R&D projects of VGB as a contribution to the market developments in Europe

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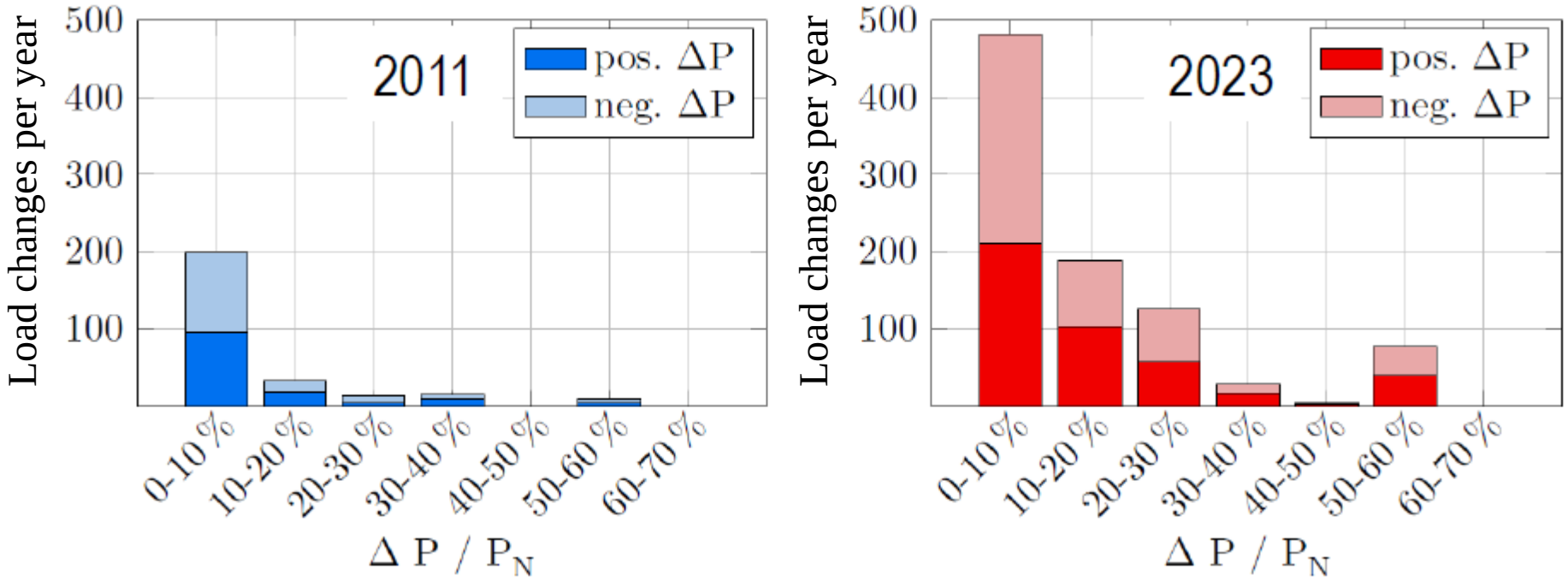
Actual and expected load changes for Power Plant Jänschwalde (lignite base load, 500 MW units) from VGB R&D project 333



- Increased requirements to power plants by liberalisation and „Energiewende“
- Rising number of startups and shutdowns, load gradients and load change
- Operation beyond original design

Wear investigation model for thermal power plants at supply of control power

VGB-Lenkungskreis zum Forschungsprojekt VGB 632

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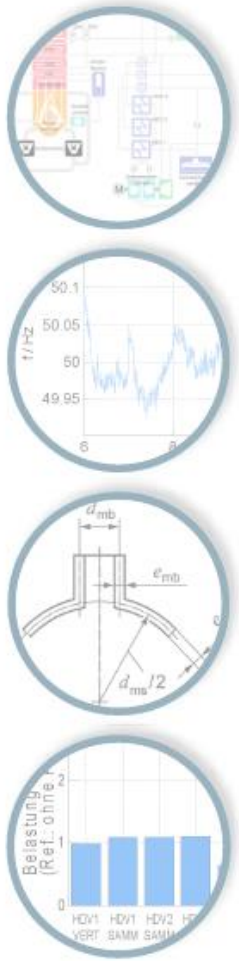
Wear investigation model: project aims

- Determination and comparision of lifetime consumptions of defined components of water-steam-cycle
- Development of detailed transient power plant models for simulation of primary and secondary control demands (process technology and control system)
- Verification und validation of dynamic models
- Analysis of primary and secondary control demand (grid frequency, secondary control set points) for selection of the simulation scenarios
- Selection suitable structural mechanic models for lifetime calculation at stress by control operation



Wear investigation model: procedure

- Determination of component stresses on the basis of pressure and temperature gradients from the simulation calculations

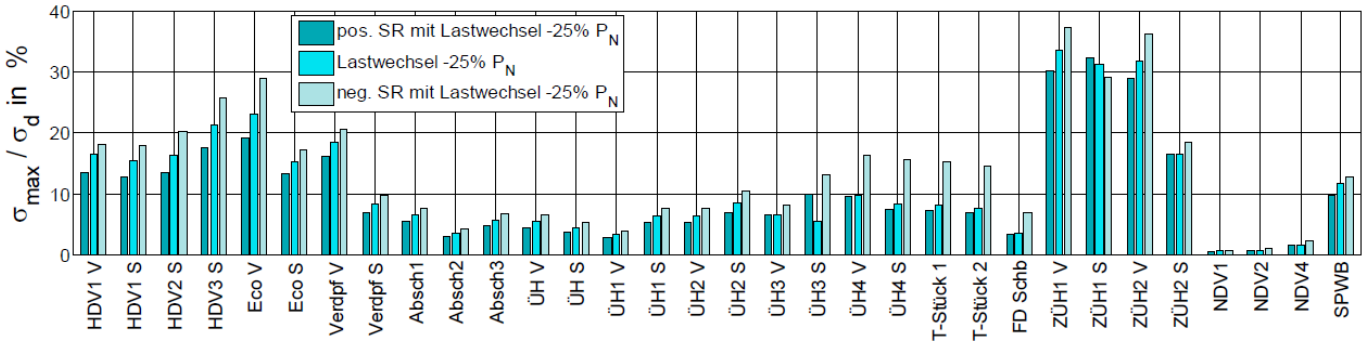
- Transient thermodynamic power plant models for 3 reference power plants
  - *Lignite-fired power plant Jänschwalde*
  - *Coal-fired power plant Rostock*
  - *Combined-cycle plant Mainz-Wiesbaden*

  including simulation of original control technology for showing primary and secondary control processes

- Damage mechanism, stress and lifetime consumption

- Wear of control valves at primary control

- Rising number of startups and shutdowns, load gradients and load change -> Operation beyond original design
- Impact of primary and secondary control regarding fatigue limit according to DIN EN 12952 for defined components in the water-steam- cycle uncritical (approach: investigation of components free of cracks)



- Continous primary control (by throttling) leads to reduced operation duration of turbine control valve by at least 20%
- Small and frequent load changes through primary and secondary control lead to an increased crack growth failure at single components

„Analysis of impacts of delivery of reactive power on electrical components”

Research institutions:

Sensoplan GmbH, Hohentengen am Hochrhein, Germany
Project manager: Thorsten Wasmuth

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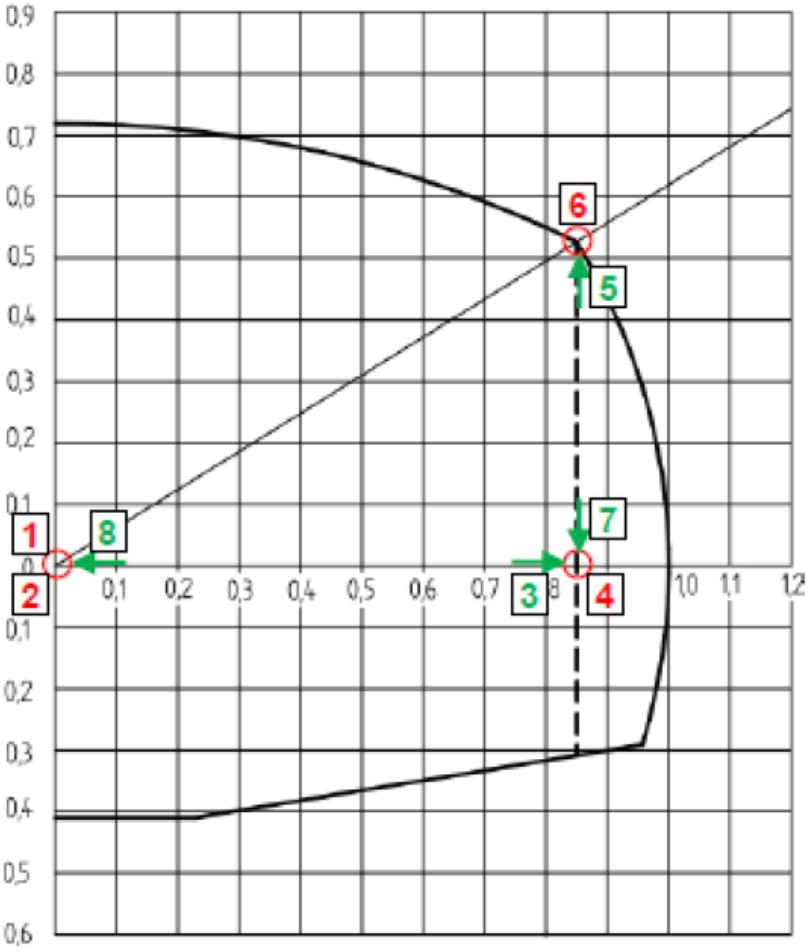
Project Manager: Prof Jens Paetzold

HRW HOCHSCHULE RUHR WEST UNIVERSITY OF APPLIED SCIENCES ENERGY CAMPUS

- Generator
- Unit transformer
- On-load tape changer of the unit transformer
- Auxiliary power transformer
- On-load tape changer of the auxiliary power transformer
- Exciter system
- Generator busduct
- Generator circuit breaker

Full load cycle



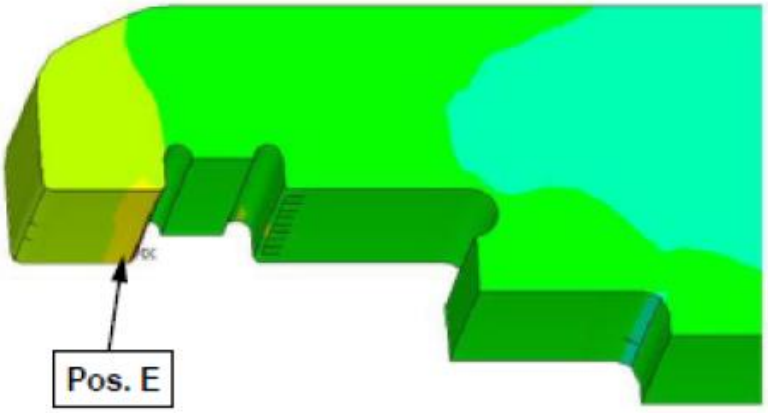
$$\Theta_h(t) = \Theta_a + \Delta\Theta_{oi} + \left\{\Delta\Theta_{or} \bullet \left[\frac{1 + R \bullet K^2}{1 + R}\right]^x - \Delta\Theta_{oi}\right\} \bullet f_1(t) + \Delta\Theta_{hi} + \left\{Hg_r K^y - \Delta\Theta_{hi}\right\} \bullet f_2(t)$$

Analysis of delivery of reactive power: wear mechanism

The following impact are known as wear mechanism :

- Heat input due to increased current load (failure of adhesive bonds, aging, thermal overload, deformation
- Wear due to increased switching rate of tap changer
- Magnetic forces (abrasion, deformation)
- Vibrations (fatigue, abrasion)

Tension distribution rotor cap

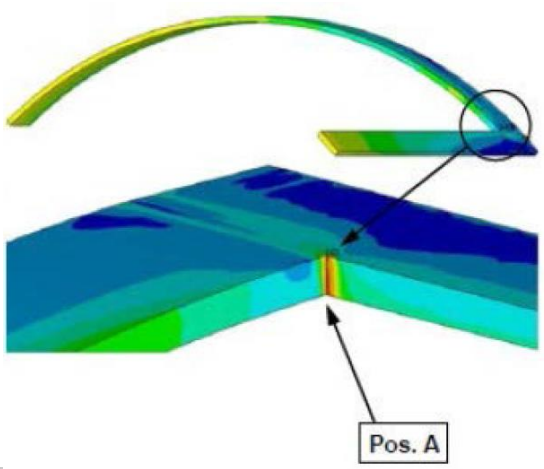


Procedure (Example generator)

Investigation of load case combinations at cyclic operation:

- Cyclic start-stop-operation on active power only:
  Standstill ➔ rated speed cold ➔ active power only ➔
  rated speed cold ➔ standstill

- Cyclic load change-operation by change in reactive power between active power and full apparant power:
  Active power only ➔ rated point with full apparant power ➔ active power only



Tension distribution long conductor

Analysis of delivery of reactive power: results

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Components	Investment-change	Maintenance, wear	Operation
Generator, exciter	Increase apparent power Sizing or design of cooling are changing	Reduction of lifetime by: Increased current load of windings Alternating stress Steep gradients at supply of reactive power	Additional cooling at operation When necessary increased use of operating and auxiliary material at required H_2-cooling
Unit transformer	Increase apparent power	Increased current load of windings reduces lifetime Wear by temperature fluctuations at reactive power load change	Additional cooling at operation
Unit transformer-tap changer	Forced operation or extended gradation area	Reduction of inspection cycle by increased switching	insignificant
Auxiliary power transformer-tap changer	Necessary implementation	Reduction of inspection cycle by increased switching	insignificant
Generator bus duct	Forced cooling	Maintenance efforts when forced cooling is necessary by supply of reactive power	Expenditure for forced cooling

german cooperation
DEUTSCHE ZUSAMMENARBEIT

धन्यवाद

Thank you

for your interest!

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