Evaluation of the Flexibility Potential of Internal Storage Options in Thermal Power Plants by Means of Transient Simulation

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Overview

- Background and Motivation
- Modeling
- Presentation of Models
- Preliminary Results
- Upcoming Tasks

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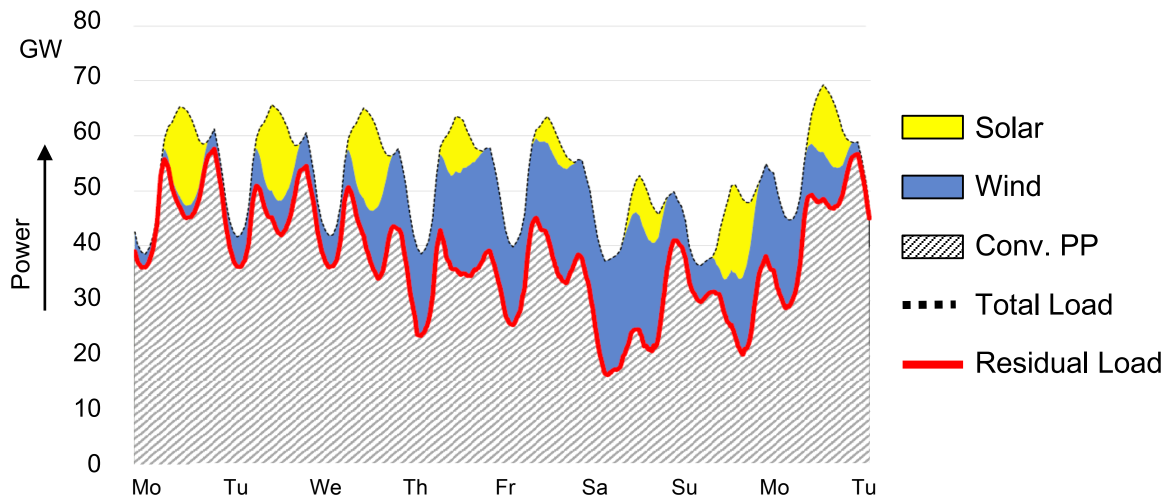
Background and Motivation

- Energy transition in Germany: Necessity to increase the flexibility of conventional power plants
  - Increased number of load changes
  - Lower minimum load
  - Higher load gradients



- Measures to increase plant flexibility necessary → internal storages
- Dynamic simulation: Possibility of analysis of time-dependent effects of the energy transition on conventional power plants independent from real power plant operation

Background and Motivation

- Goal: Short-term provision of power (primary control)

- Measures:

→ Usage of existing storage in water-steam cycle
  – Condensate retention
  – Deactivation of preheaters

→ Potential through extension of existing storage
  – Feedwater tank
  – Cold condensate tank

→ Outlook: Potential of combined heat and power in district heat networks
  – Heat storage
  – Power-to-heat

Approach / Status

- Power plant modeling with regard to design data / performance data
  - Detailed modeling of water-steam cycle of reference plant: ✓
  - Detailed modeling of steam generator: ✓
  - Merging of models: *In progress*
  - Implementation of detailed unit control: *In progress*

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- Reference plant : Community power plant Hannover Stöcken
  - Dual block CHP plant (hard coal, 230 MW_{net} / 425 MW_{th}, process heat)

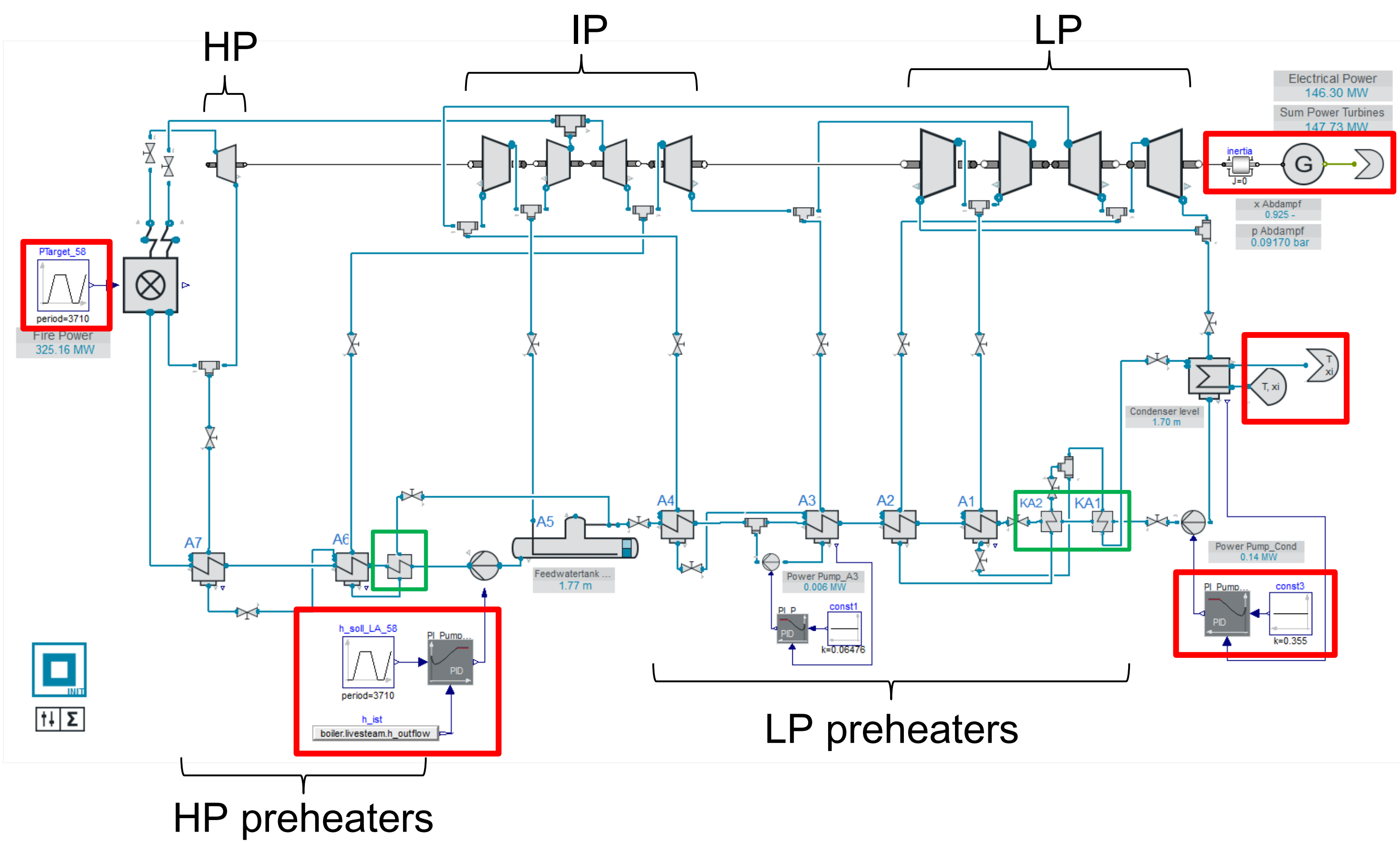
[3]

- Usage of dynamic simulation environment Dymola
  - Component library ClaRa

[4]

Model of Water-Steam Cycle

- Current model (without detailed steam generator) contains all significant parts of WSC
- Detailed geometric parametrisation of components → Implementation of thermal inertia



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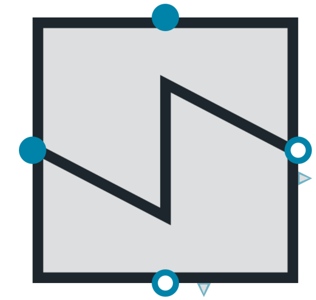
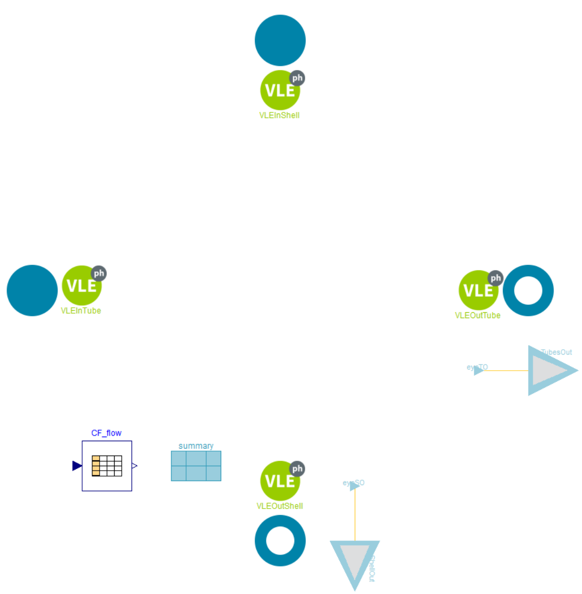
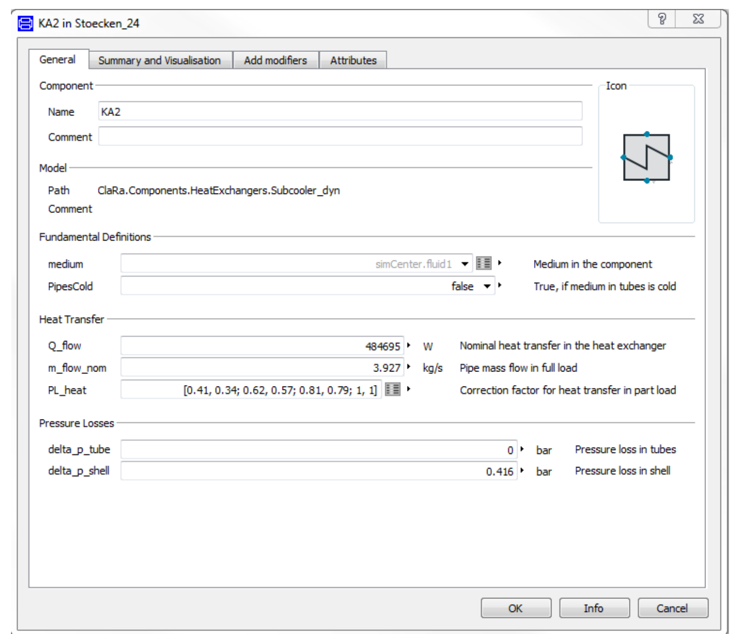
Own Model of Simple Subcooler

- Aim: Very simple modeling of heat transfer between shell / tubes
- Thermal inertia neglected
- For sub-cooling purposes only
- Characteristic line for part load heat transfer

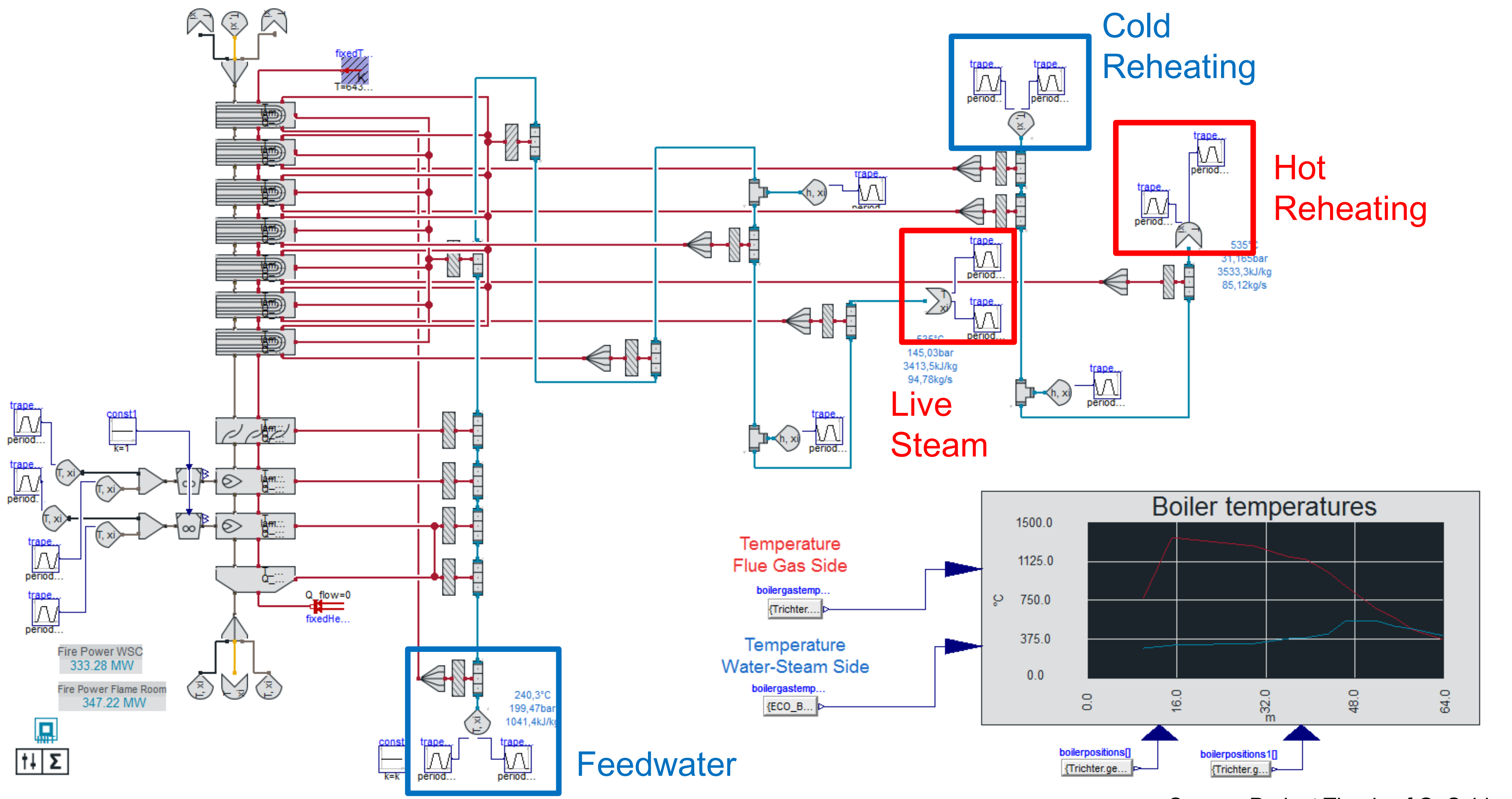






Model of Steam Generator

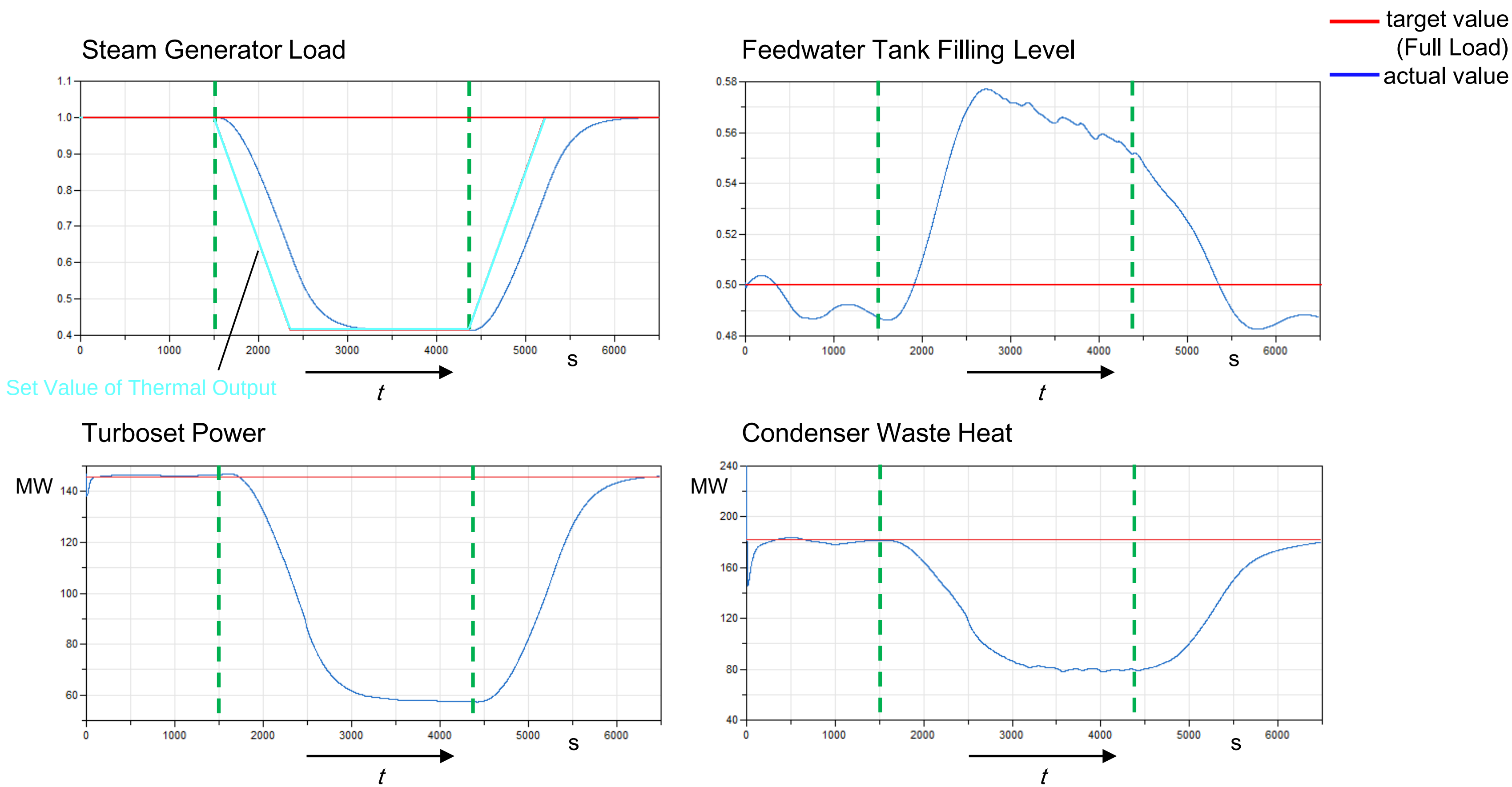
- Current model (without WSC) contains all significant parts of a steam generator
- Detailed geometric parametrisation of components → implementation of thermal inertia



Source: Project Thesis of O. Schirmbeck

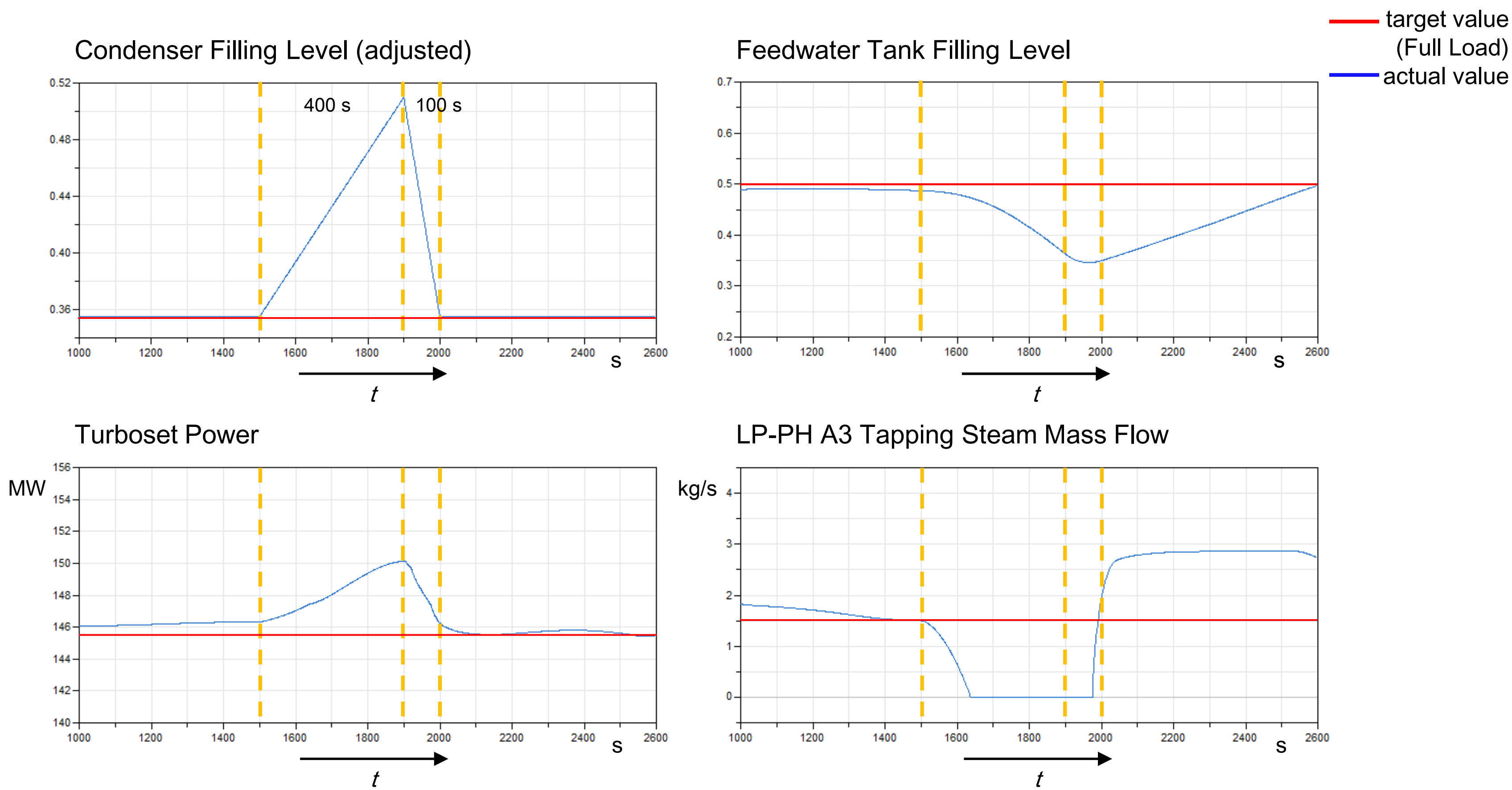
Preliminary Results WSC: Load Cycle 100 – 40 – 100 % Load

- Simulation of low partial load already successful due to implementation of characteristic lines
- Good accordance with target values
- Resulting load gradient ≈ 4.8 MW/min



Preliminary Results WSC: Cond. Retention / Extension FWT

- Simulation of indirect cond. retention for short-term power increase to support primary control
- Water-side flow LP preheater reduced by throttling condensate pump
- Short-term power increase of 2.6%



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Preliminary Results WSC: Cond. Retention / Extension FWT

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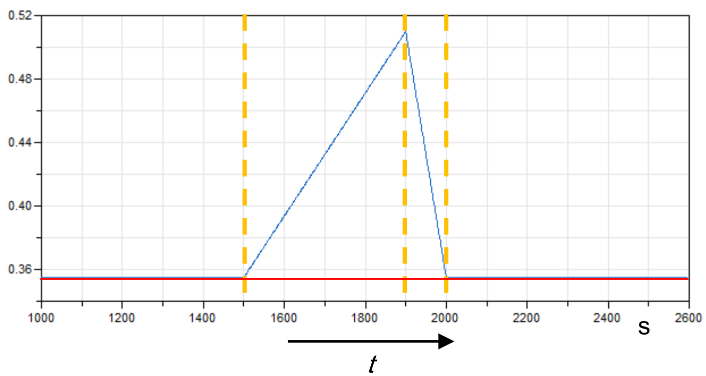
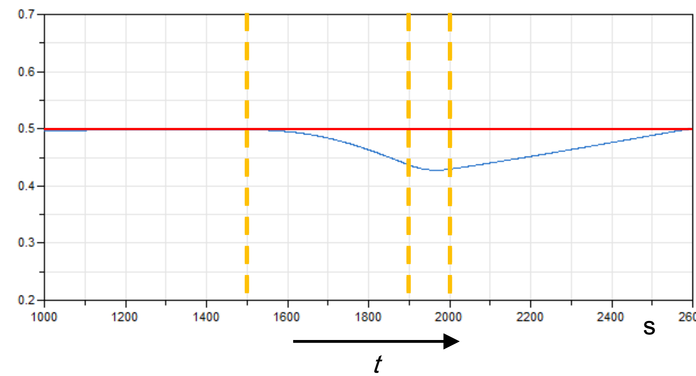
- Example: Extension of feedwater tank (14.5 m → 29 m): Longer cond. retentions possible

target value (Full Load)
actual value

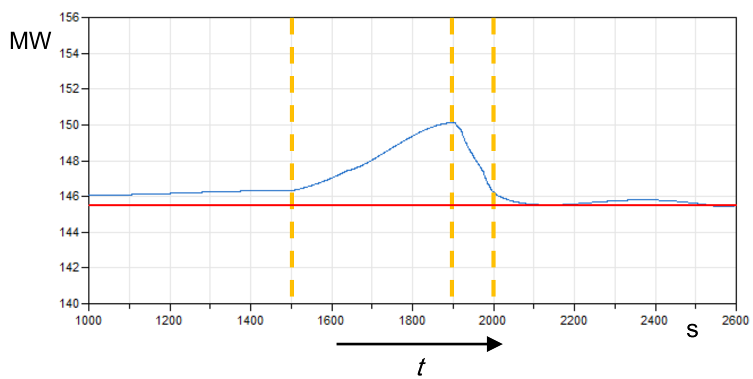
Condenser Filling Level (adjusted)



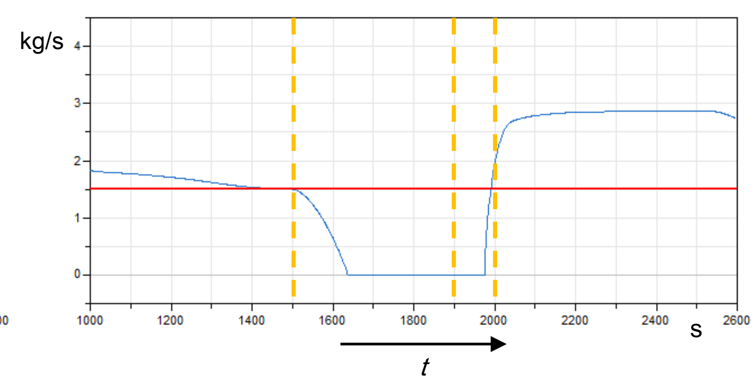
Feedwater Tank Filling Level



Turboset Power

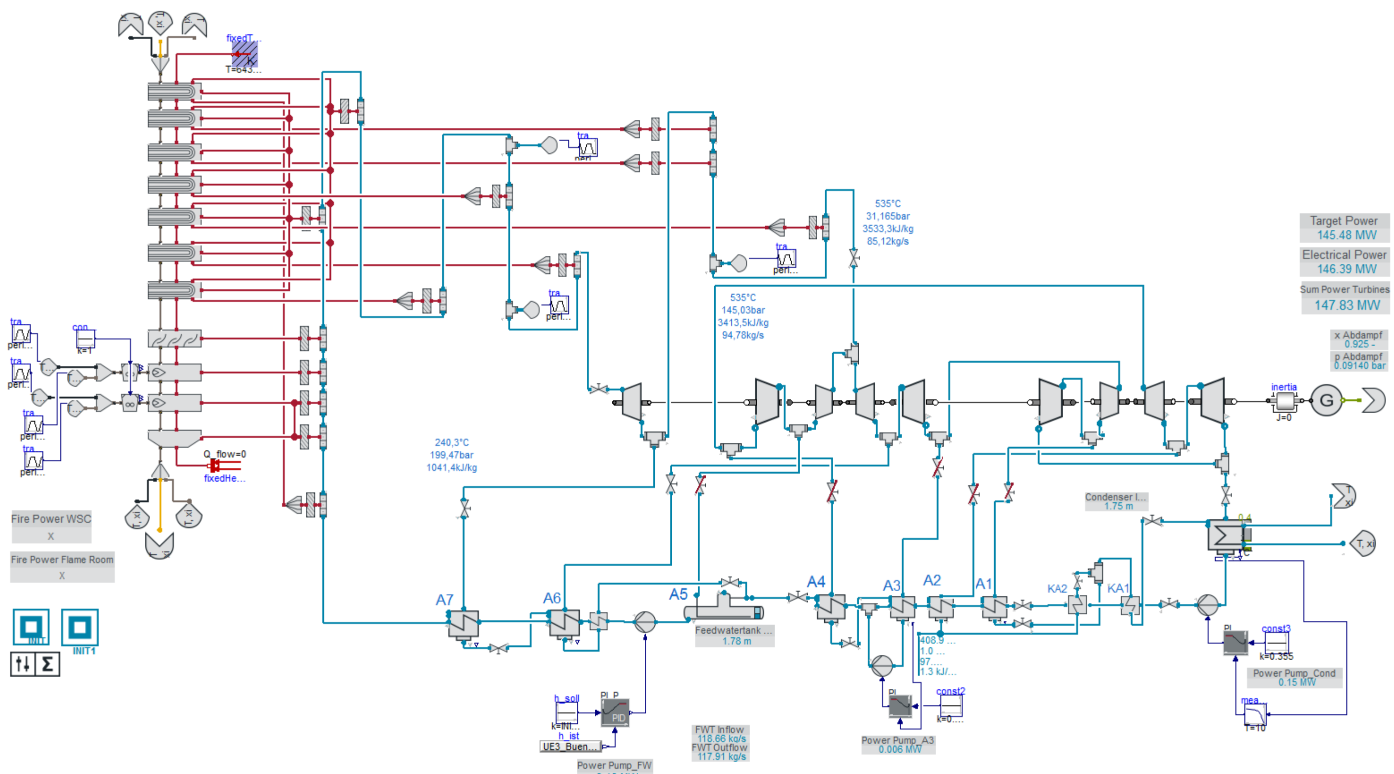


LP-PH A3 Tapping Steam Mass Flow



Upcoming tasks

- **Merging of WSC- and steam generator model**
- Implementation of detailed unit control
- Bugfixes in model
- Integration of cold condensate storage
- Integration of a model of the district heating network of Hannover



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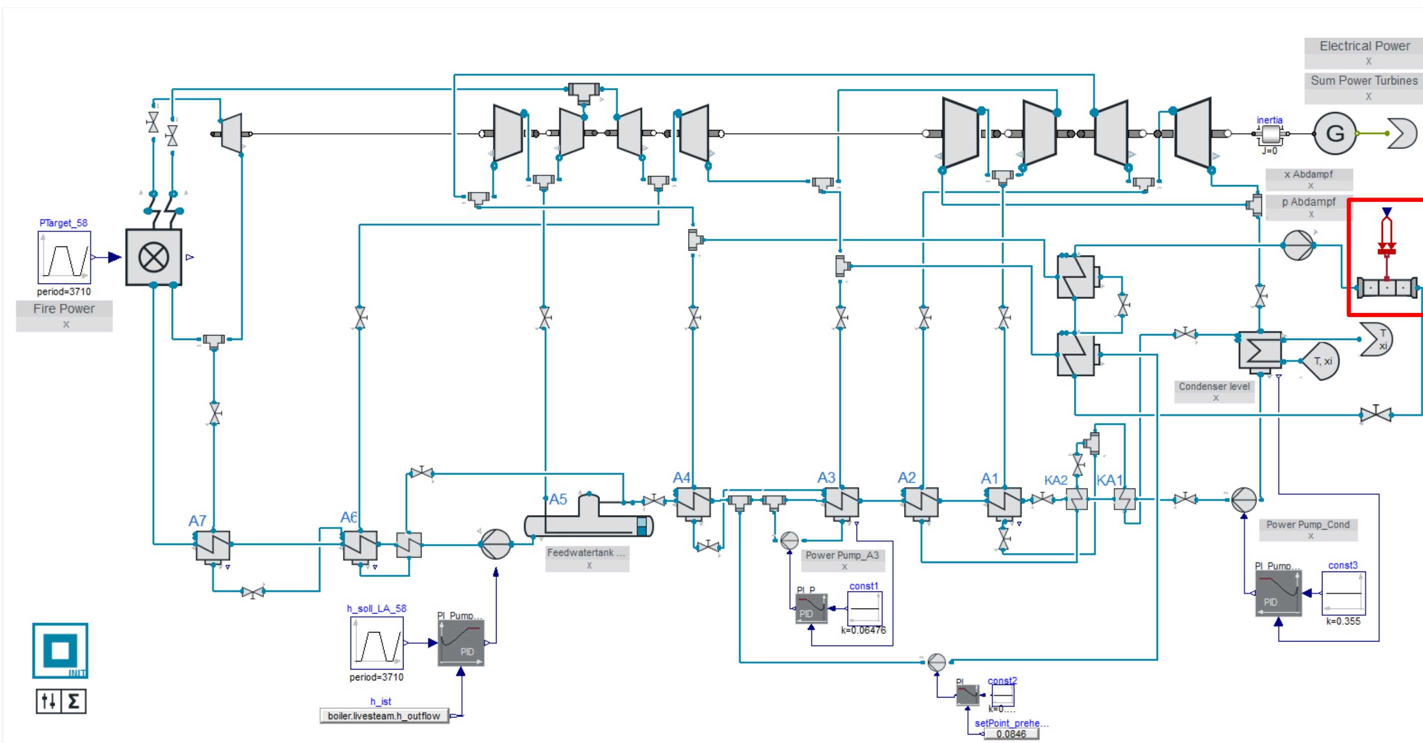

Big Heat Consumers

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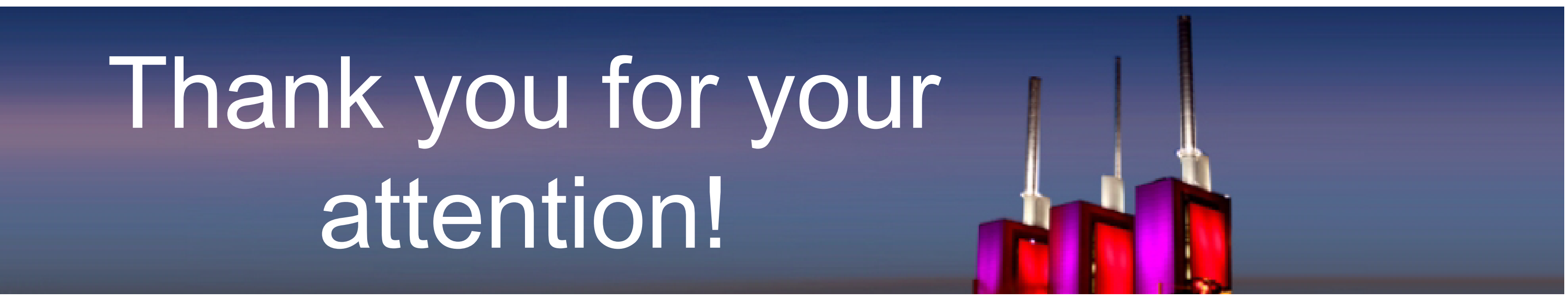

References

[0]: https://commons.wikimedia.org/wiki/File:Power_Plant_Stoecken_Hanover_Germany.jpg

[1]: Scharf: Vorlesung Kraftwerkstechnik II, 2019

[2]: www.haz.de

[3]: www.enercity.de

[4]: www.claralib.com

[4]: www.bildindustrie.de