

Striving for Operational Excellence:

A Holistic Approach through Dynamic Study of Integrated Steam and Power System

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Case Study

Reliance Industries

India



Challenge


Integration of CPP into existing sites; ensuring high quality and availability of steam, electrical supply

Solution

A series of detailed studies, including integrated steam and power studies for islanded and grid connected operations, relay co-ordination, load flow, transient stability, island mode operation tests etc.

Result

Faster transition to new power sources; control systems well-tuned; efficient operating strategies implemented



Integrated Steam and Power Studies

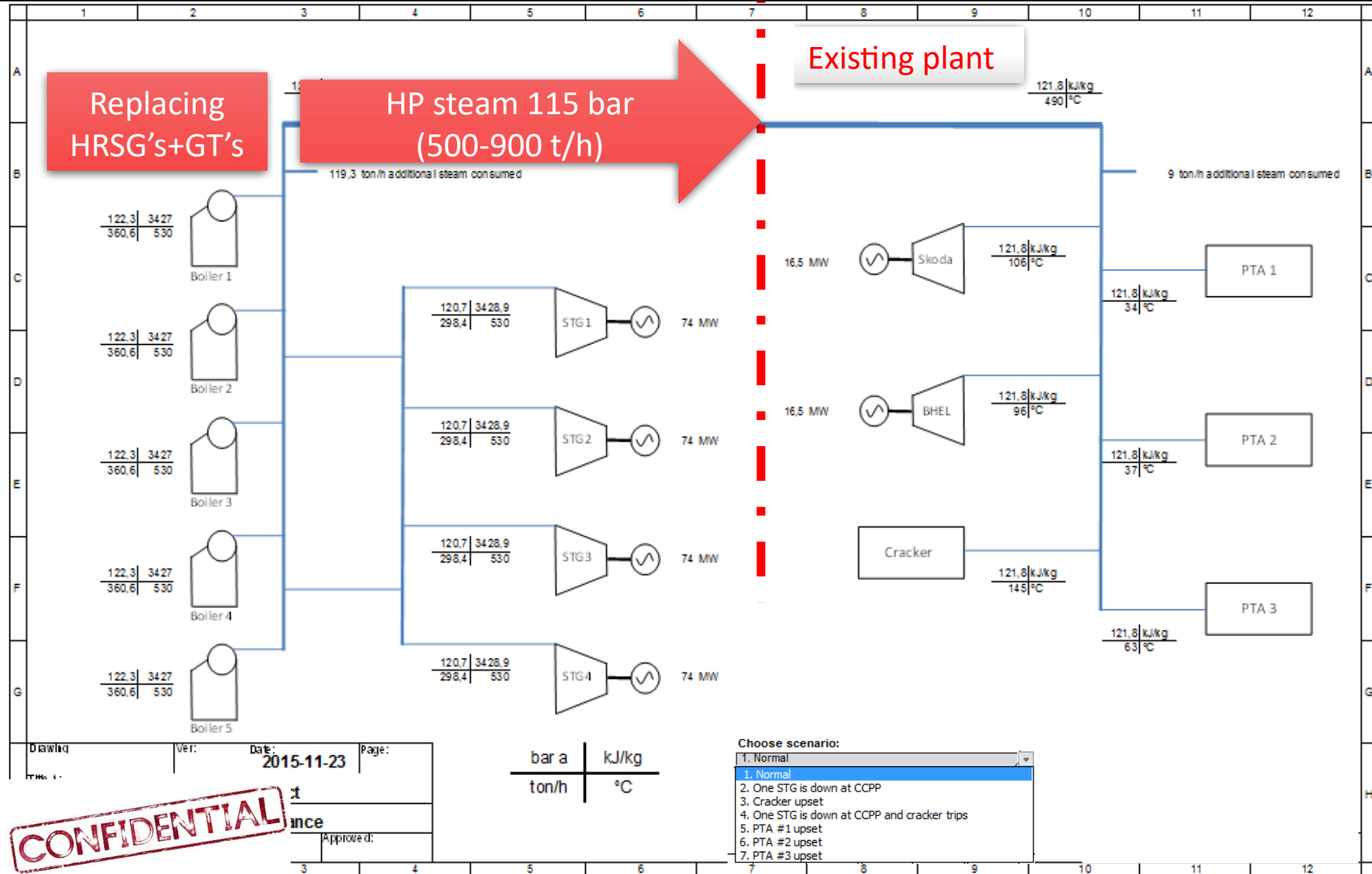
- Study of Fuel, Steam & BFW systems, Electric system and...
 - ...the control systems for all the above
 - Before commissioning
 - Verify control functions and "modify functions to make it work"
 - Auto Tune control functions (PID-param, feed-forwards etc.)
- ...for all specified scenarios:
 - Normal load variations
 - Contingencies; plant trips outside CPP and CFBC or STG trips
 - Both grid and islanded conditions
 - ...so that load shedding is kept to a minimum
 - ...and plant param. are kept within Acceptance Criteria (p [bar], f [Hz])



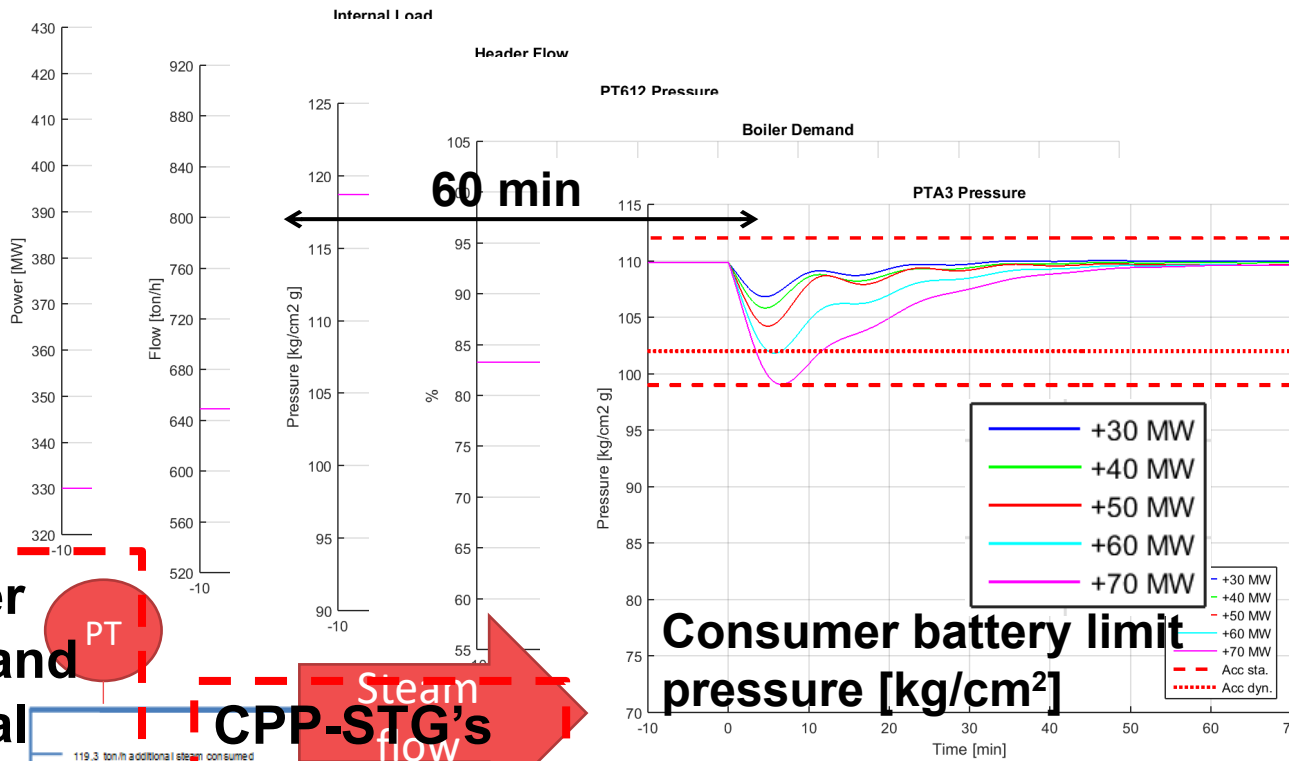
To ISPS presentation

Plant configuration:

NEW: 5 boilers of 500 t/h + 4 Turbines of 93MW

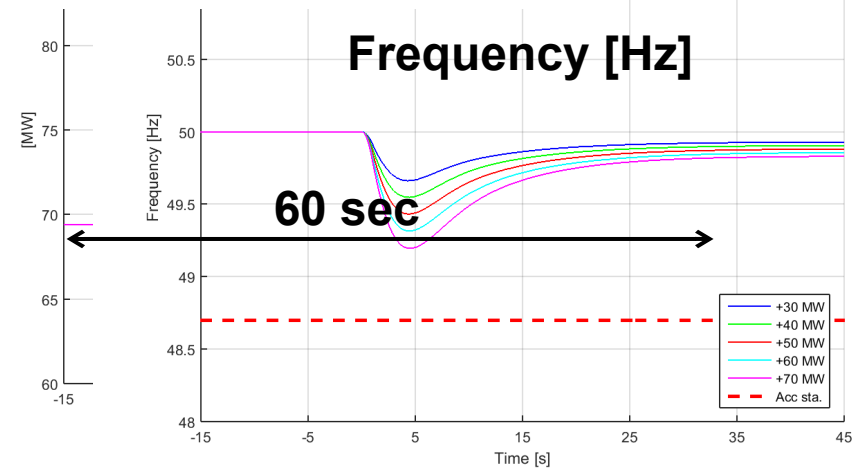
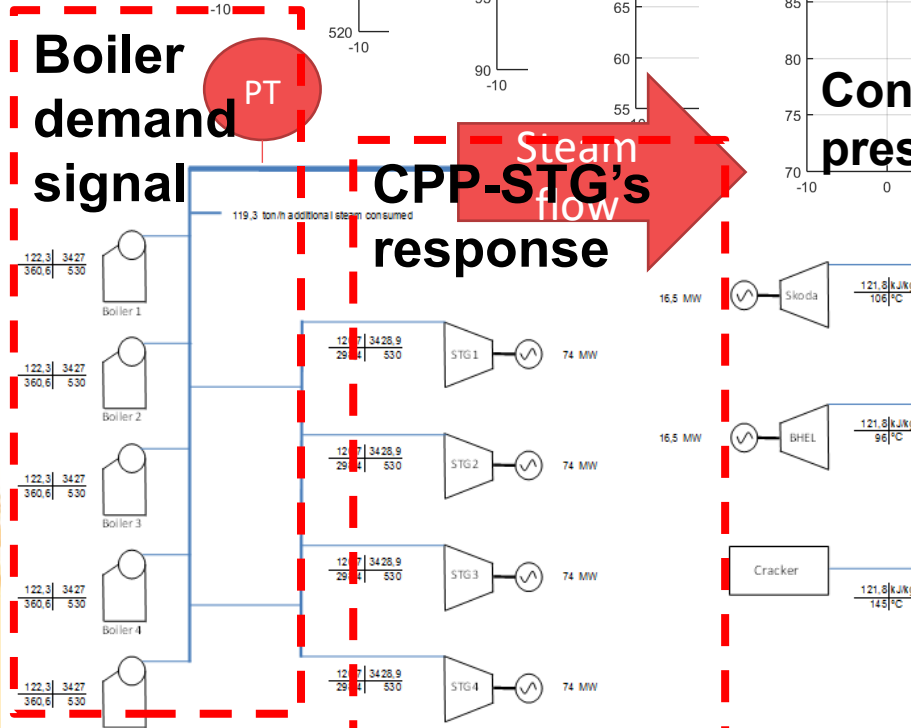


Sensitivity Study Results



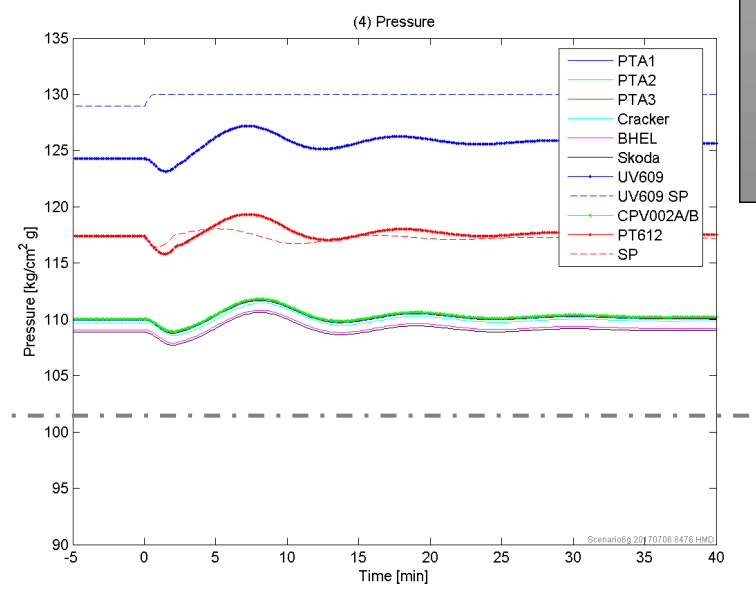
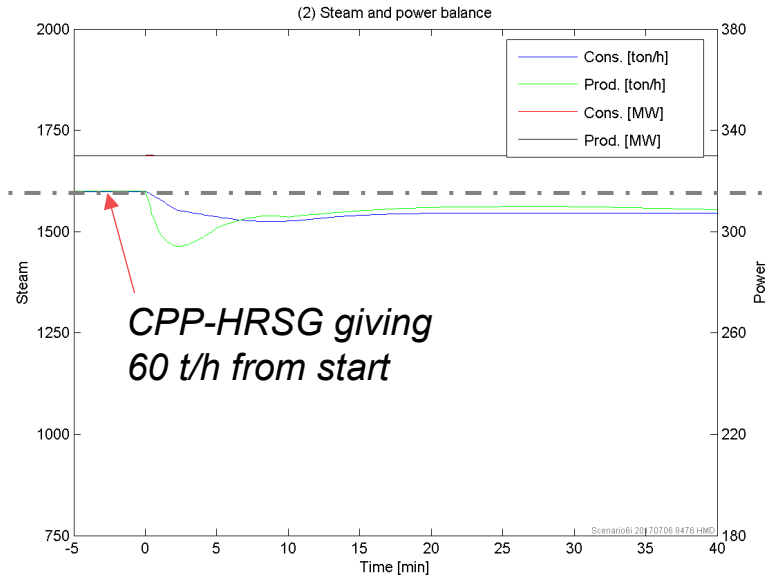
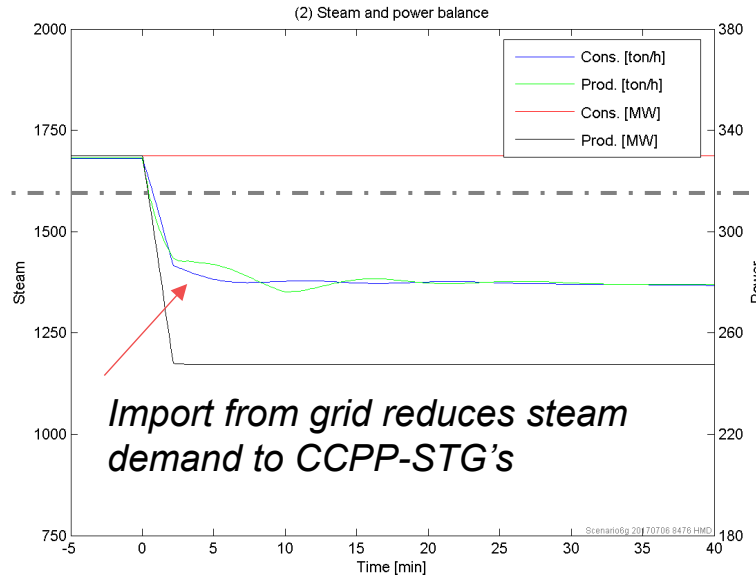
Electrical Load step in Island Operation:

+30, 40, 50 MW... until acceptance criteria is violated – consumer pressure OR grid frequency

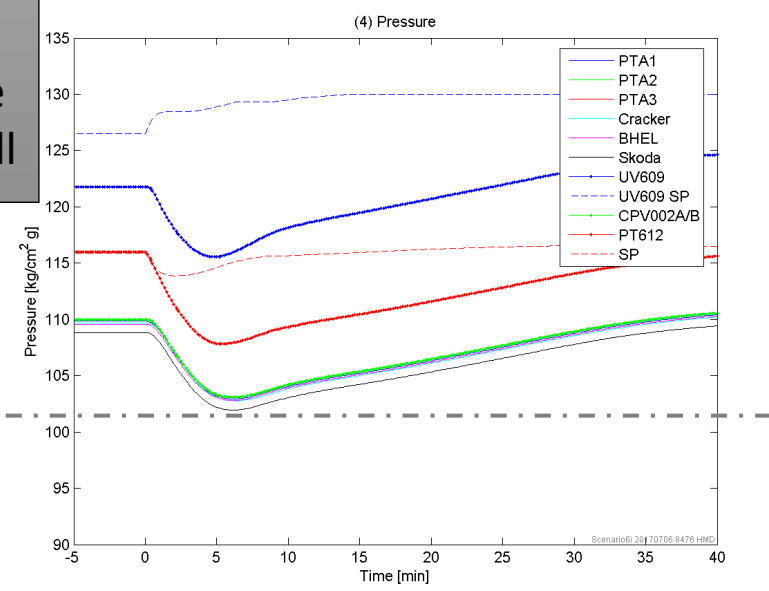


Simulation Case: Grid Connected vs Islanded

Trip of 1 boiler, while another not running

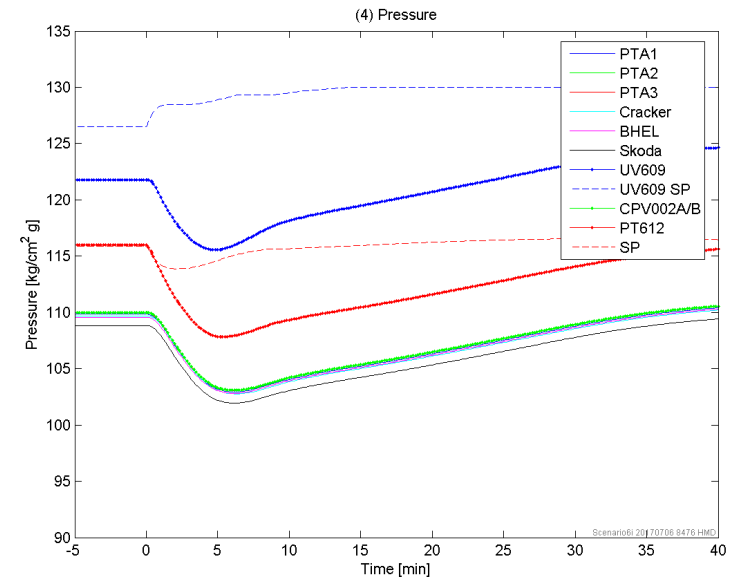
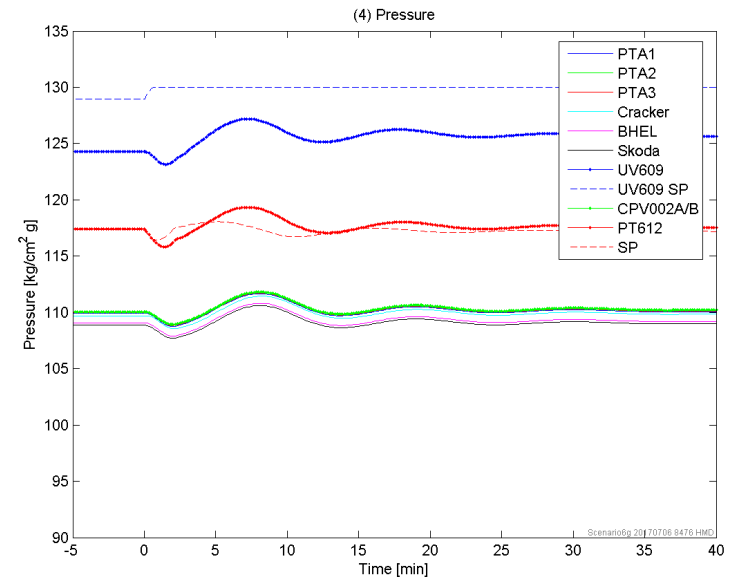
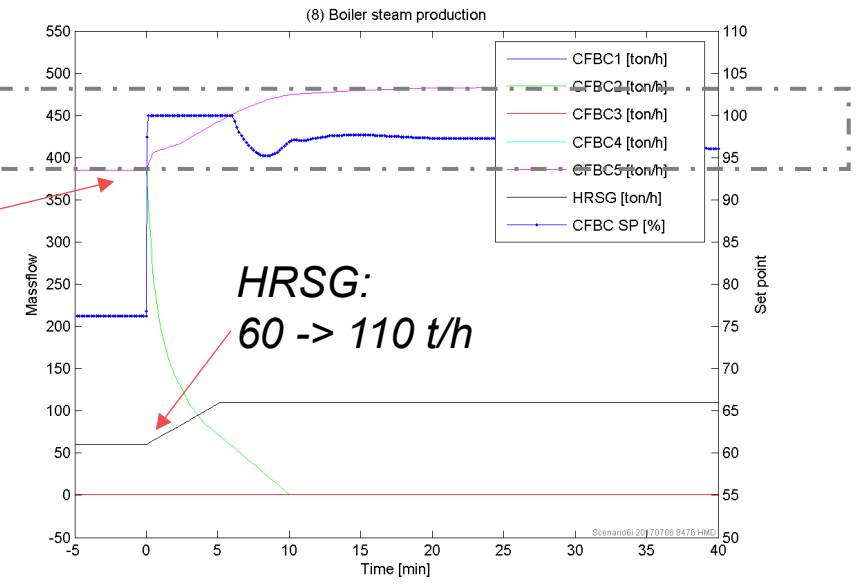
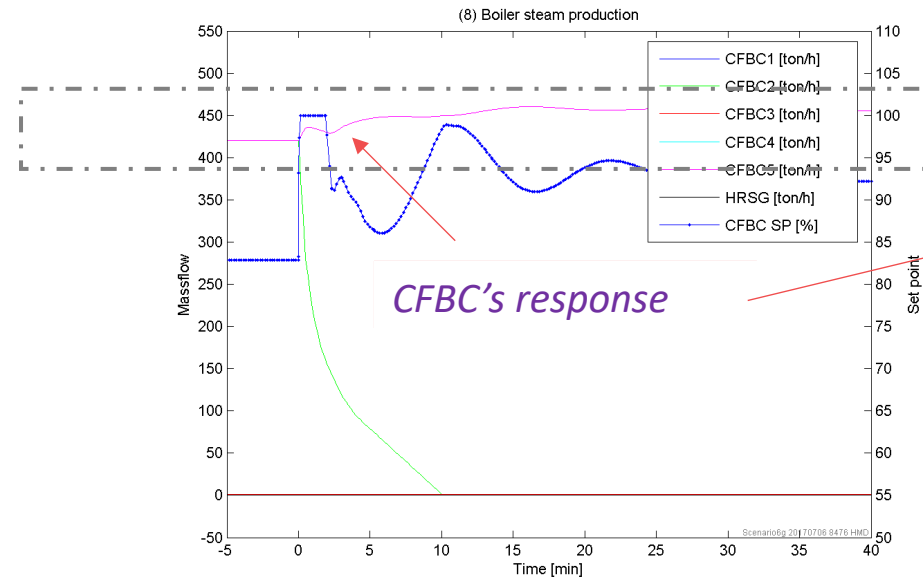


Pressures can not be kept as well



Simulation Case: Grid Connected vs Islanded

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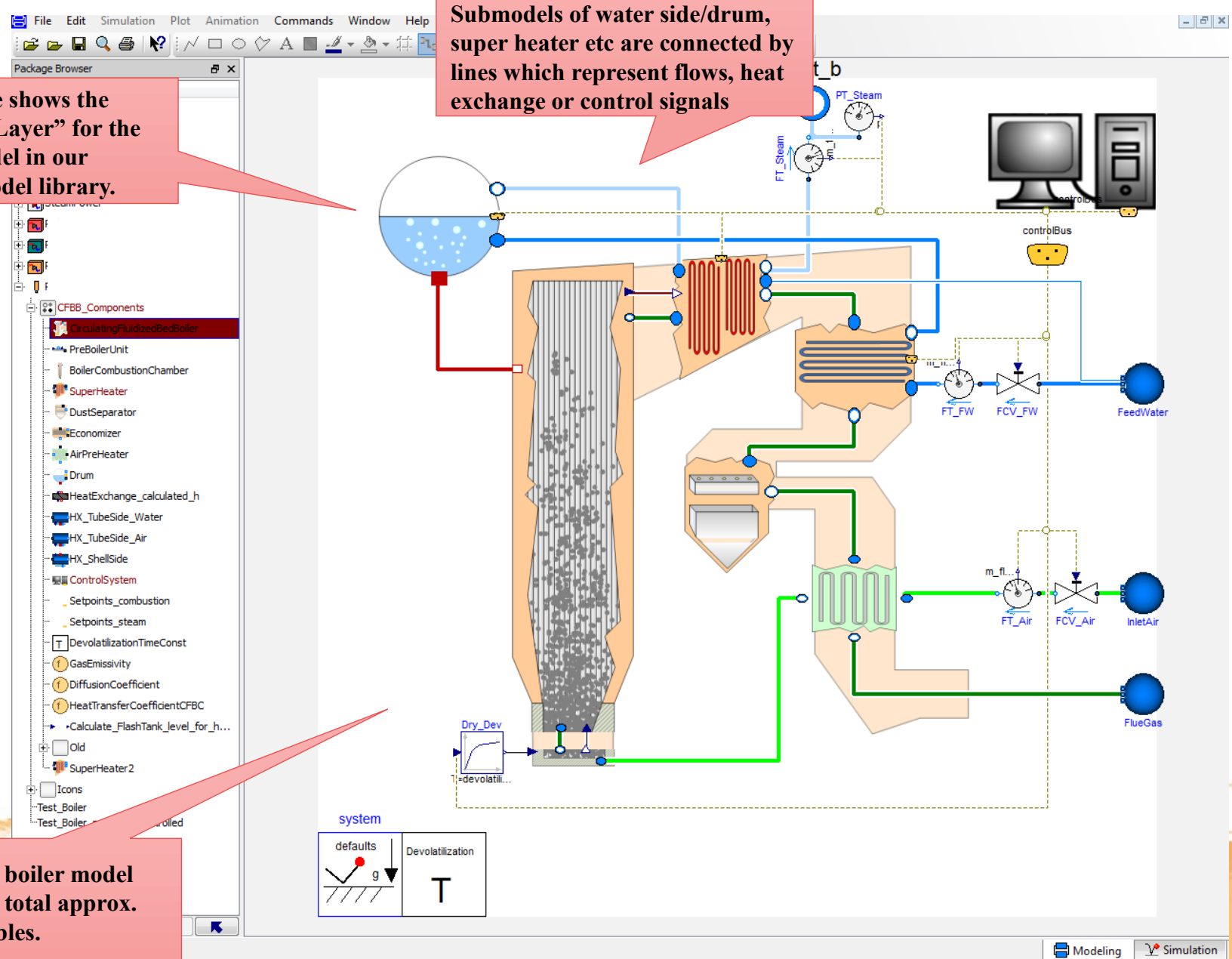


The CFBC Model in a test bench

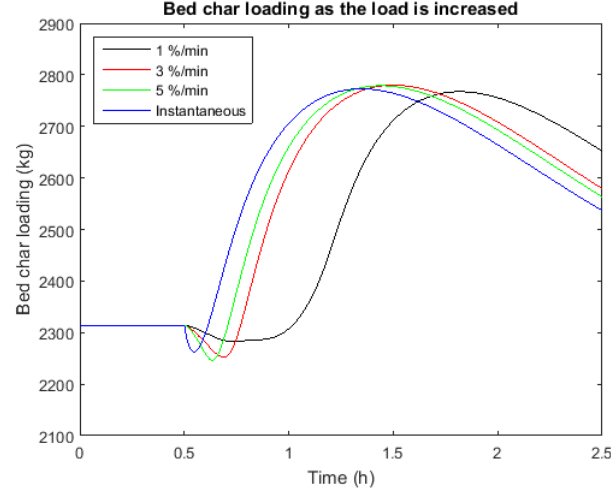
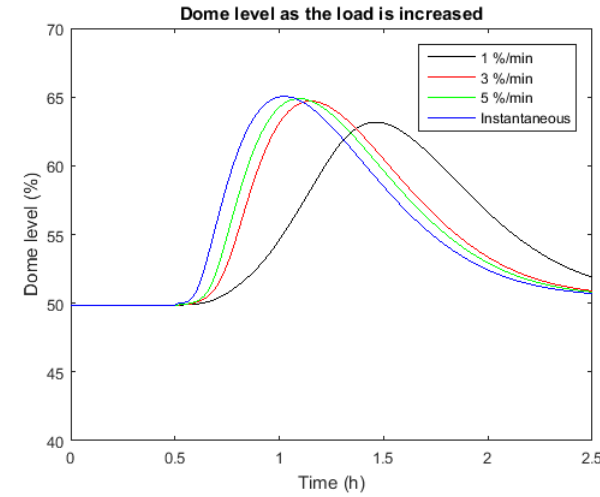
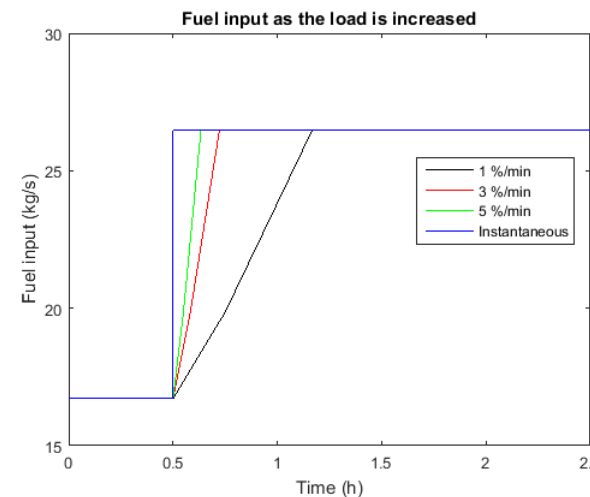
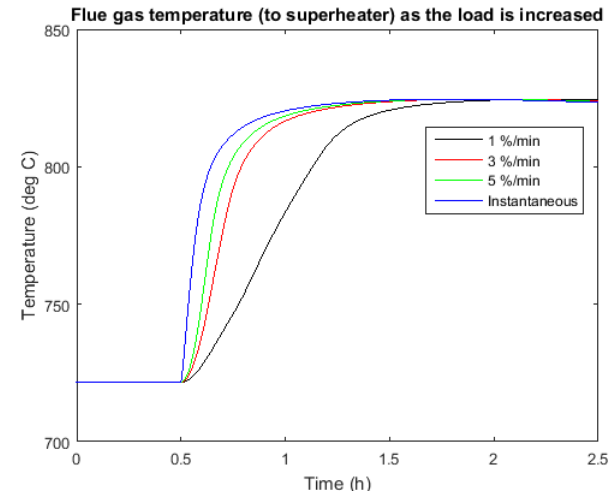
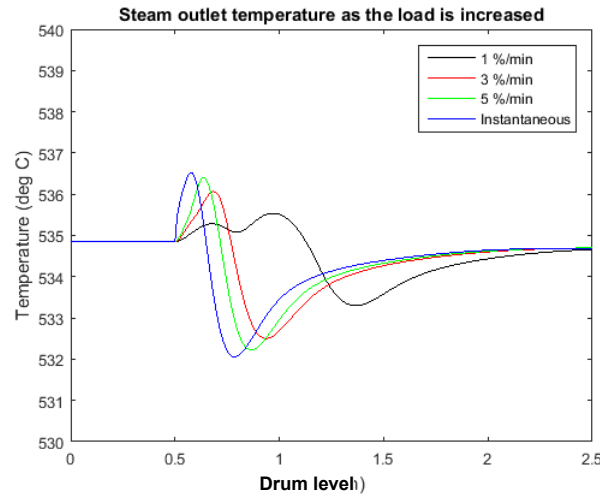
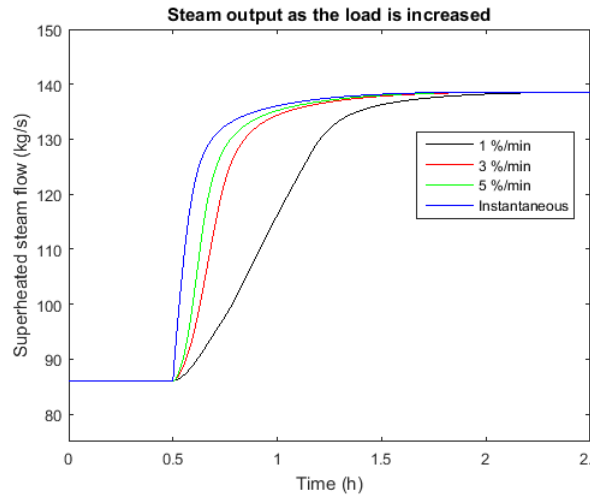
The picture shows the "Diagram Layer" for the CFBC-model in our Dymola model library.

Submodels of water side/drum, super heater etc are connected by lines which represent flows, heat exchange or control signals

The CFBC boiler model contains in total approx. 3500 variables.



Simulation Results



Vast improvement in Boiler ramp rates from ~12 min. to ~6 min.

Quote: "We not only automated & improved our boiler pressure control but also reduced the downtime by not having a single trip from last 5 years!" Reliance Industries

Case Study

IGGESUND MILL

Sweden



Challenge

Establish an overall operating strategy to ensure optimal operation of new recovery boiler, turbine, and existing biofuel boilers

Solution

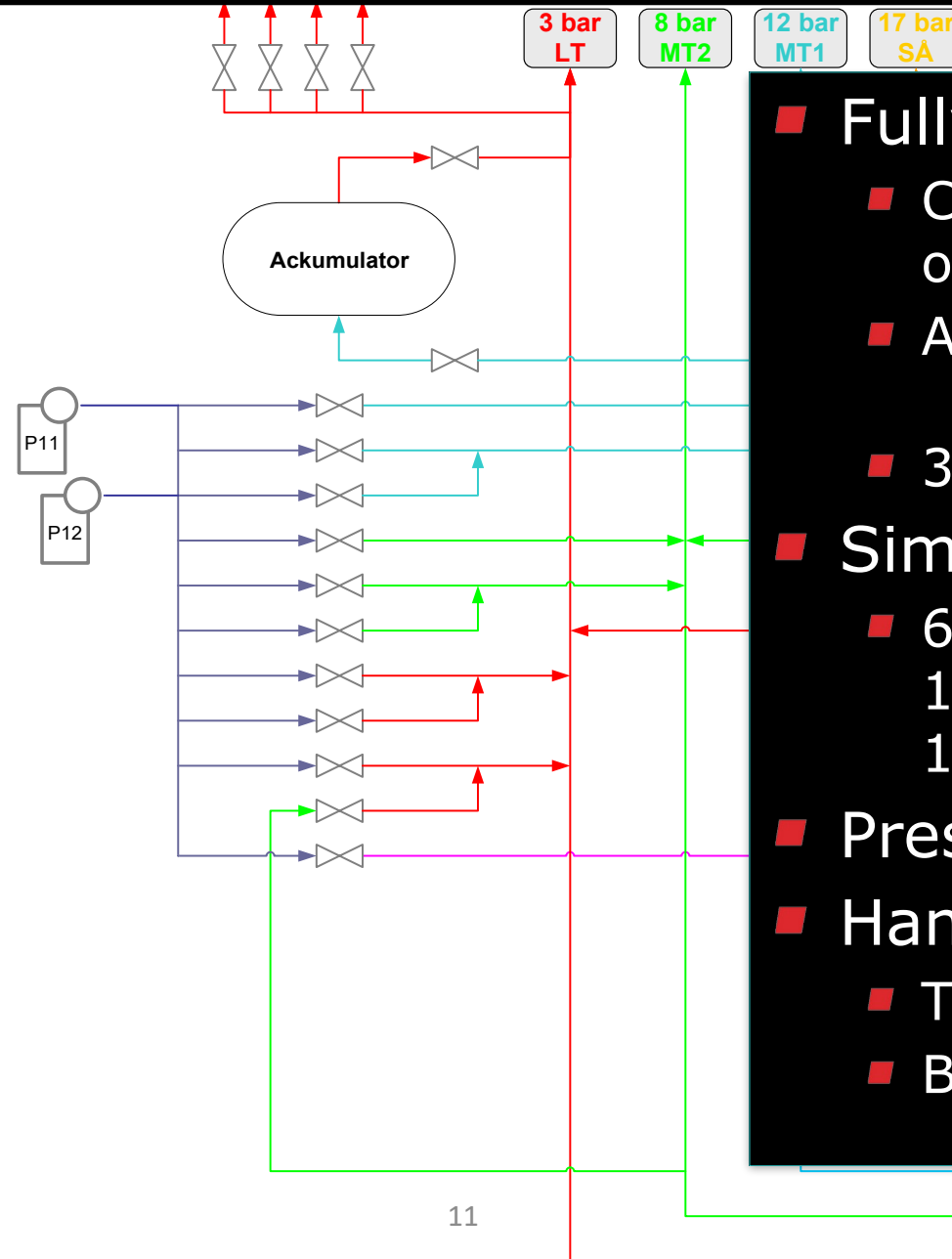
Design of steam distribution control philosophy for grid-connected and electrically islanded operations; simulator studies; performance tests & operator training

Result

Smooth start-up of new plant; no control system tuning, or re-working required; spot market flexibility further boosts energy and operational efficiency

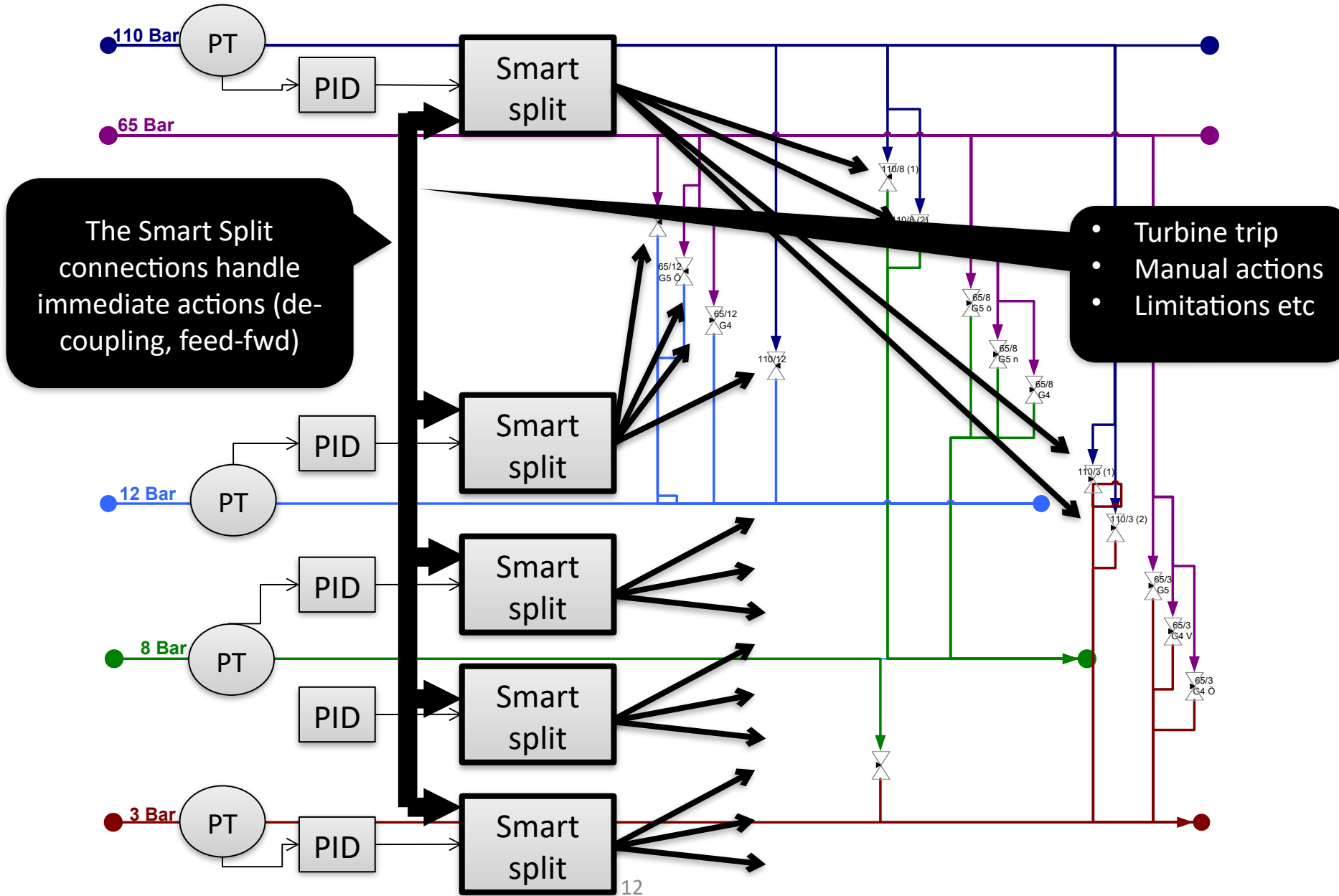
Design Requirements

- Fully integrated pulp and paperboard mill
- 330,000 tonnes Annual Production Capacity
- 150 TPH Boiler
- 50 MW Turbine

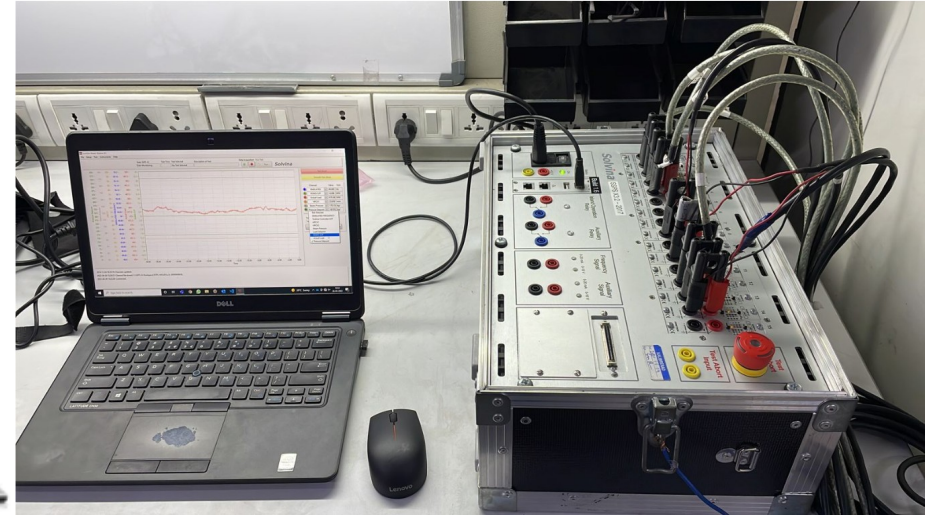
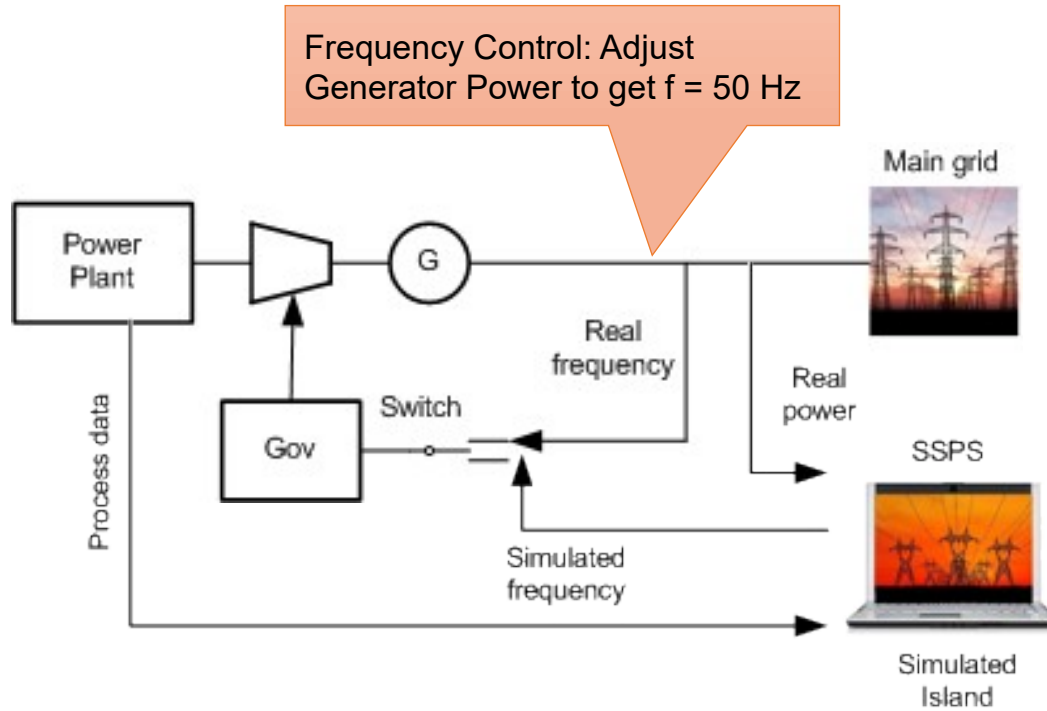
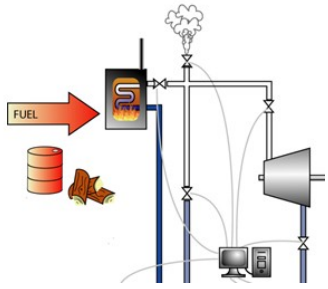


- Fully automatic operation
 - Compensation for all manual operations
 - All turbine control modes:
 - Back pressure, frequency/power
 - 35 valves
- Simple structure
 - 6 PI-controllers –
1 / Steam Net pressure:
110, 65, 17, 12, 8 & 3 bar
- Pressure stability +/- 1-3%
- Handle large load swings:
 - Turbine trip
 - Board machine start/stop

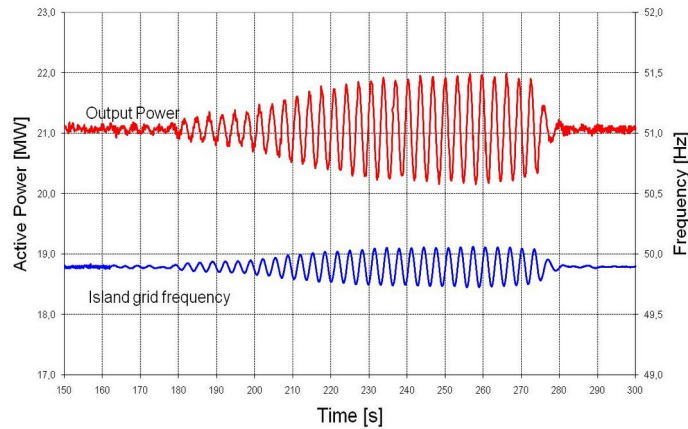
The Steam Net Control Design principle



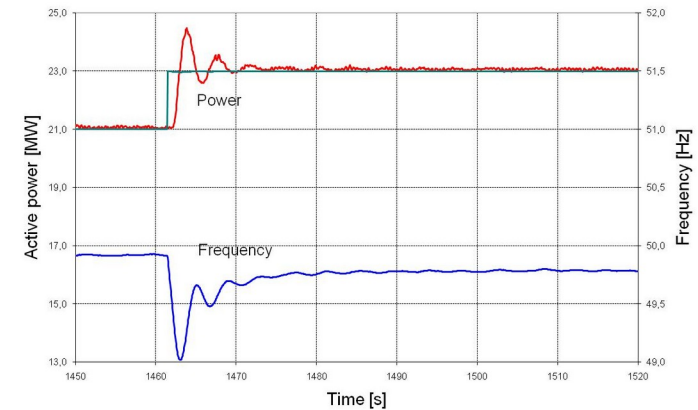
Performance Testing & Tuning - Method



– SolvSim Power Station

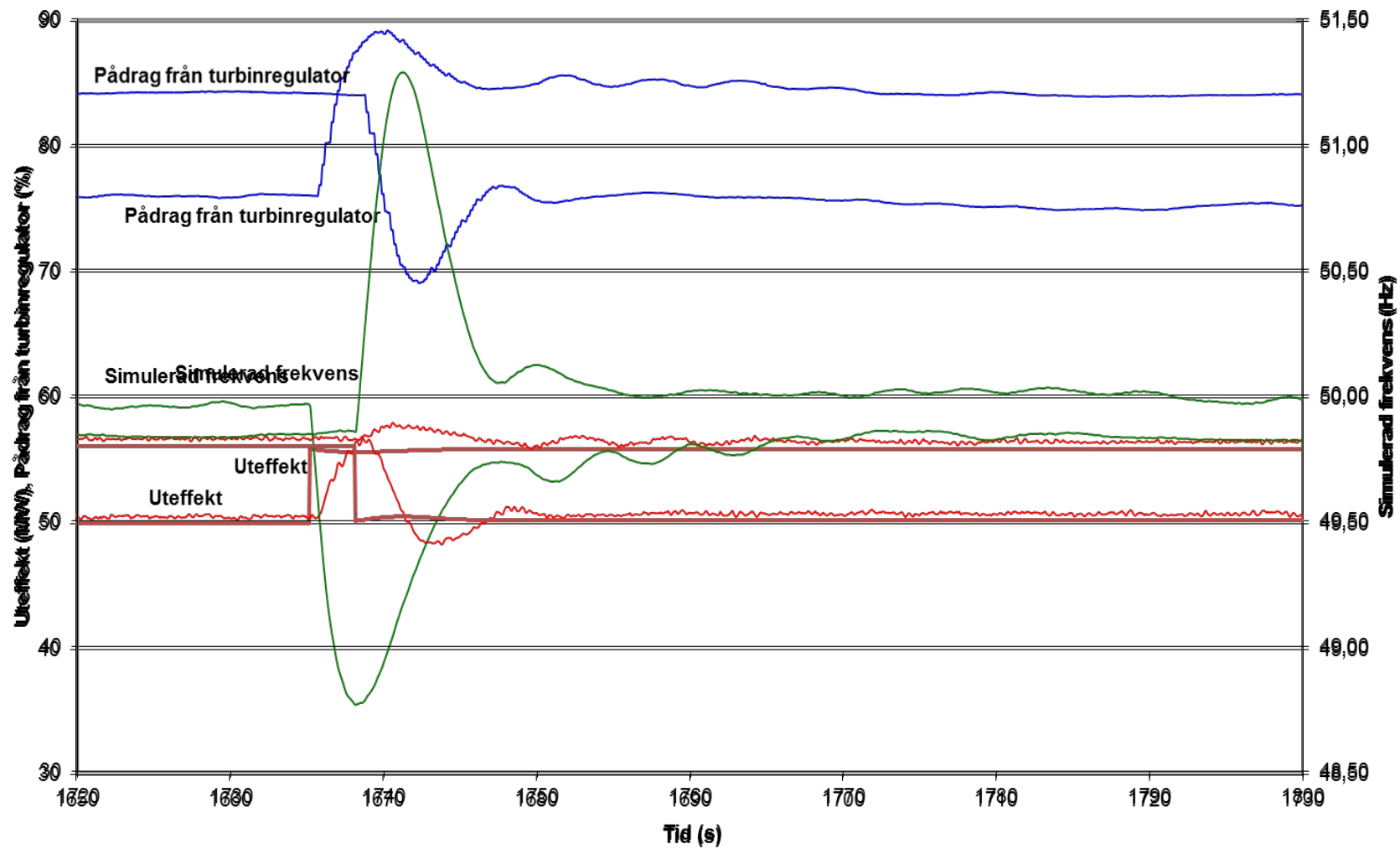


Unstable operation



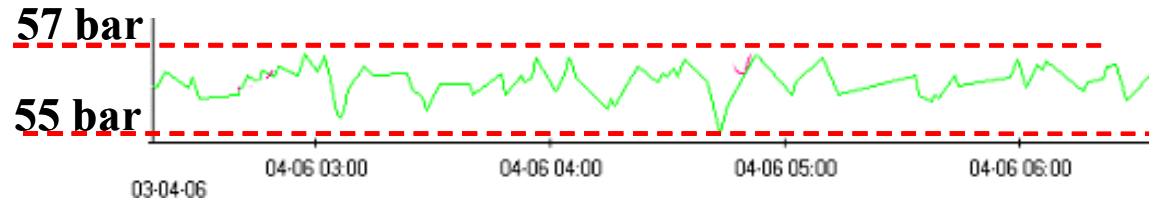
Stable operation with tuned parameters

Discrepanci 6rM&MW

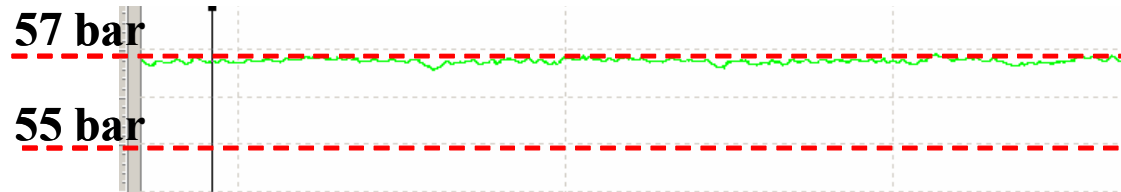


Results

Boiler pressure
before control
redesigned



Boiler pressure
after control
redesigned



- Robust control
- Steam pressure stabilized
- Stable island operation
- **Vast energy savings** from less unused steam releases up to **~10% savings**

Benefit Analysis

- Electricity production cost is **5-15 cents US \$ per kWh**
US \$ depending on source/fuel type
- **50 MW** industrial power plant with 8000 hour operation (~91%) per year will cost **20-60 Million US \$** annually
- 10% savings means **2-6 Million US \$ savings annually**
- **Payback less than 6 months**

Thank you!

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