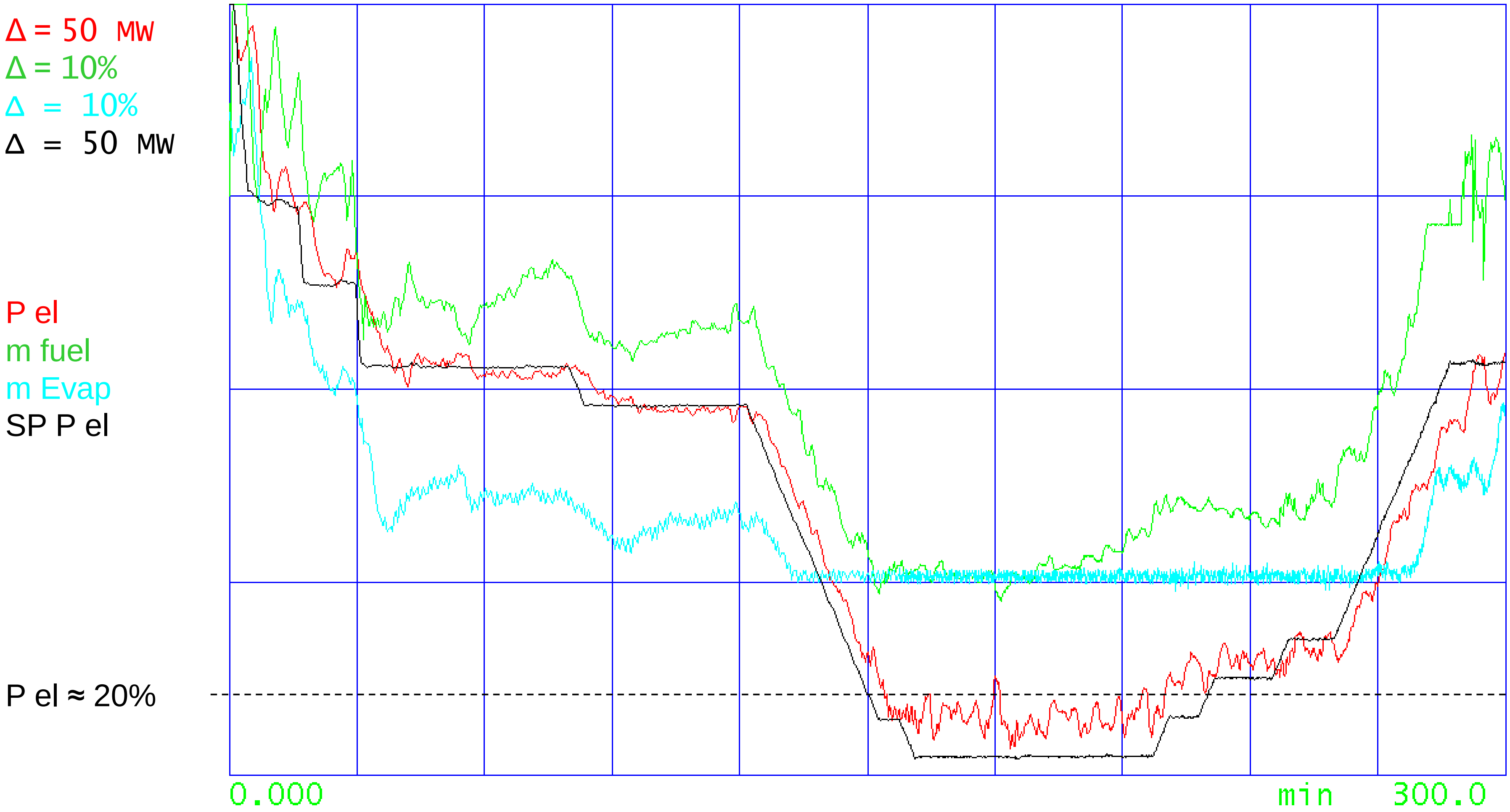


- Reference plants in Germany built between 1970 – 1990
- But reduction of load will decrease efficiency

(2) Optimisation of low load operation of STEAG Power Plants



Results in a STEAG power plant



APC based optimization without any process modifications required

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Start-up optimization

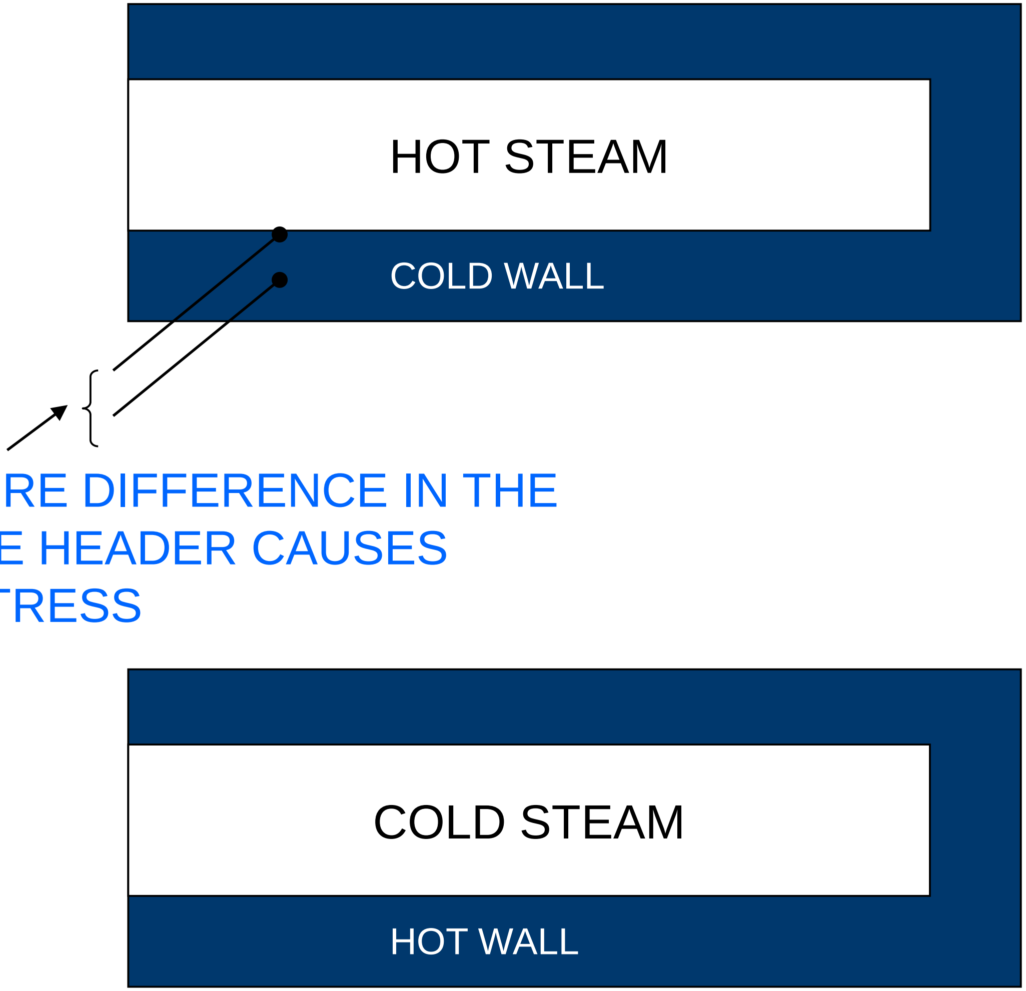
Market volatility → More start-ups → Need for start-up optimization

Areas with potential

Reproducibility	Firing rate	HPB

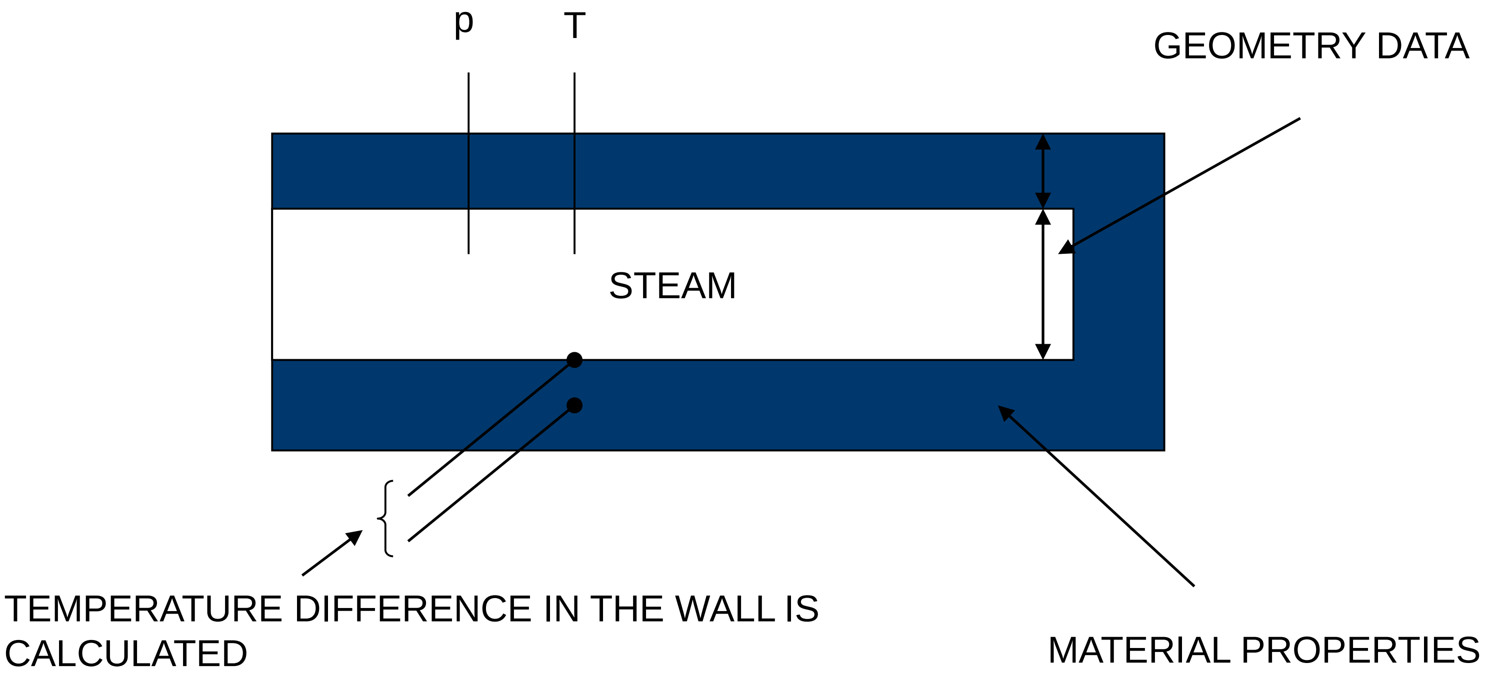
Manual start-ups → Automated, reproducible start-ups → Reduced fuel consumption / start-up time

Thermal Stresses in Header‘s Wall during Start-Up and Shut Down



TEMPERATURE DIFFERENCE IN THE WALL OF THE HEADER CAUSES THERMAL STRESS

Parameter for Calculation of Fatigue



Start-up control overview scheme

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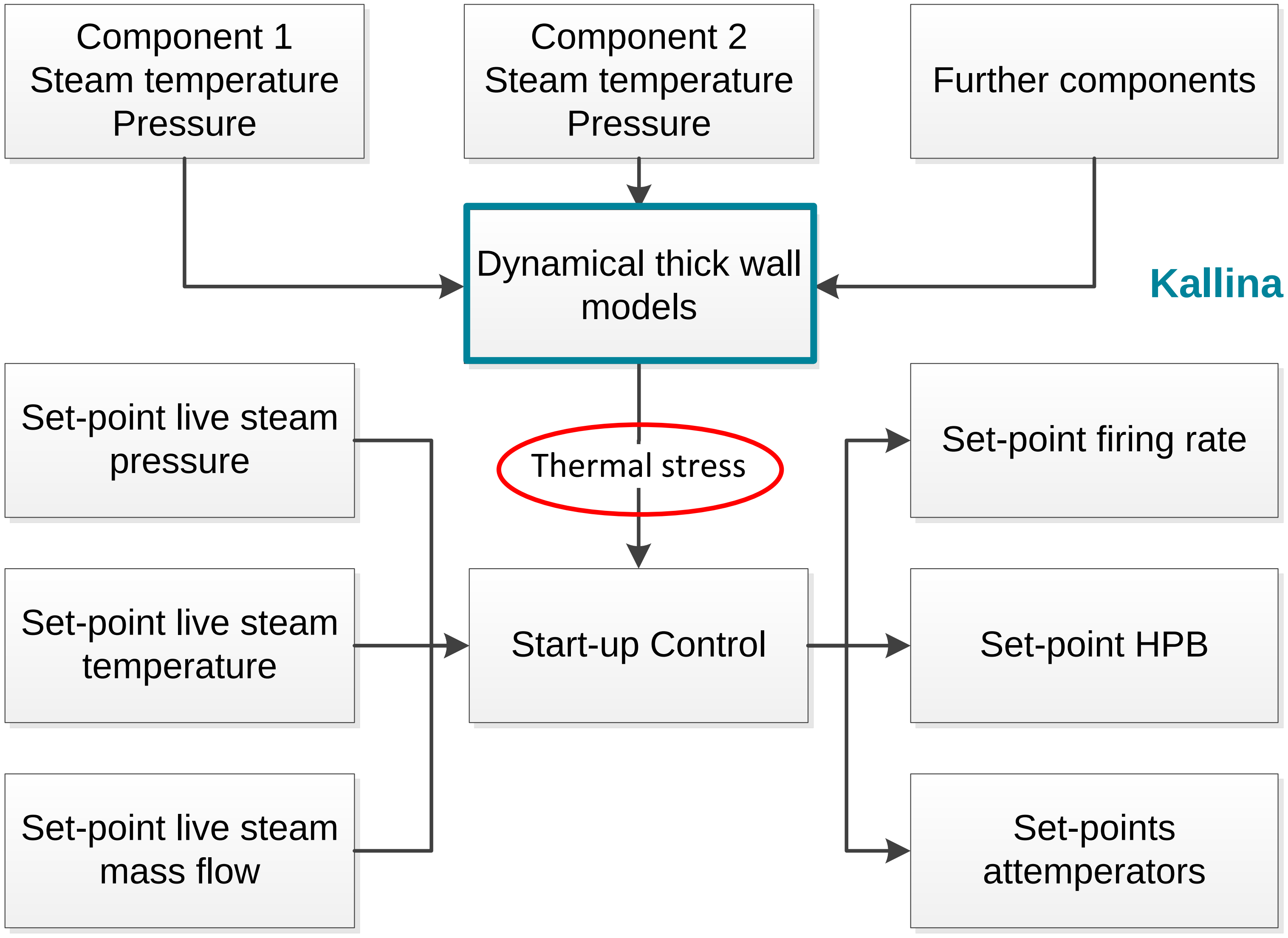
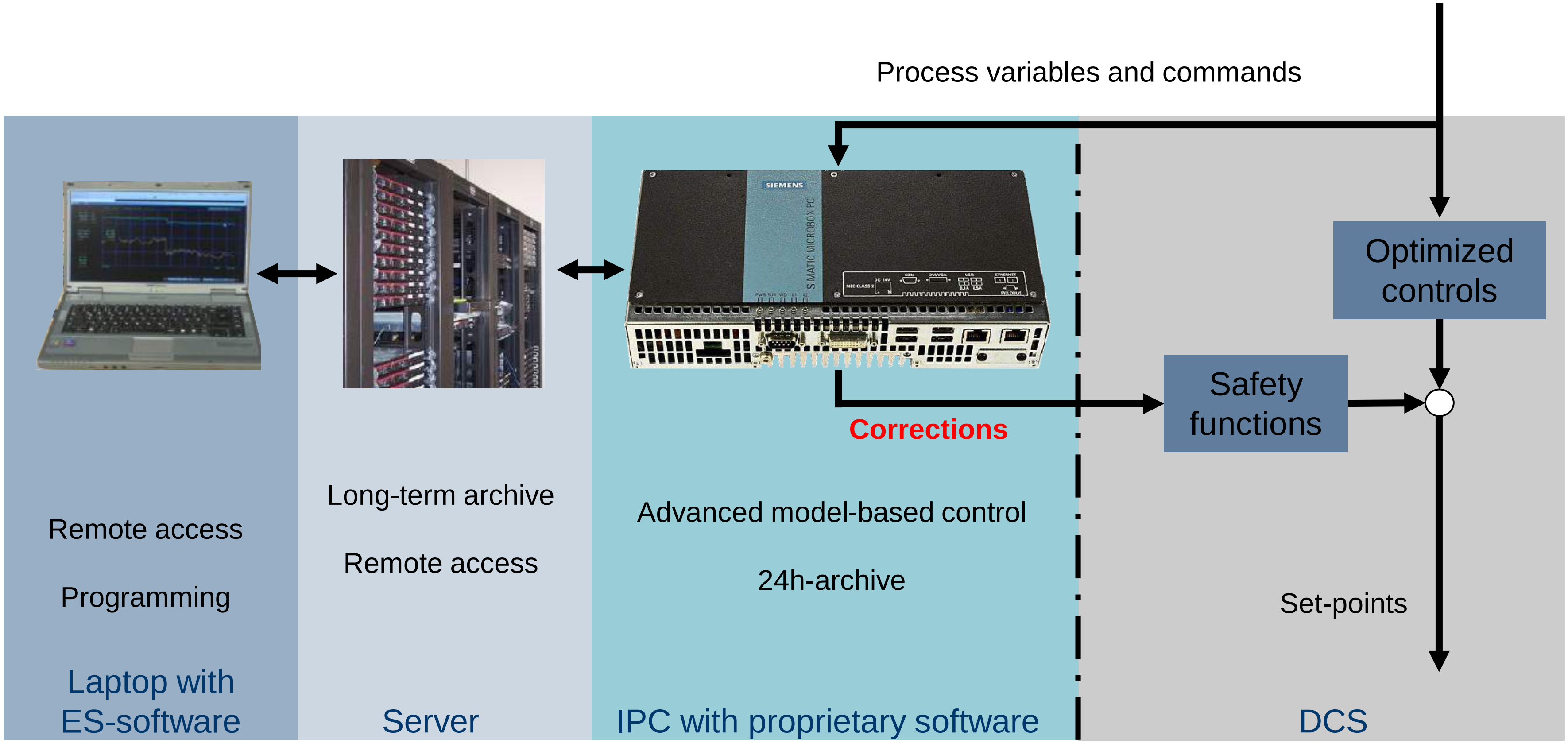
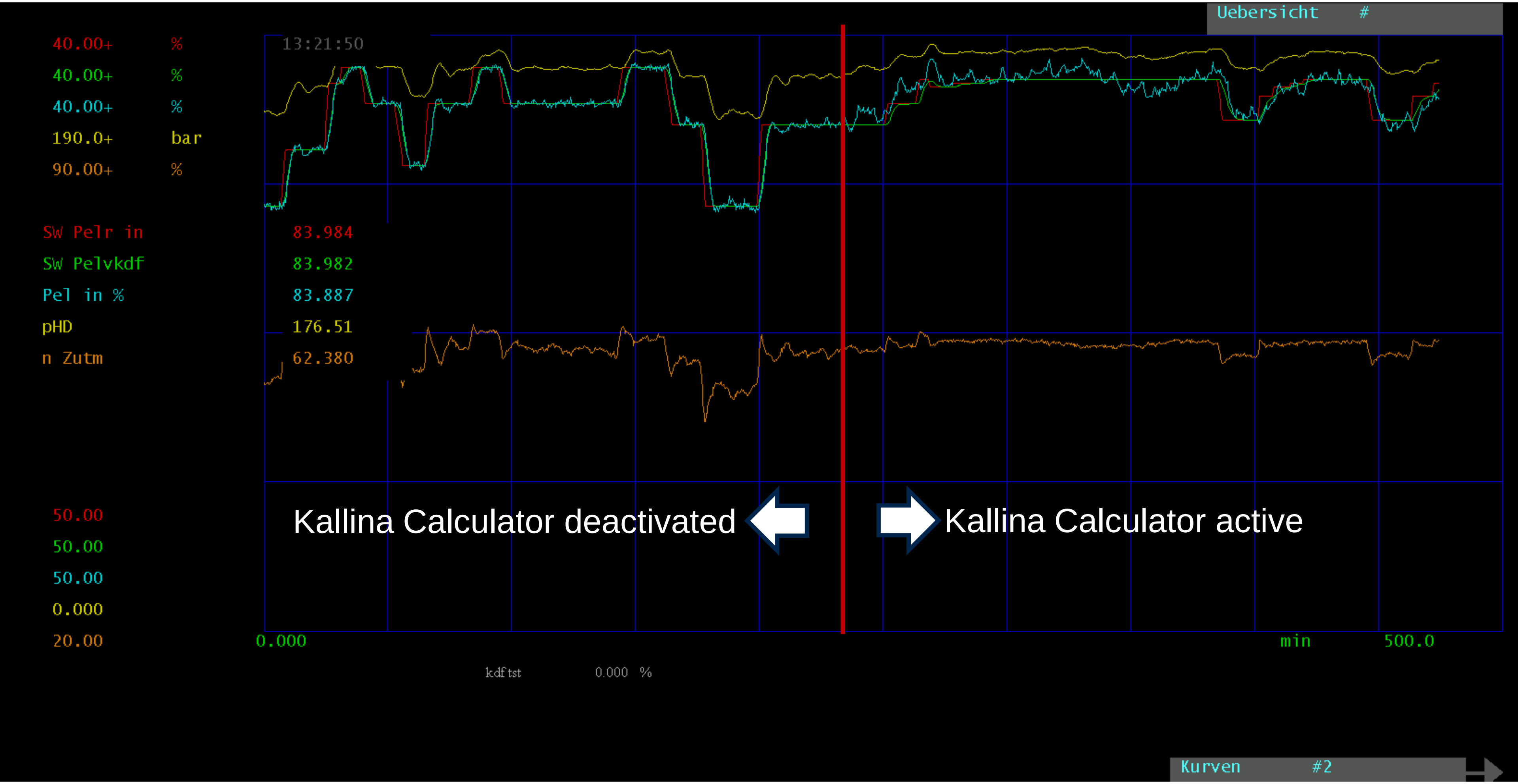


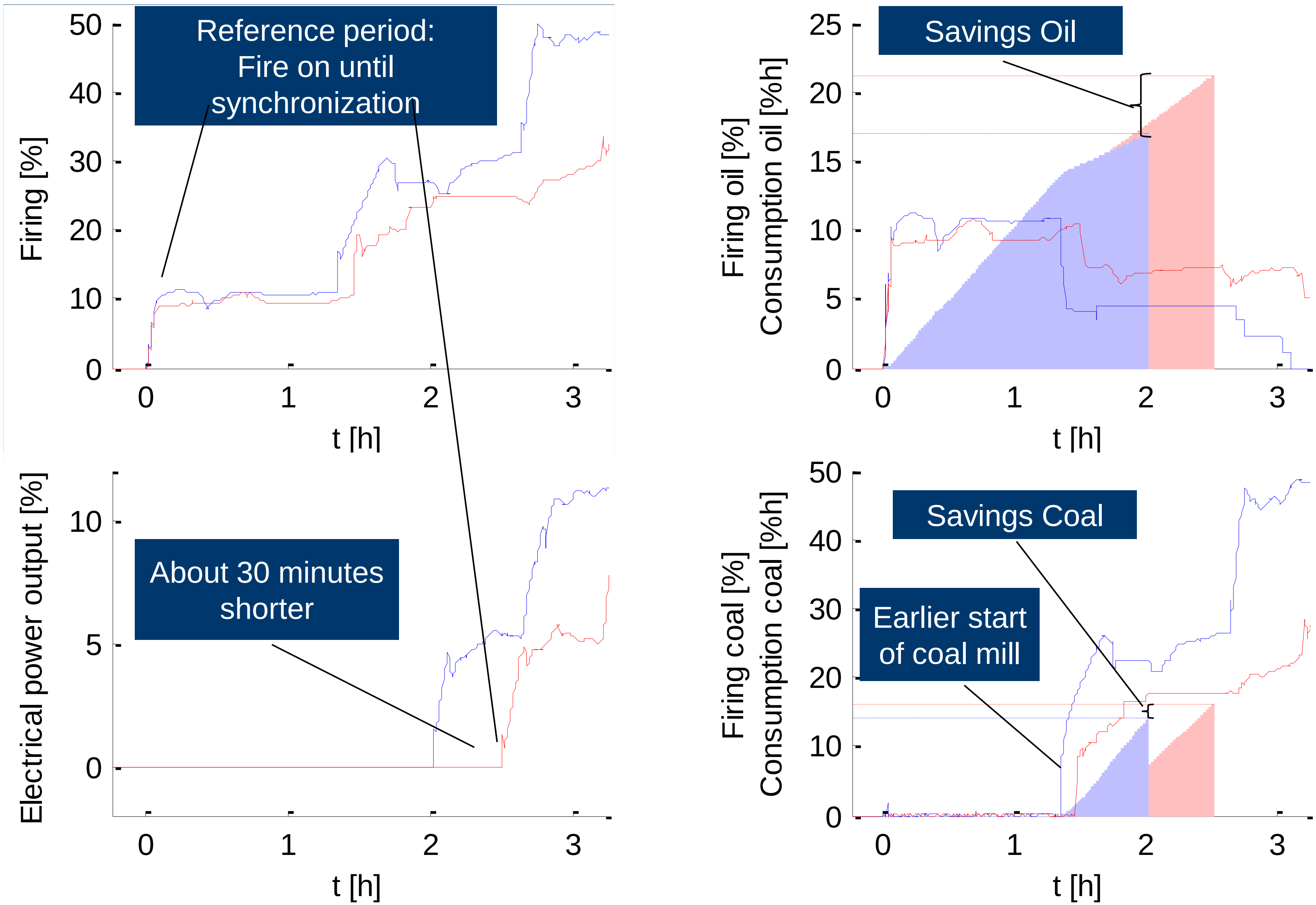
Kallina Calculator



Kallina Calculator – Optimized vs non-optimized behavior



Results in a STEAG power plant
Automated start-up vs. Good manual start-up



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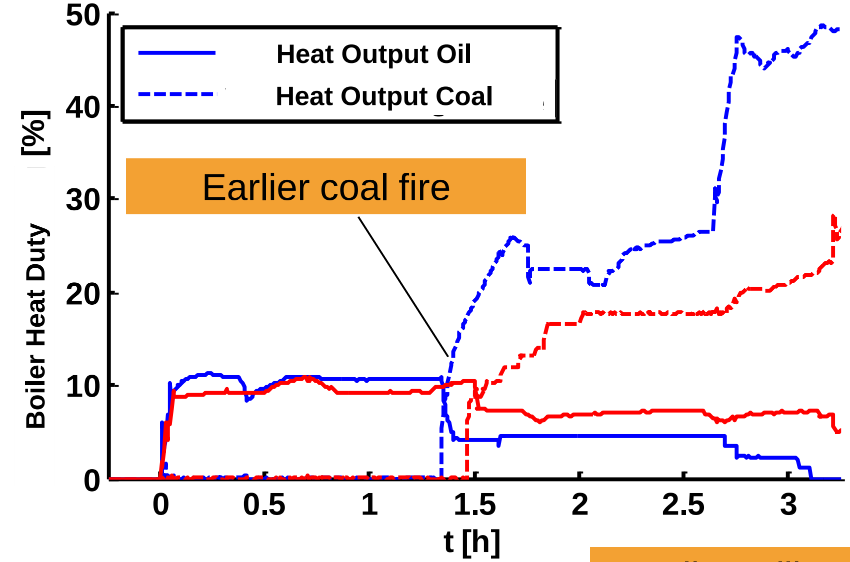

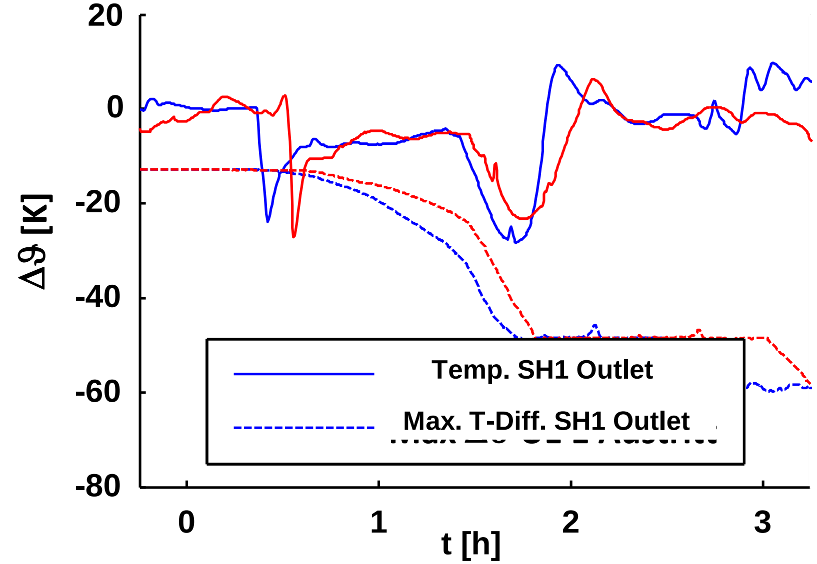

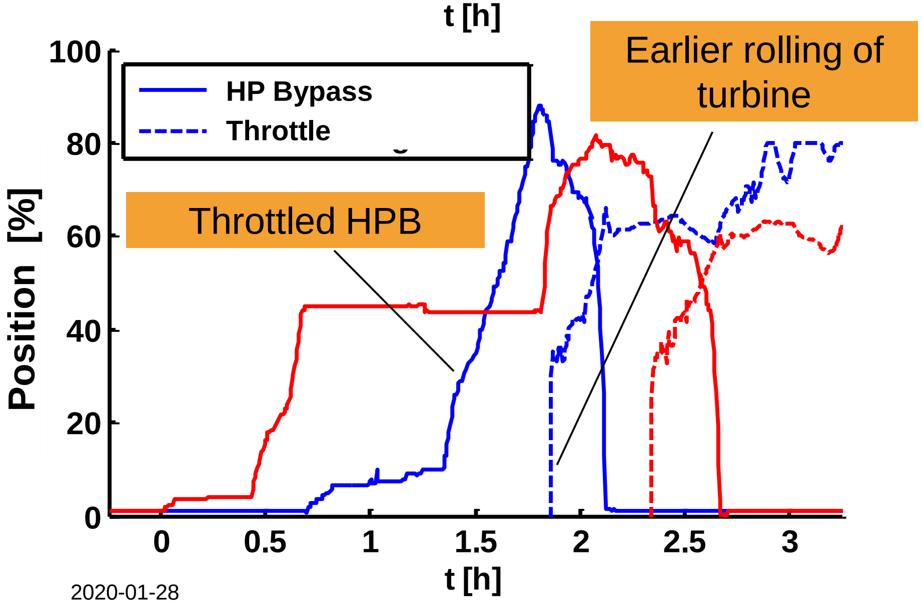

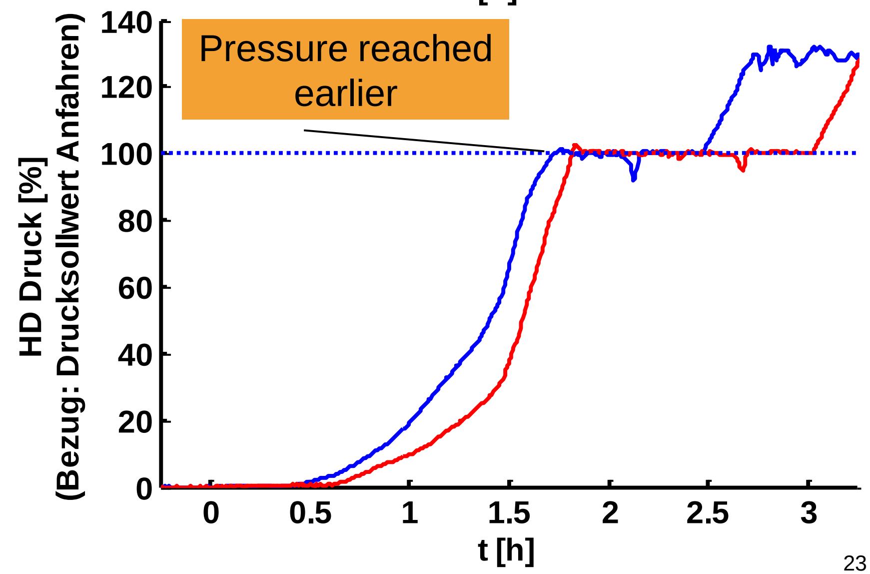

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Reserve Controls

Primary control reserve:

Provided according to the solidarity principle by all Transmission System Operators (TSOs) synchronously connected within the ENTSO-E area
Automatic and complete activation of primary control reserve within 30 seconds
Period per incident to be covered: 0 < t < 15 min

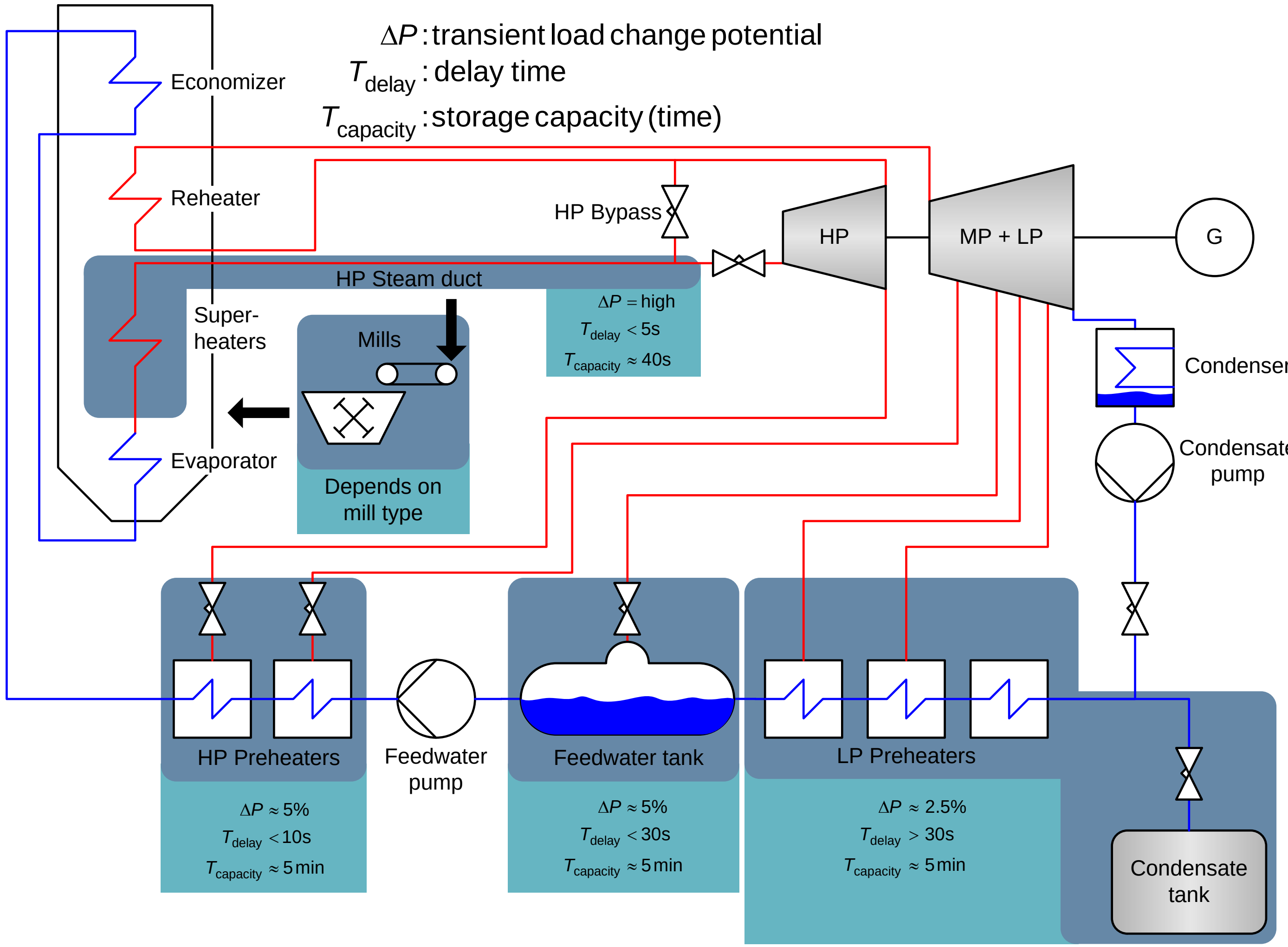
Secondary control reserve:

Energy balance of the control area and frequency control
immediate automatic activation by the concerned TSO
complete activation within five minutes (at most)

Minute reserve (tertiary control reserve):

The activation is based on MOLS by a Merit-Order-List (electronical activation) since 2012
Complete activation within fifteen minutes
Period per incident to be covered t > 15 min to 4 quarter hours or up to several hours in case of several incidents

Inherent storages



Example: 780 MW unit

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PiT Navigator - APC Solution for Optimization

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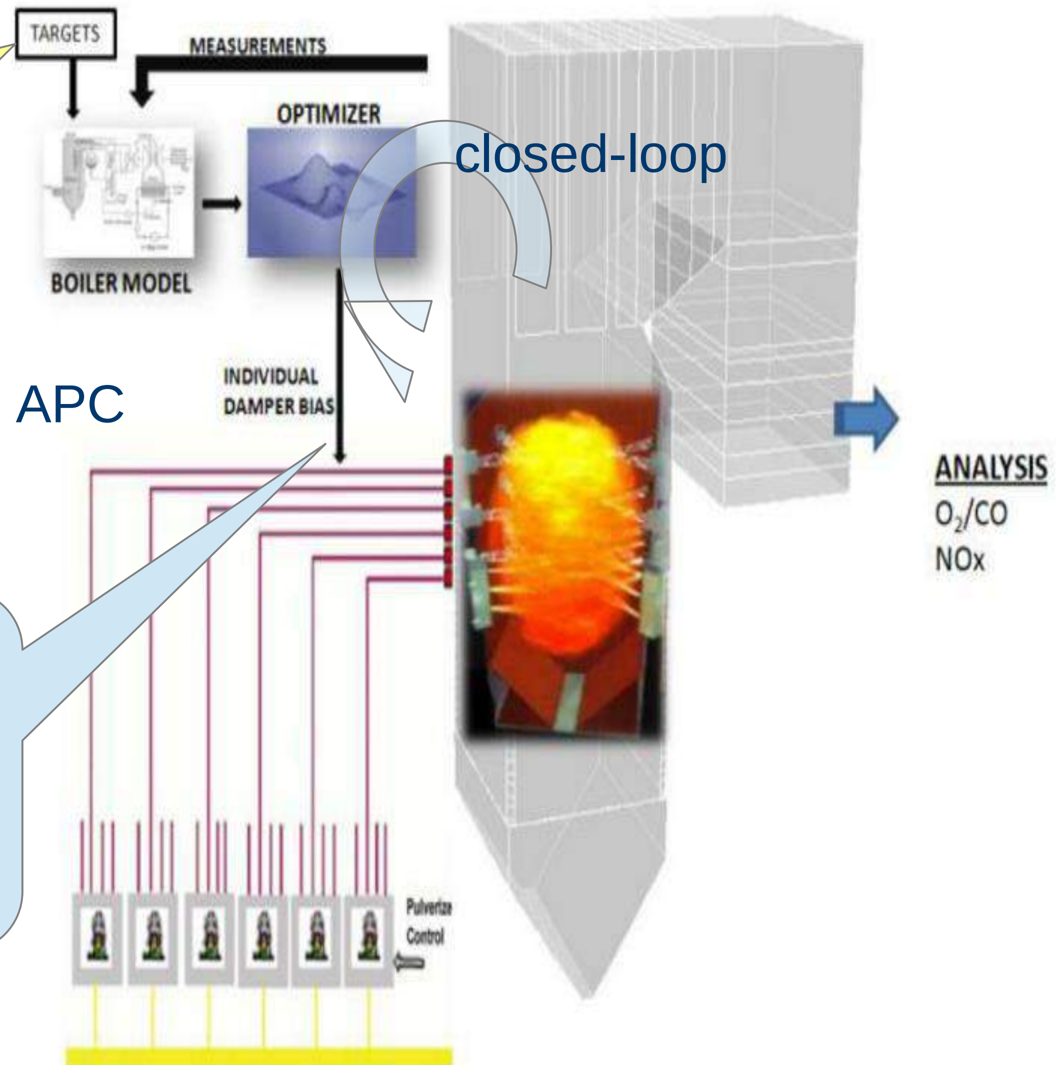
<u>Targets to be optimized:</u>
- Temperature imbalances
- Metal temperatures
- Steam temperatures
- Efficiency
- NOx



<u>Outputs (Biases) to be controlled:</u>
- Auxiliary air dampers
- Cornerwise burner tilts
- Over fire air dampers
- Mill loading
- RH/SH-spray flows

Optimization Results from Jharsuguda

Achieved Improvements	From normal operation	To Pit Navigator	Improvement
Av. duration of RH-Metal Temperature excursion	13min/d	5.9min/d	>50%
Av. RH-Steam Temperature	532.2°C	535.2°C	3K
Av. RH-Spray	49.8t/h	43.9t/h	6t/h
Av. SH-Steam Temperature	538.4°C	539.2°C	0.8K

Unit heat rate improvement of 5 kcal/kWh by higher average steam temperatures and reduced RH-spray

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Control optimization with respect to		
Minimum load	Start-ups	Control power

Results*		
Minimum loads below 15 %	Reduction of oil consumption by 20% or more	Prequalification for primary and secondary control

*general potential; depends on individual plant characteristics

References

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Project	Power Plant Walsum Unit 10/9
Country	Germany
Client	STEAG GmbH
Technical Data	800 MW / 410 MW – Once through boiler
Scope of Services	Minimum load reduction / Frequency control / start-up optimization , soot blowing optimization – Studies as well as implementation
Project Finalization / Duration	Since 2010 – ongoing

Project	Power Plant Bexbach
Country	Germany
Client	STEAG GmbH
Technical Data	780 MW – Once through boiler
Scope of Services	Frequency control, ramp rates, SH/RH Temperature Excursion Reduction – Studies & implementation
Project Finalization / Duration	2016 – 2017

Project	PPs Guacolda / Bocamina Unit 1/2 / Santa Maria
Country	Chile
Client	CDEC SIC
Technical Data	4*150 MW / 128 MW / 350 MW / 350 MW – Drum boiler
Scope of Services	Minimum load reduction / ramp rates / start-up optimization – Audit
Project Finalization/ Duration	2015 – 2017

Project	Power Plant Zonguldak Unit 2/3
Country	Turkey
Client	Eren Energii
Technical Data	2*615 MW – Once through boiler
Scope of Services	Minimum load reduction – Study
Project Finalization / Duration	2017 / 3 month

Project	Power Plant Dadri / Simhadri
Country	India
Client	NTPC
Technical Data	210 MW / 500 MW – Drum boiler
Scope of Services	Minimum load reduction / ramp rates / start-up optimization – Study
Project Finalization/ Duration	2017 / 6 month

Project	Power Plant HKW West 2/3
Country	Germany
Client	STEAG GmbH
Technical Data	Drum boiler
Scope of Services	Ramp Rate Optimization and SH/RH spray optimization
Project Finalization / Duration	2012

Thank you very much for your attention!

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