




STEAG Energy Services Approach to Higher Flexibilization
“Tools and Results”

Jatinder Singh
30.11.2018

steag
ENERGY SERVICES

Challenges of Flexibilisation

- **Decreased, but still robust low load operation**
- **Faster start-up and ramping dynamics**
- **Controllability: proof of potential to provide grid services (e.g. frequency control)**

Crucial Aspects of Flexibilisation

ENERGY SERVICES

- Increased wear and tear of equipment
- Revenue loss due to reduced full load operation
- Diligent adjustment of O&M procedures
- Need to enhance overall plant performance and efficiency

STEAG Energy Services

Pyramid of SES Power Plant Flexibilization

steag
ENERGY SERVICES

Main topics of flexibilization

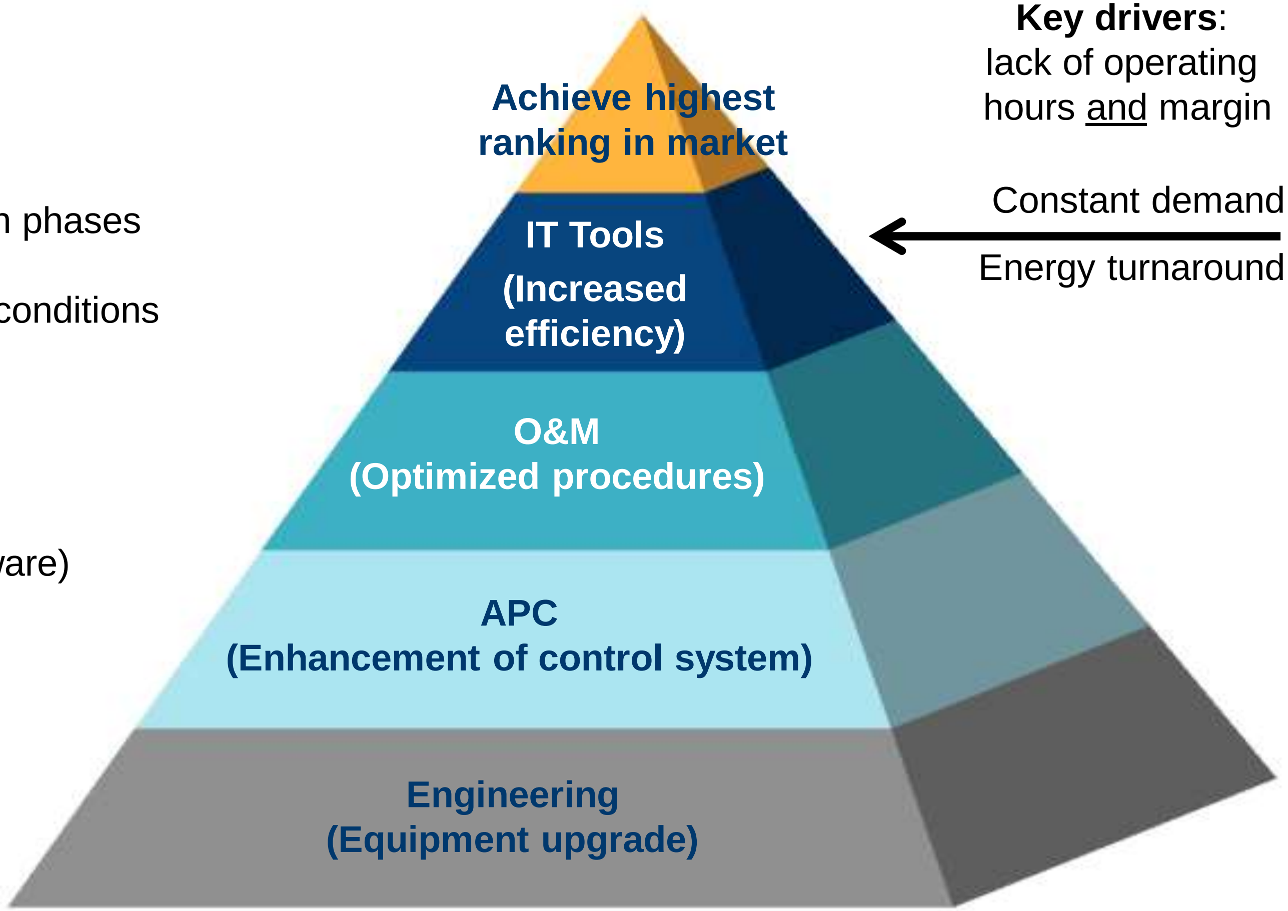
- Start-up optimization: reproducible, faster, cheaper due to saving start-up fuel
- Minimum load reduction: keep plant in operation at negative margin phases to avoid start-up costs
- Increased ramp rates to ensure a fast reaction to changed market conditions

Measures of flexibilization

- Identification of limiting components
- Control optimization (software modification)
- Evaluation and optimization of components and aggregates (hardware)

Improvement of O&M processes

- Evaluation of best-practice procedure, e.g. for start-up, shut-down, overhauls etc.
- Harmonization of organizations and processes within the fleet
- Workshops



Key drivers:
lack of operating hours and margin

Constant demand

Energy turnaround

STEAG Tool Kit

STEAG ENERGY SERVICES

- Retrofitting with regards to mechanical engineering as well as process engineering
- Enhancement of the underlying control loops
- Improved utilization of system inherent storage capabilities
- Applying advanced process control (APC) based on physical modelling as well as neural network solutions
- Optimization of Ramp rate, SH/RH spray control & Combustion Process etc.
- Implementation of online lifetime monitoring
- Upgrading and adjustment of respective operational procedures
- Awareness building and know-how transfer sensitizing the operators
- Applying simulator or on the job training

Reduction of Minimum Load

Optimization of relevant subordinate controls:

› **Analysis of subordinate controls like:**

- Life steam temperature control, fuel control, feed water control
- Individual analysis, adaption and optimization of each subordinate control
- Recommendation for exchange of sensors, actuators and electronic I&C cards if necessary

› **Simple modifications:**

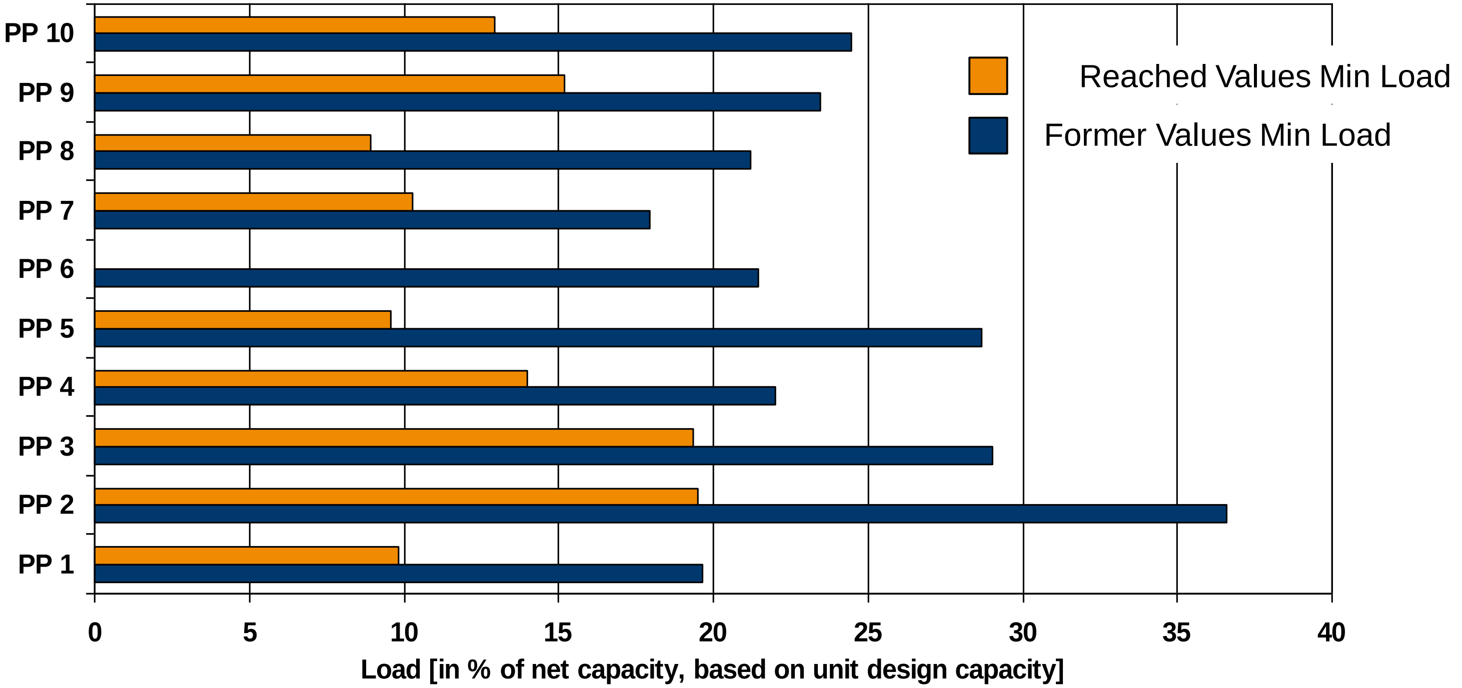
- Control concepts are based on standards
- Control is kept as simple as possible
- The Advanced model-based control unit works as a simulation environment
- Modifications first implemented by customer after successful testing

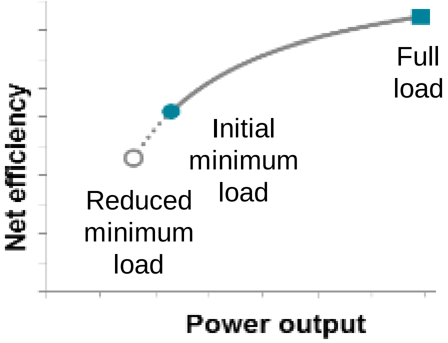
› **Reduction of boiler minimum load:**

- Obtained by optimization of subordinate controls and effective testing

Potential for Minimum Load Reduction

Big potential beyond the initial design



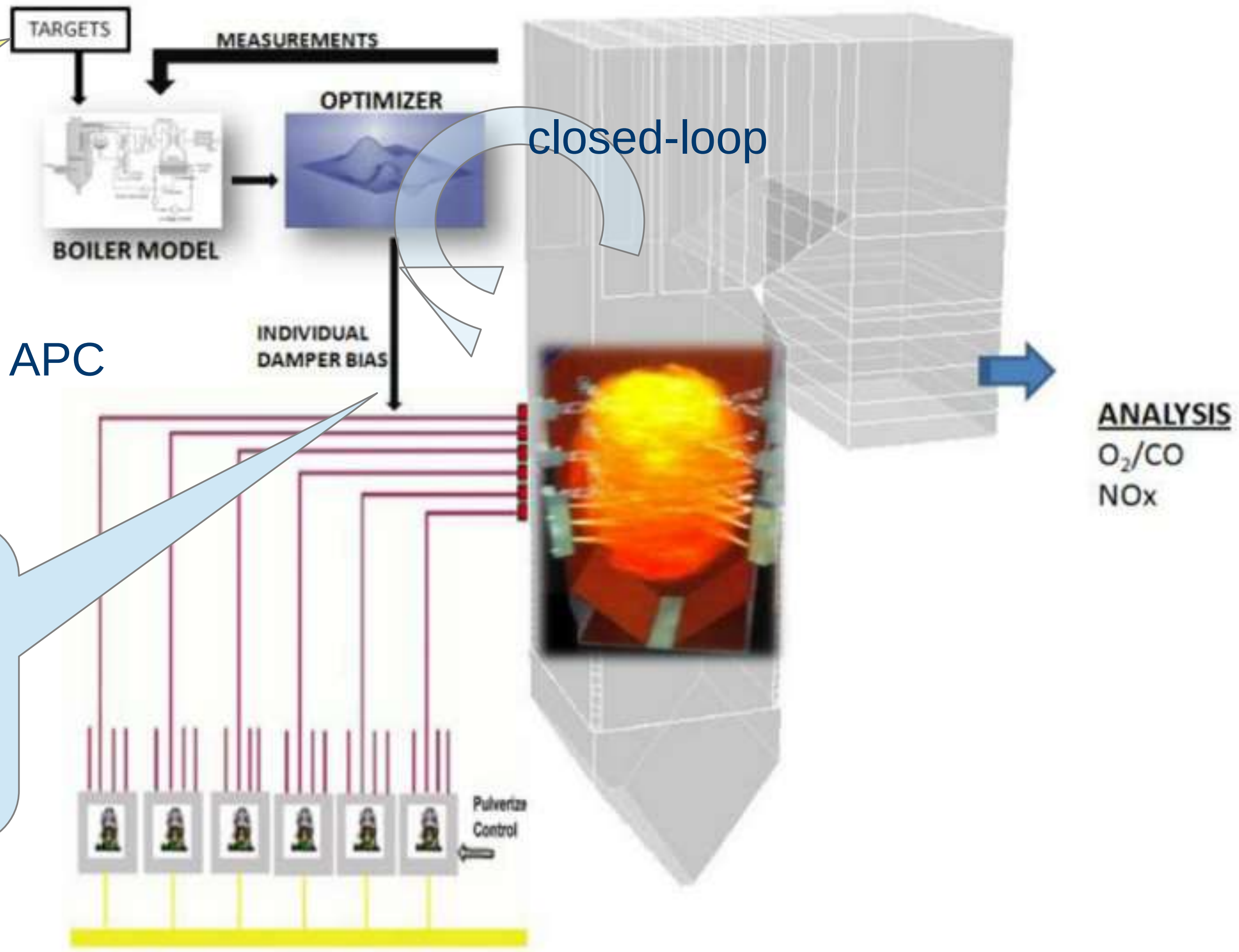


Reference plants in Germany were built between 1970 – 1990

PiT Navigator - APC Solution for Optimization

STEAG ENERGY SERVICES

Targets to be optimized:
- Temperature imbalances
- Metal temperatures
- Steam temperatures
- Efficiency
- NOx



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

Optimization Results from Jharsuguda

steag ENERGY SERVICES

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

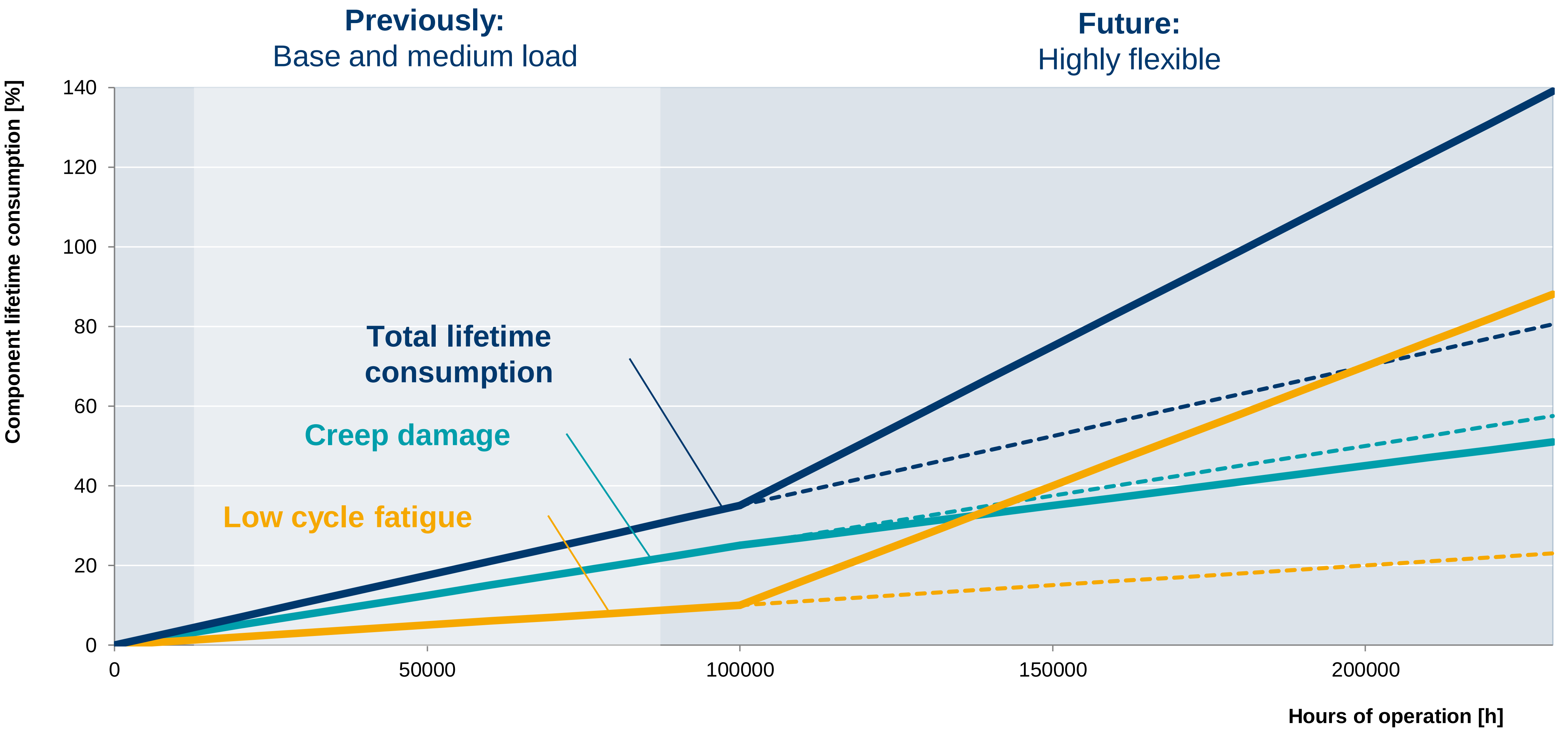
Case Study : Optimization of Operation in Respect to Fatigue

steag ENERGY SERVICES

- **Calculation of fatigue by online life time monitoring system**
- **Clasification of starts / Stress collectives**
- **How to meet the requirement to double the number of start-ups**

Increased Stress Due to Load Changes

steag ENERGY SERVICES



Calculatory Component Life Time Consumption
Extrapolation of the Life Time Consumption

Year	Operating Hours [h]	D_F [%]	$D_{F.RES}$ [%]	D_C [%]	D_{TOTAL} [%]
2014	7735	1,88	1,02	1,89	3,77

Table 1: Lifetime consumption for a selected component

Operating Hours [h]	D_f [%]	D_c [%]	D_{total} [%]
200.000h	48,6	48,9	97,5

Table 2: Linear extrapolation of the component lifetime consumption for 200,000 h

At first, apparently no potential for doubling the number of start-ups

Type of Starts / Starts Collectives

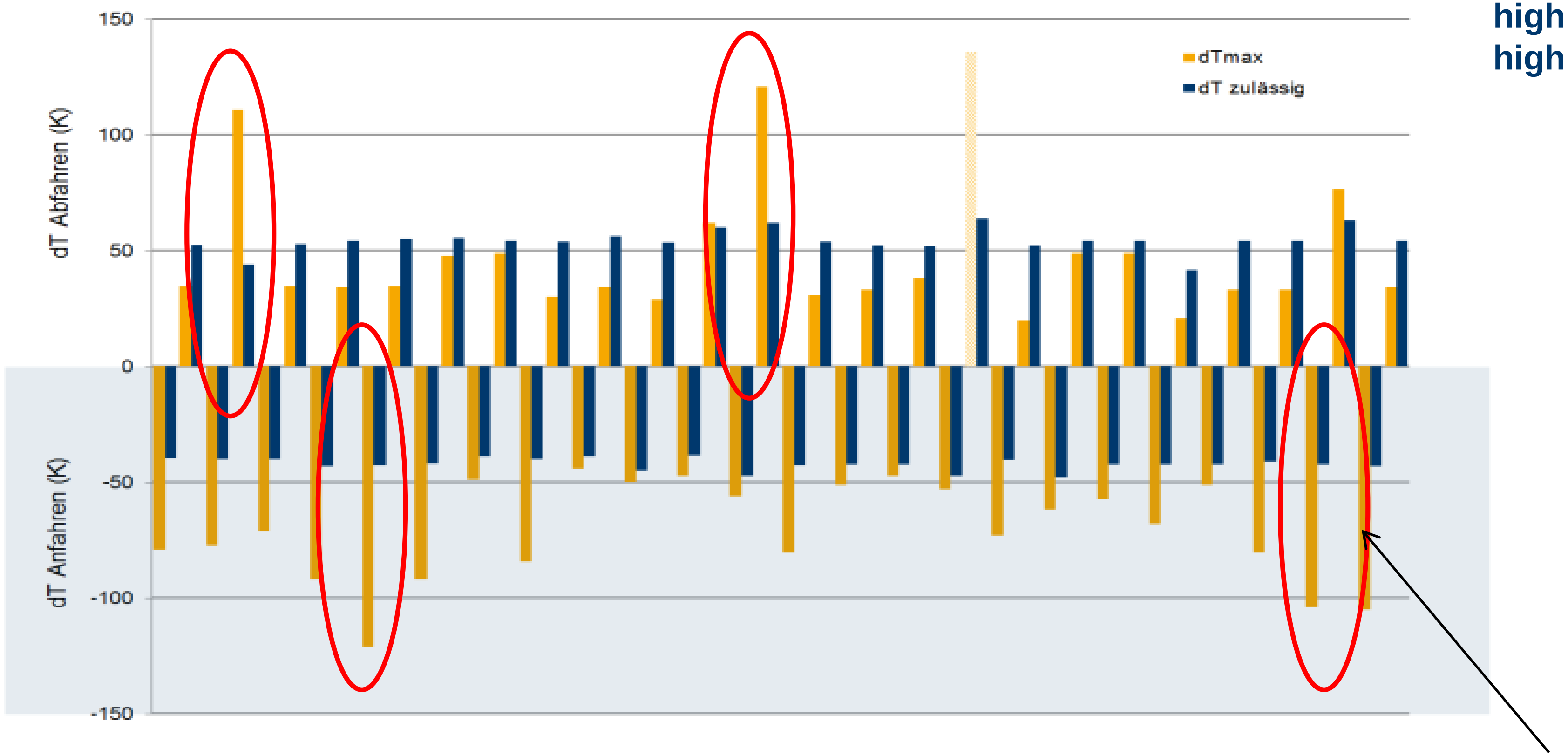
Start Type	Minimum Cycle Pressure	Minimum Cycle Temperature	Down Time
Cold Start	0 bar	>20 °C	>48h
Warm Start	0 bar	>80 °C	<48h
Hot Start	0 bar	>250 °C	<8h

Table 1: Criteria for the classification of cold, warm, and hot starts (downtime most important)

Start Type	Number	dT_{max} [K]	$dT_{max,mean}$ [K]	$Sigma_{max}$ [N/mm²]	$Sigma_{max,mean}$ [N/mm²]
Cold Start	4	-84	-76	-502	-432
Warm Start	17	-121	-69	-709	-389
Hot Start	3	-77	-70	-436	-396
Shut Down	24	111	49	804	347

Table 2: Actual stress collective of a thick-walled component

Identification of critical events



high temperature difference =>
high thermal stress =>
high fatigue

Exceedance of the admissible temperature difference during start-up, shortfall during shutdown

Potential for adjusting the admissible limits exists.

Lifetime Consumption per Warm Start at Optimized Mode of Operation

Event	Df [%]	Number per Year	Df per Year [%]
$WS_{,max}$ + Shut Down$_{,max}$	0,58	2	1,16

Table 3: Lifetime consumption due to critical cycle (warm start + shutdown)

Reduction of the lifetime consumption per year by 1.16% conceivable.

Operating Hours [h]	D_f [%]	D_{total} [%]	$D_{f,optimiert}$ [%]	$D_{total,optimiert}$ [%]
200.000h	48,6	97,5	**18,6**	**67,5**

Table 4: Linear extrapolation to 200,000h of the stress determined in 2014 (with and without consideration of an optimized mode of operation)

By avoiding critical conditions, reserves for doubling the number of start-ups can be generated.

Conclusions from the Study

steag
ENERGY SERVICES

- **Adaption to flexible operation requires detailed knowledge of fatigue**
- **Online monitoring of fatigue provides this knowledge to plant engineers**
- **Avoidance of very fast ramping enables for increasing the number of starts**

Overview of Selected References

STEAG ENERGY SERVICES

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 – 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 – Studies as well as implementation
Project Finalization / Duration	2015 – 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 Energji
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	Mainova
Technical Data	Drum boiler
Scope of Services	1-mill operation – Study as well as test r
Project Finalization / Duration	2017

International proven references by STEAG Energy Services

Summary

STEAG has unique approach to flexibilization of power plants based on

- **operating expertise**
- **innovative software solutions like PiT-Navigator (APC), Life Time Monitoring System etc.**
- **special engineering services**

This approach has been successfully applied to several power plants !

Time for Flexibilization

by

STEAG Energy Services

STEAG Energy Services India
A-29, Sector -16,
Noida – 201 301
Telefon +91 120 4625 000
Telefax +91 120 4625 100
www.steag.in

steag
ENERGY SERVICES