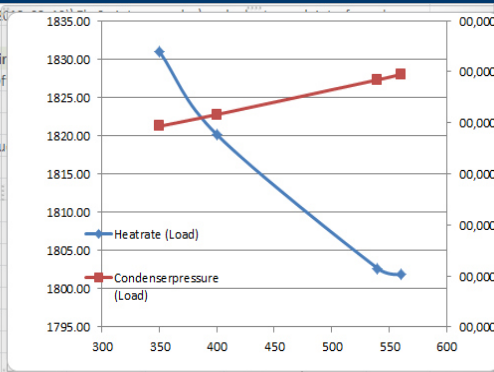


ModelFile C:\Users\f9511465\Desktop\India BEE (2018_02_16)\Wolf (2018_02_16)\Wolf (2018_02_16).ebs

BeginData	Type	Name	Description	Unit	File
		@ProfileName			Of
		@Errors			
		@Warnings			
		@Status			Su
		@ExecutionTime			
	spec	Feedwater_flow.MEA	Measured or star	kg/s	
	result	PKOND.RESULT	Calculated value at		
	result	Efficiency_meter.ETA	Efficiency	%	
	result	GEN_LEISTG.RESULT	Turbine Heatrate	kcal/kWh	
	result	GEN_LEISTG.RESULT	Calculated value	MW	

EndData



EBSILON® Professional

Benefits for Offline- and Online Applications

Dr.Hans-Peter Wolf (STEAG Energy Services, Germany),



EBSILON[®] Professional + Optional Add-on Modules

steag

EBSILON[®] Professional

EbsScript

Script Language
and Interface
functionality
(EbsOpen)

1

EbsConfigurator

build model of
steam power
plant or
combined cycle
in short time

2

EbsBoiler

Detailed
calculation of
Boiler

3

VTU OEM Piston
Engine Library

Piston Engine
Model based on
OEM Data

EbsSolar

Detailed Design
of
CSP-Solar field

EbsOptimize

Optimization of
Design
specifications

EbsValidate

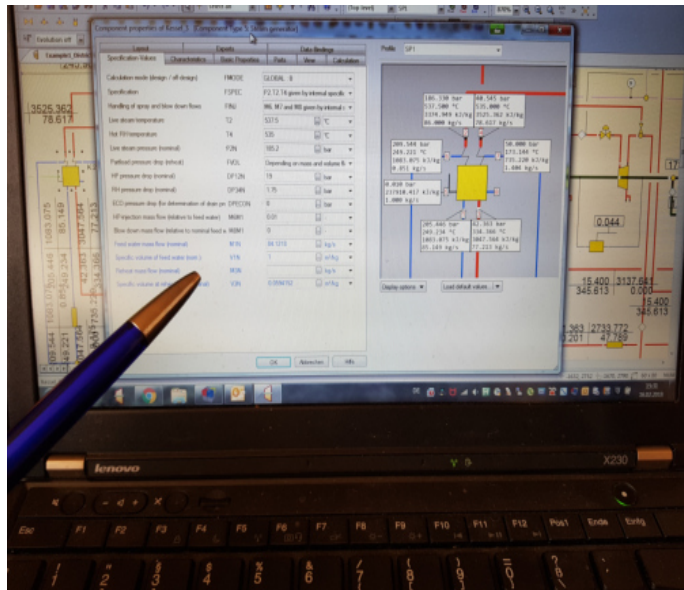
Statistical
Method for data
reconciliation of
measurements

All modules suitable for Offline- AND for Online simulations using thermodynamic EBSILON model based on 1-st principle Physics

EBSILON® Professional Offline / Online simulations



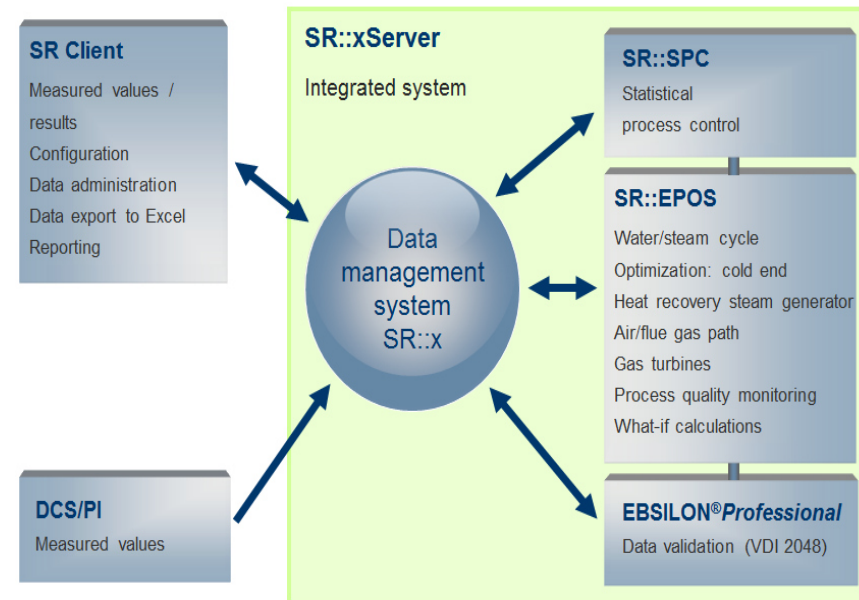
Offline



i.e. manual interaction of user with EBSILON

19.02.2018

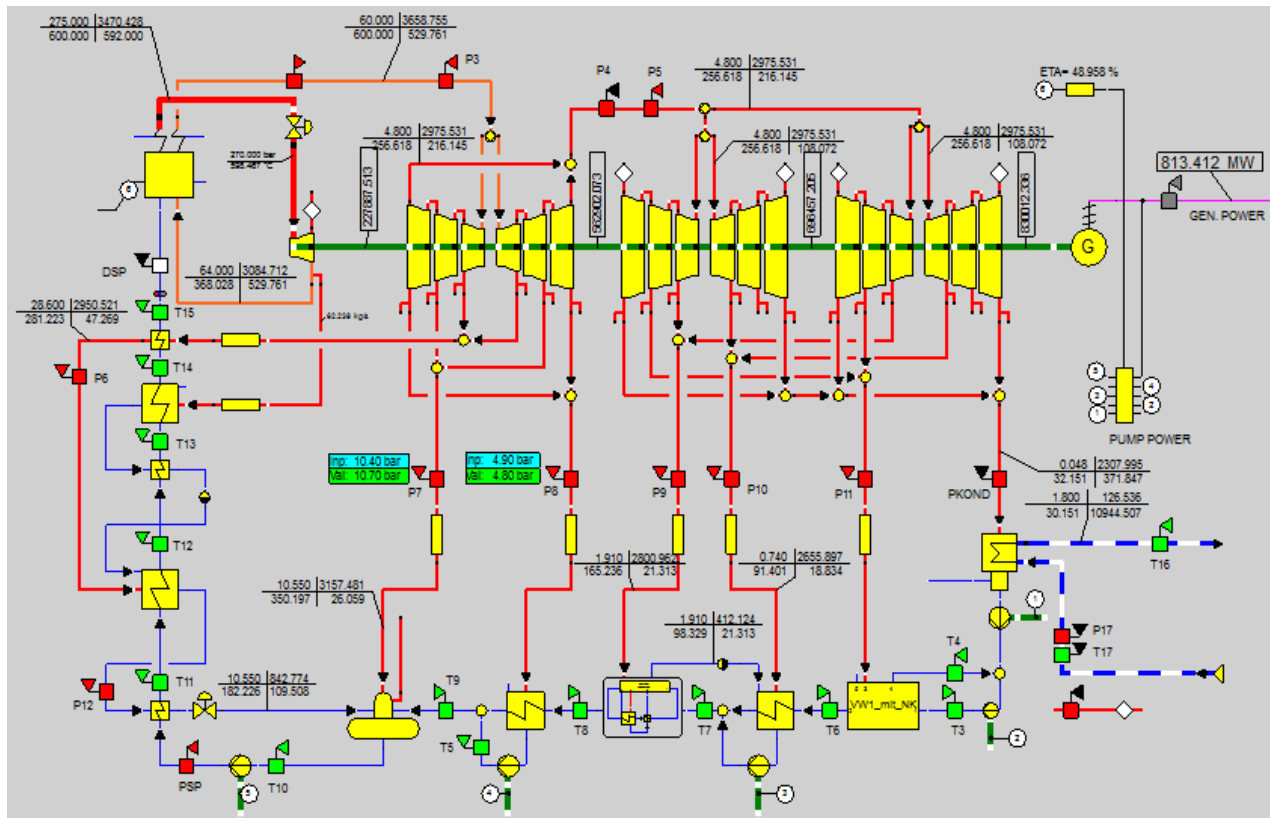
Online



i.e. automatic calculations and communication between different modules, No user-interaction

EBSILON® Professional

1-st principles thermodynamic model



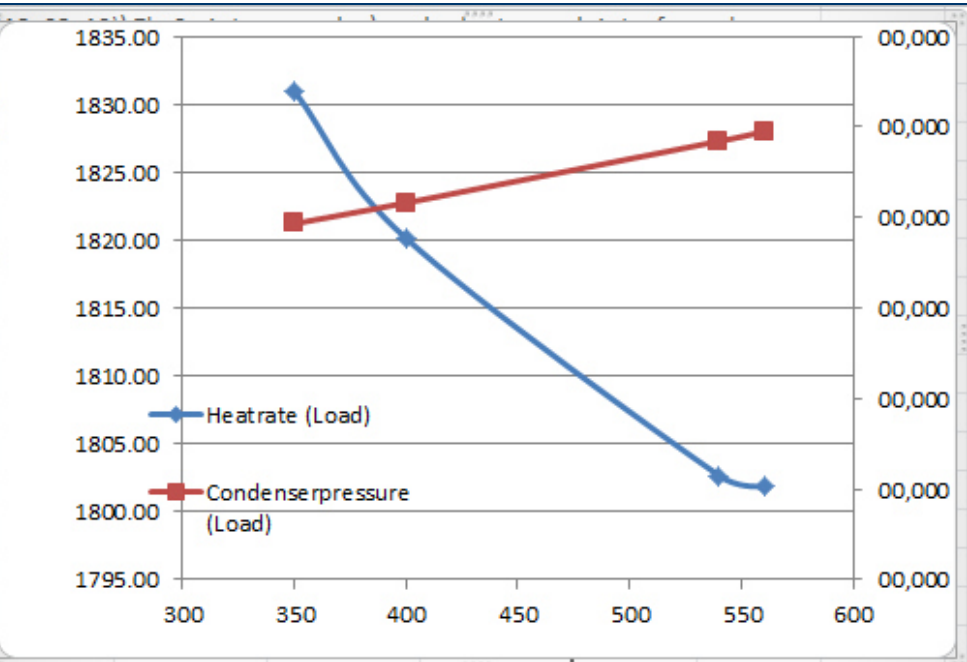
Calculations are based on 1-st principle physics

- Conservation of mass and heat
- Design and partload
- Fast and stable solution algorithms
- High accuracy and realistic results
- Same model for Offline and Online

ModelFile C:\Users\f9511465\Desktop\India BEE (2018_02_16)\Wolf (2018_02_16)\Wolf (2018_02_16).eps

BeginData	Type	Name	Description	Unit	Fir
		@ProfileName			Of
		@Errors			
		@Warnings			
		@Status			Su
		@ExecutionTime			
	spec	Feedwater_flow.MEA	Measured or star	kg/s	
	result	PKOND.RESULT	Calculated value at		
	result	Efficiency_meter.ETA	Efficiency	%	
	result		Turbine Heatrate	kcal/kWh	
	result	GEN_LEISTG.RESULT	Calculated value	MW	

EndData



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EbsScript

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EbsScript

Scripting and interface capabilities



- **PASCAL based scripting language for EBSILON**
 - Variables and functions e.g. mathematics, loops, if/case etc.
- **Applicable on different application levels**
 - **Model: EbsScript for automated calculations (Offline as well as Online, example: PADO)**
 - **Component: Kernelscripting with programmable physics allows to create tailor-made components**
- **Additionally it includes Interface for COM and .NET environment („EbsOpen“)**
 - **VBA/C++/C#/Matlab/Python ... functions with full access to EBSILON models**
 - **MS Excel Addin (based on EbsOpen), no programming required, user does not have to be EBSILON expert**

EbsScript MS Excel Addin



Additional functionality (independent of „Pascal programming“)

- **automatic data-transfer between Excel and EBSILON**
- **automatic EBSILON calculations triggered from Excel sheet**
 - **→ no detailed knowledge of EBSILON model required**
- **Calculation of what-if scenarios and parameter studies**

Example: Load variation via Excel-Addin

EbsScript MS Excel Addin

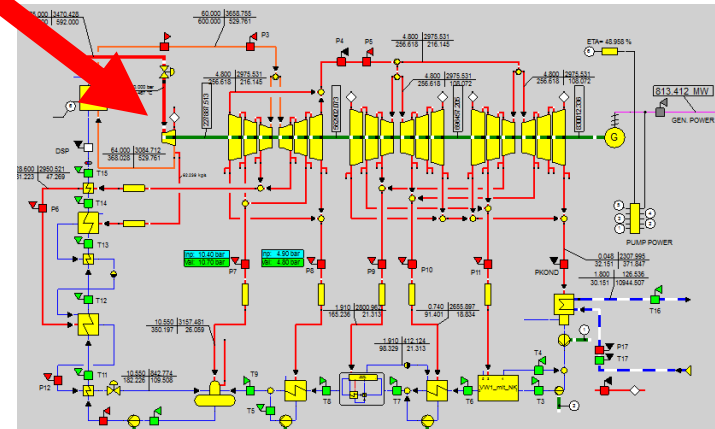
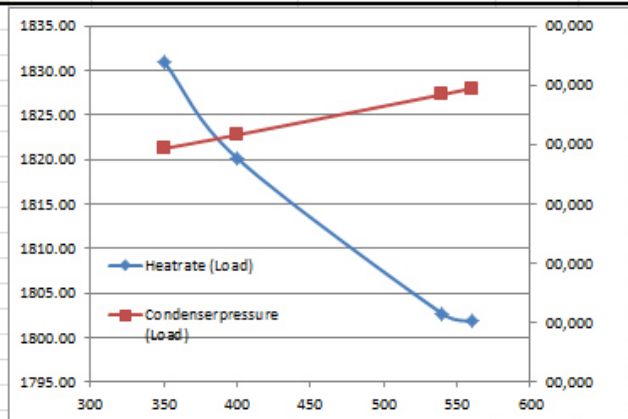


ModelFile C:\Users\9511465\Desktop\India BEE (2018_02_16)\Wolf (2018_02_19)\EbsScript_examples\coal_plant_excel_interface.et

BeginData	Type	Name	Description	Unit	FirstProfile	LastProfile
		@ProfileName			Offdesign	Offdesign
		@Errors			0	0
		@Warnings			0	0
		@Status			Success	Success
		@ExecutionTime			20:43:21	20:43:22
spec		Feedwater_flow.MEASM	Measured or start value	kg/s	560	350
result		PKOND.RESULT	Calculated value	at	0.0495	0.0393
result		Efficiency_meter.ETA	Efficiency	%	47.78	47.01
result		GEN_LEISTG.RESULT	Turbine Heatrate	kcal/kWh	1801.83	1831.01
result		GEN_LEISTG.RESULT	Calculated value	MW	774.21	793

Communication between Excel and EBSILON through EbsOpen interface

EBSILON model is invisible to Excel user



EbsScript Summary and Benefits



- **Powerful tool for automated calculations (Online) and parameter studies (Offline)**
- **Possibility for data import/export**
- **Automated reports**
- **Integration into software infrastructure and business processes**
- **What-if calculation (Excel-Addin) by non-EBSILON experts, for example effect of switching off equipment (HP-heaters, CW-pumps, ...)**



EBSILON® *Professional*
EbsConfigurator

**for steam power plant and
combined cycle power plant**

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EbsConfigurator for steam power plant and combined cycle

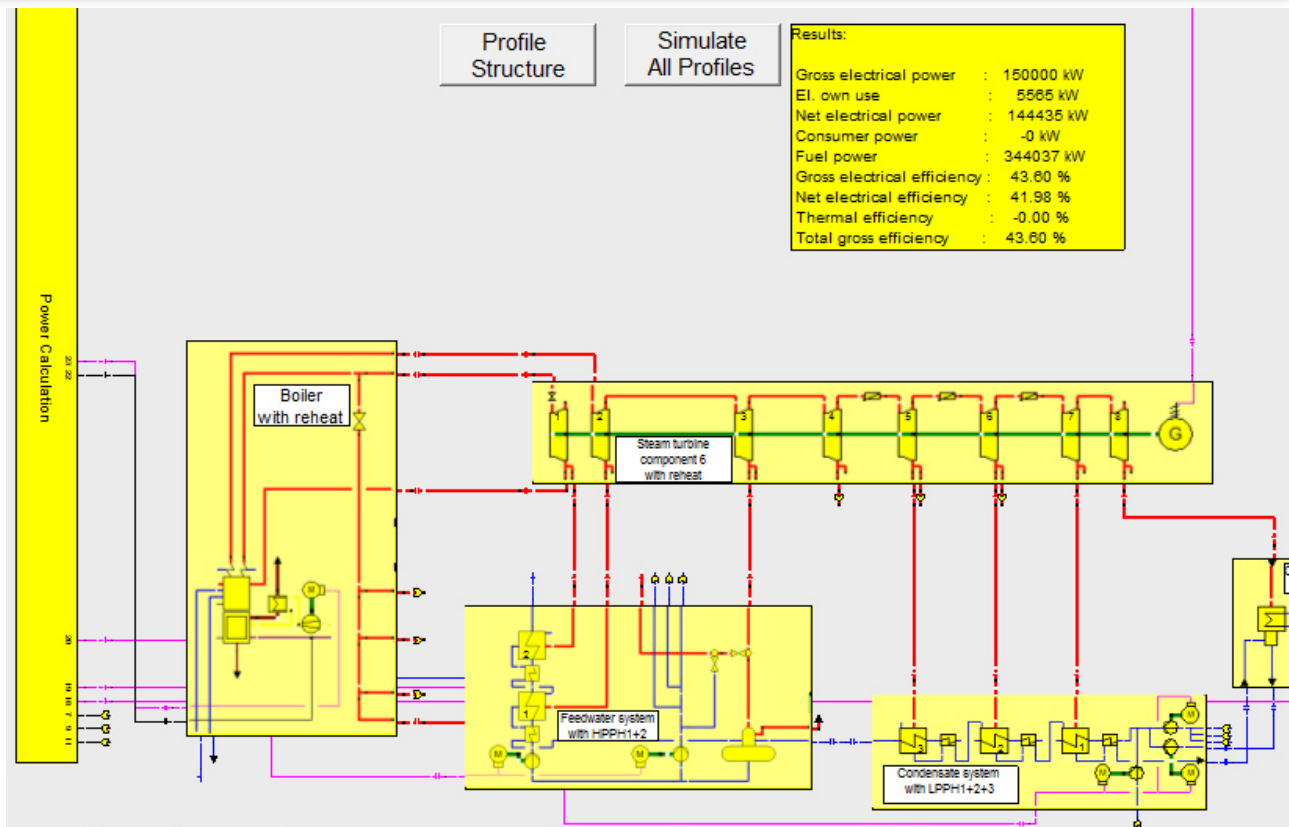


- predefined macros for power plant elements
- easily configured, automatically connected by „Connector“-Component
- EbsScript generates Design and Offdesign calculation
- easy-to-use calculation, but with high level of detail
- full flexibility for modifications according to EBSILON philosophy
- configurator available for : Process steam plant, combined cycle power plant etc.

Example: configurator

EbsConfigurator steam power plant

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< 5 minutes to create complete model of steam power plant

no expert knowledge of EBSILON required

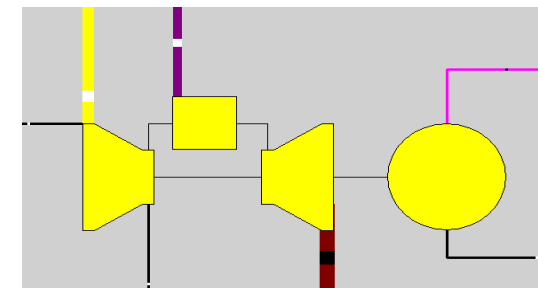
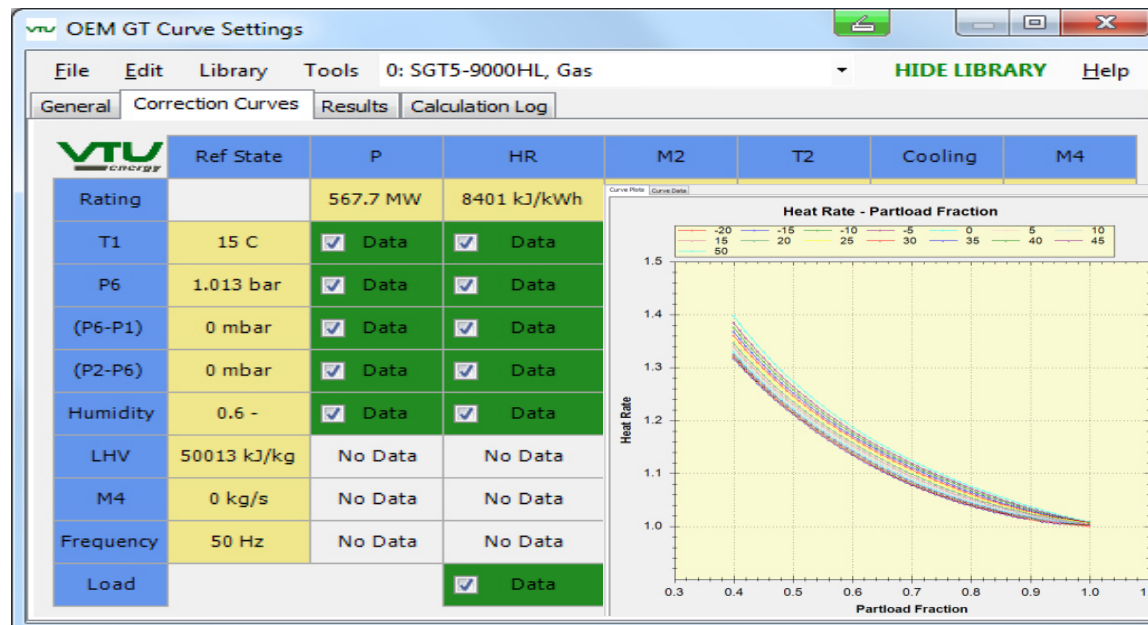
Uses pre-configured macros

Details of Model can be configured by the user

EbsConfigurator for Combined Cycle PP

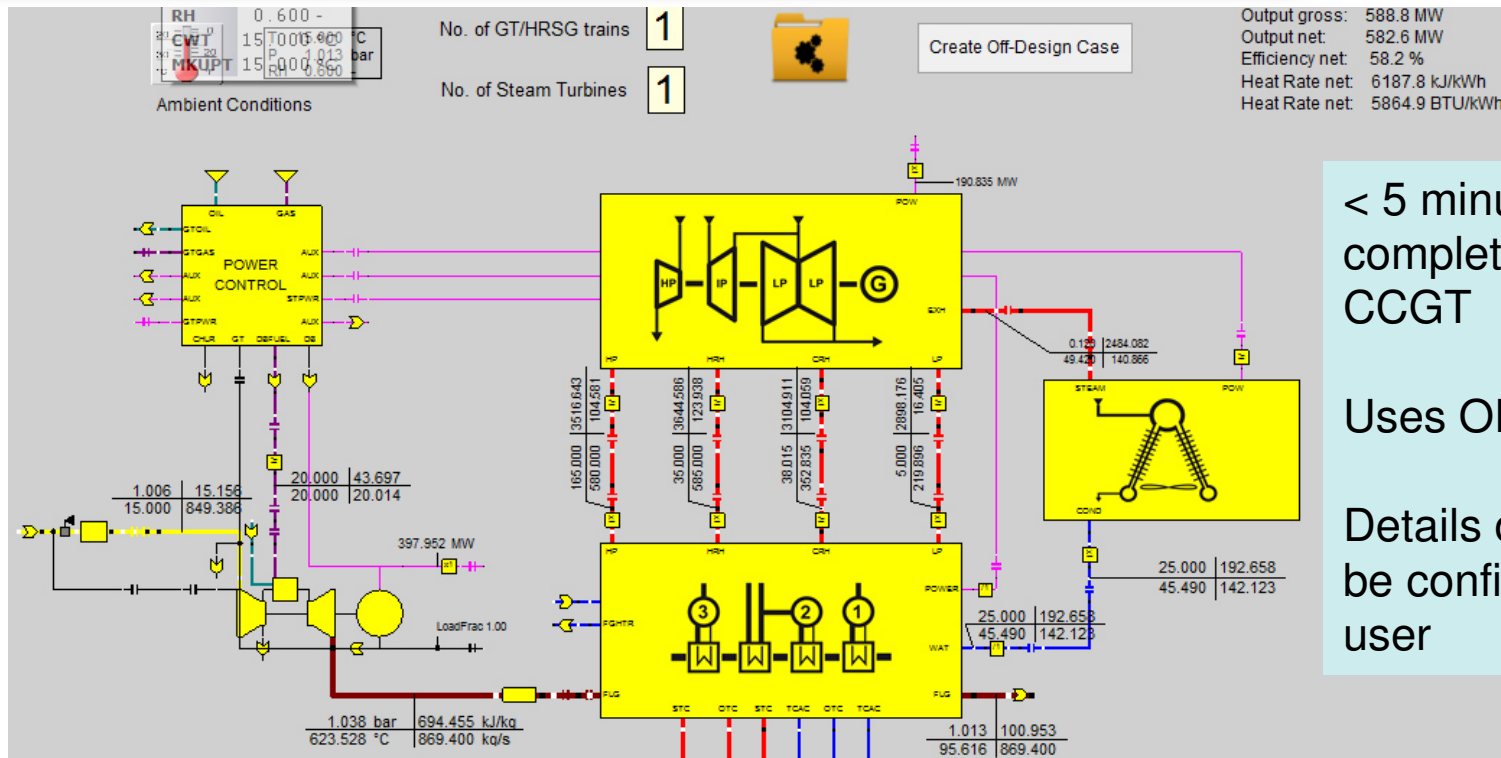


- detailed OEM performance information for 733 gas turbines, 30 kW to 567 MW
- from 13 Manufacturers (Siemens, GE, Mitsubishi, Alstom, Ansaldo, Rolls Royce, etc.)



Comp 106: OEM GTLib

EbsConfigurator for Combined Cycle PP



< 5 minutes to create complete model of CCGT
 Uses OEM GTLib
 Details of Model can be configured by the user

EbsConfigurator Summary and Benefits



- **no expert-knowledge required to create full-fledged model of complete power-plant in very short time**
- **elements of the configurator can be extended by the user**
- **together with OEM GTLib possible to create model of combined cycle power plant based on gas turbines manufacturers data**
- **reliable results**



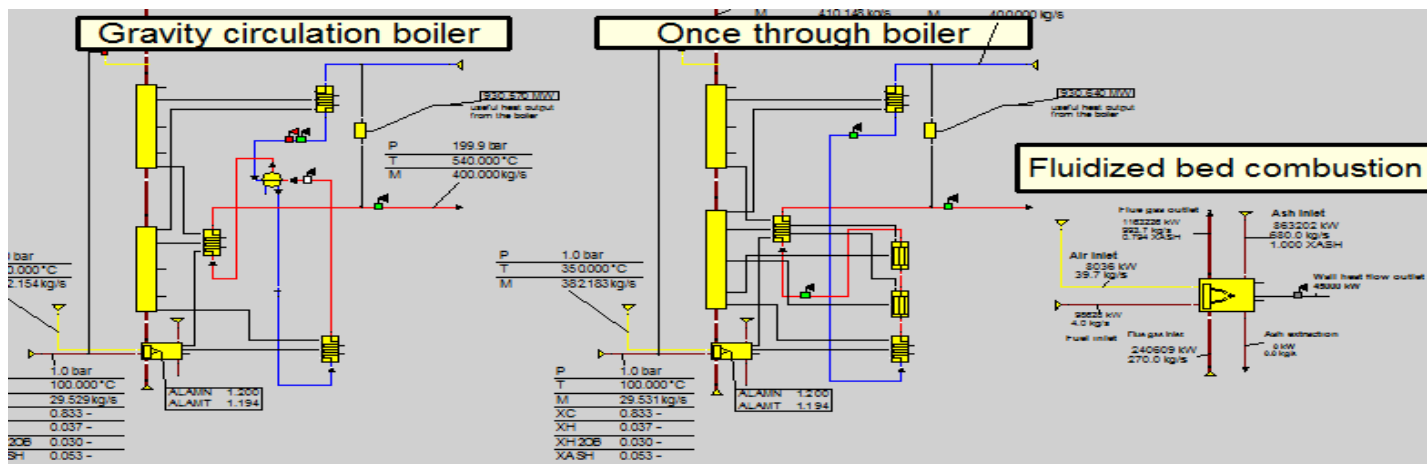
EBSILON® *Professional*
EbsBoiler Module

steag

Motivation

EbsBoiler components

- Heat transfer based on geometric and material data (calc. based on VDI Heat Atlas)
- Simulation of radiative/convective heat transfer in boilers (drum, once through)
- Ash recirculation for CFB boiler also possible
- Evaluation of heat transfer quality of individual heating surfaces possible



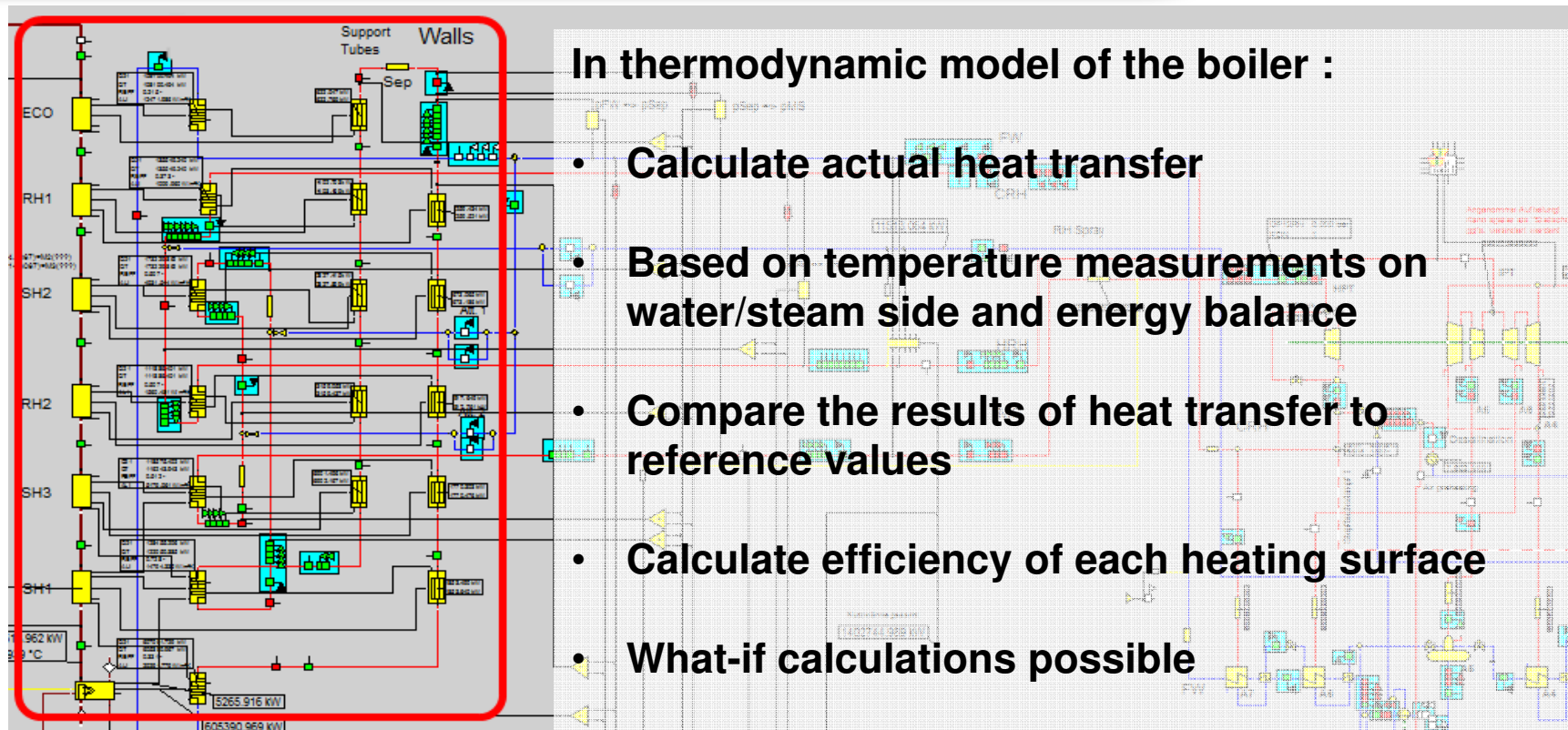
Flue gas (comp. 88, 90)

- Reaction zone: combustion, ash removal, radiation
- Radiation zone: heat transfer dominated by radiation, no reaction
- Convection zone: heat transfer dominated by convection in tube bundles, no reaction

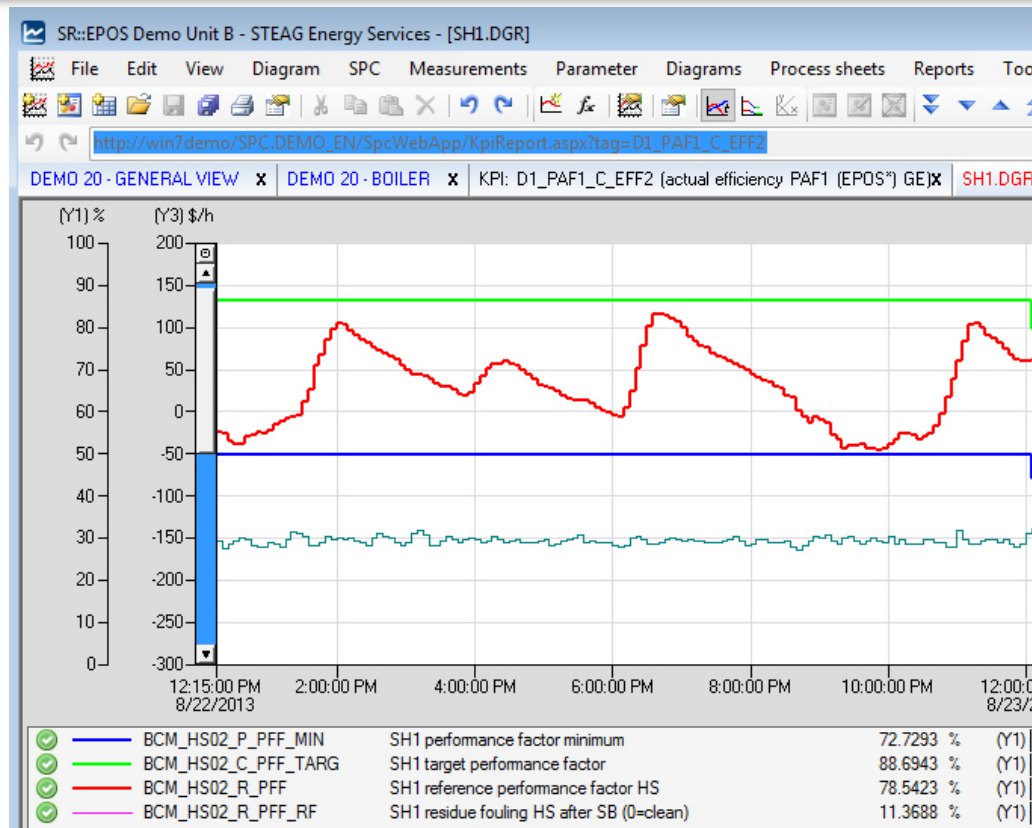
Water/Steam (comp. 89,91)

- Combustion area: bubble boiling, radiation from coke, ash and soot
- Radiation area: radiation from fluegas up/downstream
- Bundles: convective heat transfer, auxiliary heating surfaces (wall etc.)

Utilization of boiler components



Boiler components Summary and Benefits



Automatic Calculation of Heating Surface Efficiencies, based on calculation of actual heat-transfer coefficient

Advises soot-blowing

Results are input for SR::BCM

Soot-blowing condition-based instead of fixed intervals

- **Automatic calculation (using EbsScript) in Online systems for Boiler diagnosis**
- **Calculation of actual efficiency of each heating-surface**
- **Results are input to SR::BCM („Boiler cleaning management) which advises for an economical condition-oriented boiler cleaning to maintain high boiler efficiency at minimal cost**

Examples:

- 1.) PADO of coal-fired power-plant, including boiler-diagnosis
- 2.) BPOS in Suratgarh Unit 6

EBSILON References offline in India (77)

- State utilities: 55
- BEE Energy Auditors: 10
- NTPC/NETRA: 1
- BHEL R&D: 1
- CPRI: 1
- NPC: 5
- Aditya Birla: 2
- TÜV Süd: 2 (worldwide > 1280)

stead