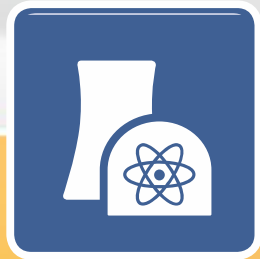


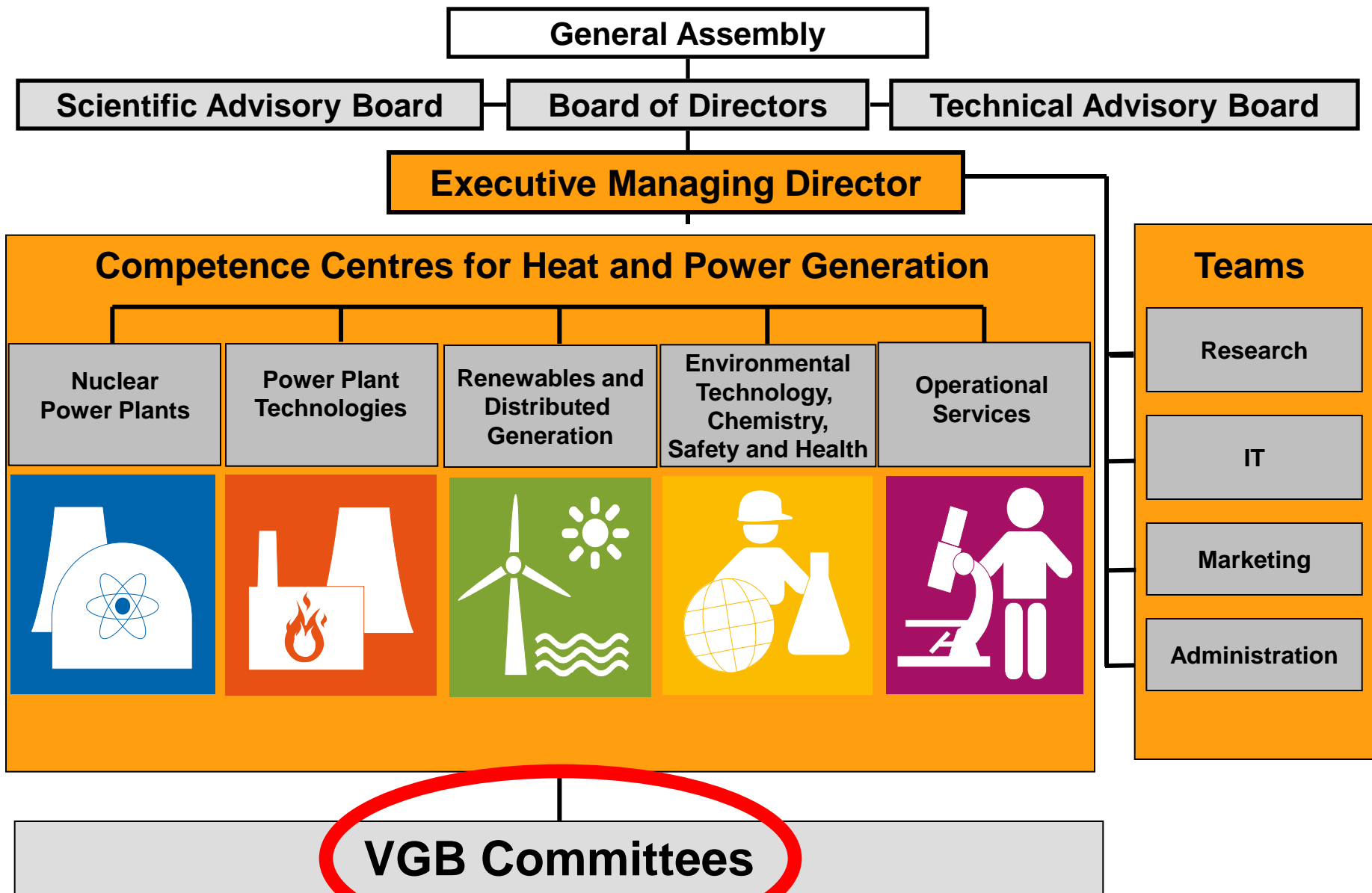


Status of VGB high temperature projects

Dr. Herbert Urban

VGB PowerTech e.V., Essen, Germany





Nuclear Power Plants

GC Nuclear Power Plants
SC Plant Engineering
WP Nuclear Engineering Standards
WP Protection against External Hazards
WP Electrical Engineering and I&C in Nuclear Power Plants
WP Qualification of Electrical I&C Equipment in Nuclear Power Plants
WP Reactor Core
WP PSA Coordinates
WP Materials and Integrity of Components
WP Non-destructive Testing
WP Ageing Management
WP Management Systems
WP Contractor Auditing
WP Nuclear Procurement
TC Nuclear Power Plant Operation
WP PWR
WP BWR
WP Practical Radiation Protection
WP Nuclear Engineering Training
WP Maintenance Manager Workshop
WP Nuclear Safety Officers and Human Factors
WP Crisis Staff Coordinators
TC Nuclear Fuel Cycle
WP Waste Management
WP Cask Handling and Storage
WP Safeguards
WP Decommissioning

Power Plant Technologies

GC Combustion Power Plants
TC Power Plant Concepts
TC Steam Generation Plants
WP Steam Generators
WP Fuel Technology/Firing Systems
WP Fluidised Bed Firing Systems
WP Thermal Waste Utilisation
WP Industrial and Cogeneration Stations
WP Flue Gas Cleaning Technology
TC Machines
WP Acceptance and Control Tests
WP Reference Designation and Plant Documentation
EWG Power Generation Maintenance Optimization Network
EWG Flue Gas Cleaning
SC Emax Technology
EWG CCS

Renewables, Distributed Generation

SC Hydro Power
TC Hydro Power Plants
ETC Use of Renewables and Distributed Generation
EWG Wind Energy
EWG Biomass
EWG Biogas
SC Special Committee
TC Technical Committee
WP Working Panel
IC Integrated Committee
ICE Integrated Committee of Experts

Environmental Technology, Chemistry, Safety and Health

GC Environmental Technology, Chemistry, Safety and Health
TC Emissions/Immissions
TC Noise Control
TC Operational Water Management
TC Power Plant Byproducts
TC By-products of Waste Incineration
TC Chemistry
WP Chemistry of Water Treatment
WP Chemistry of Flue Gas Cleaning Plants
WP Analytics
WP PWR Chemistry
WP BWR Chemistry
Health and Safety (Coordination)
Fire Protection
Safety & Health at Work
Industrial and Environmental Medicine/ Health Management
WP Medical Scientists in Nuclear Power Plants
Environment
EWG Emissions Monitoring
EWG E-PRTR
Safety & Health at Work
EWG HSE for Offshore Wind Parks
Chemistry
laboration with BDEW
Climate and Environmental Protection
ICE Climate Protection
ICE Immission Control
ICE Licensing
ICE Water and Soil Conservation
ICE Waste and Byproducts
ICE Dangerous Goods/Hazardous Materials

**In more than 90 Committees
about 1,600 experts meet
regularly for Information
Exchange on all technical
Power Plant Issues.**

➤ Introduction

➤ Research Activities 700°C/720°C Technology in Europe

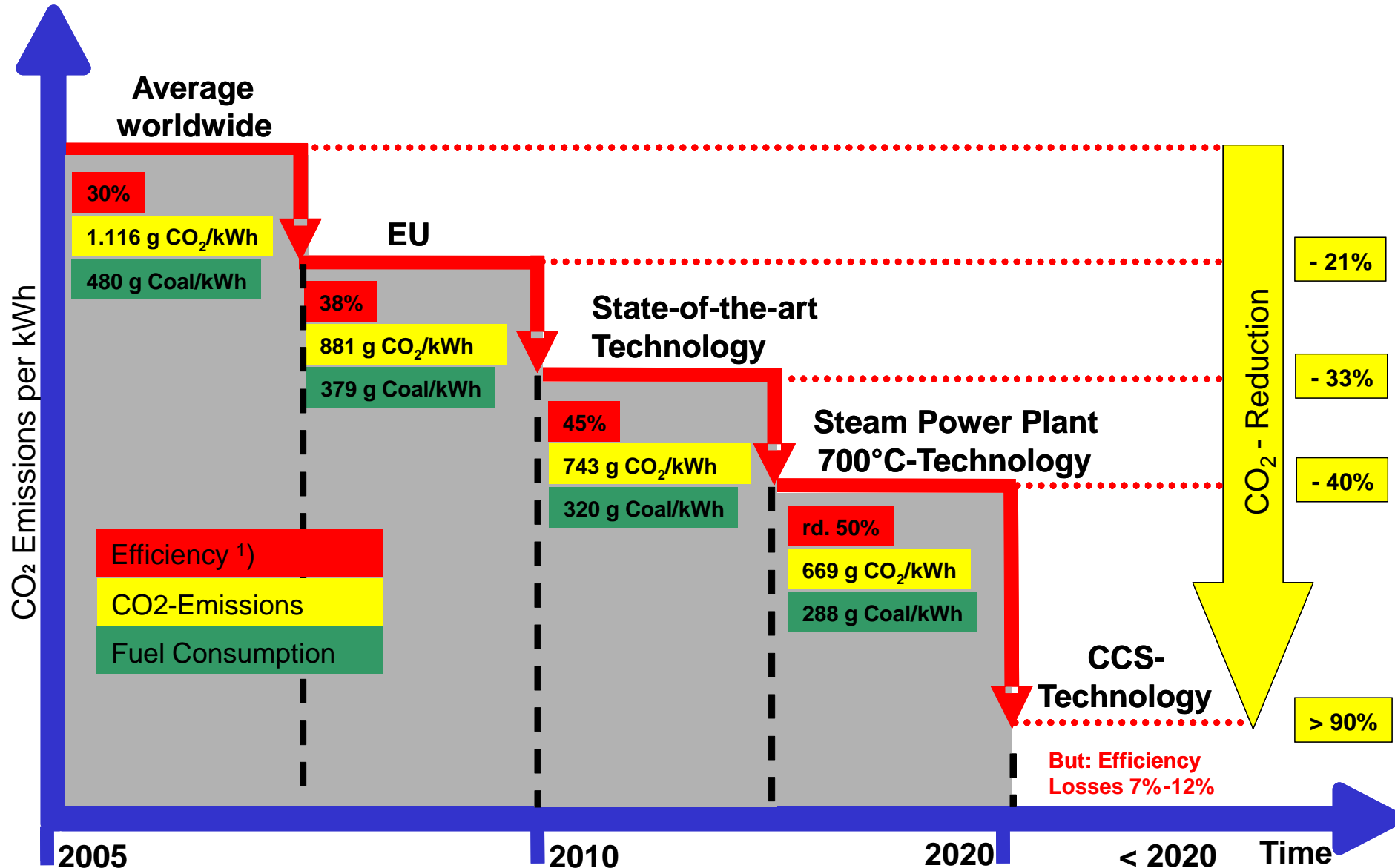
➤ COMTES700

➤ HWT II

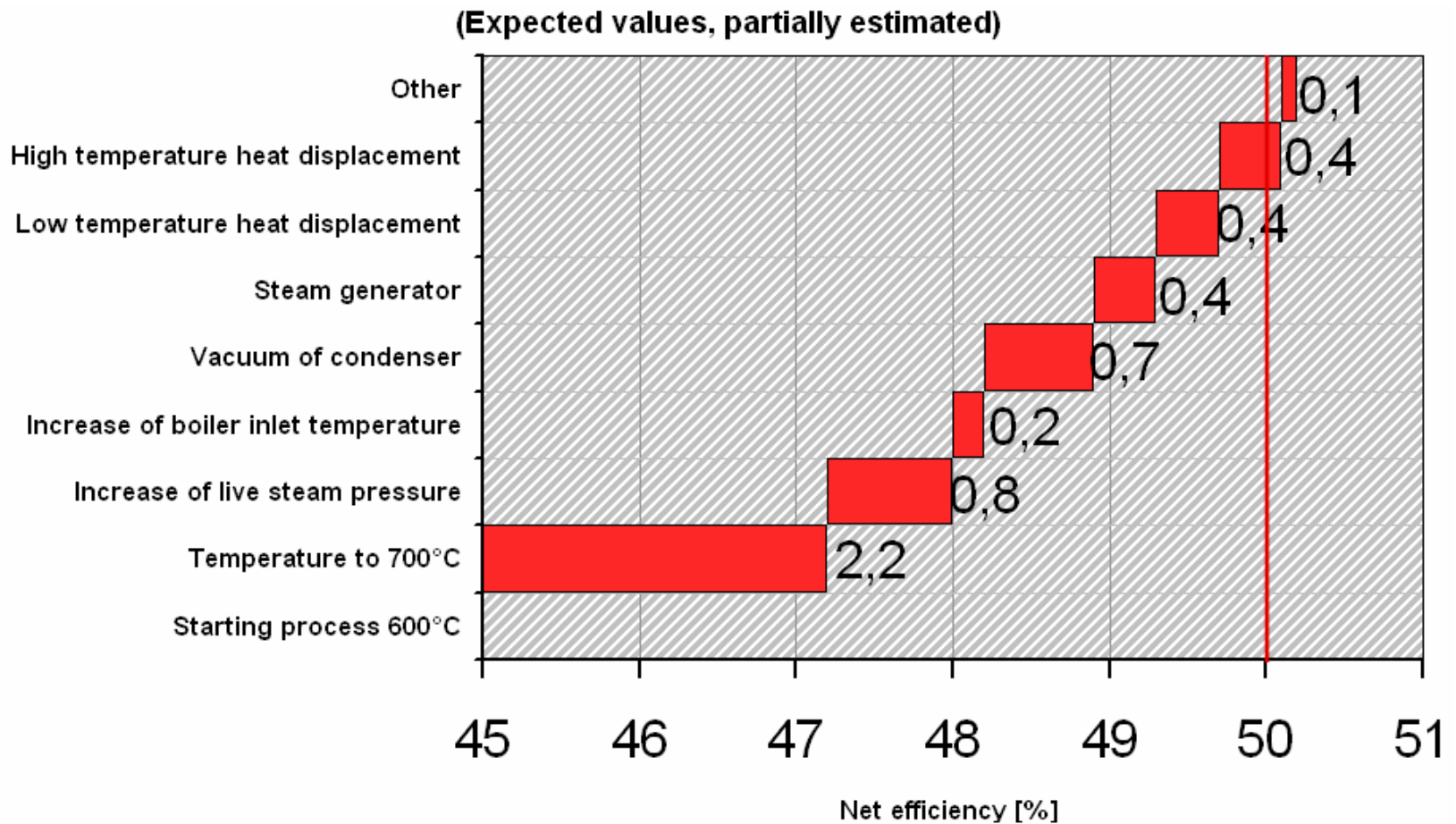
➤ ENCIO

} Comtes+

➤ Summary



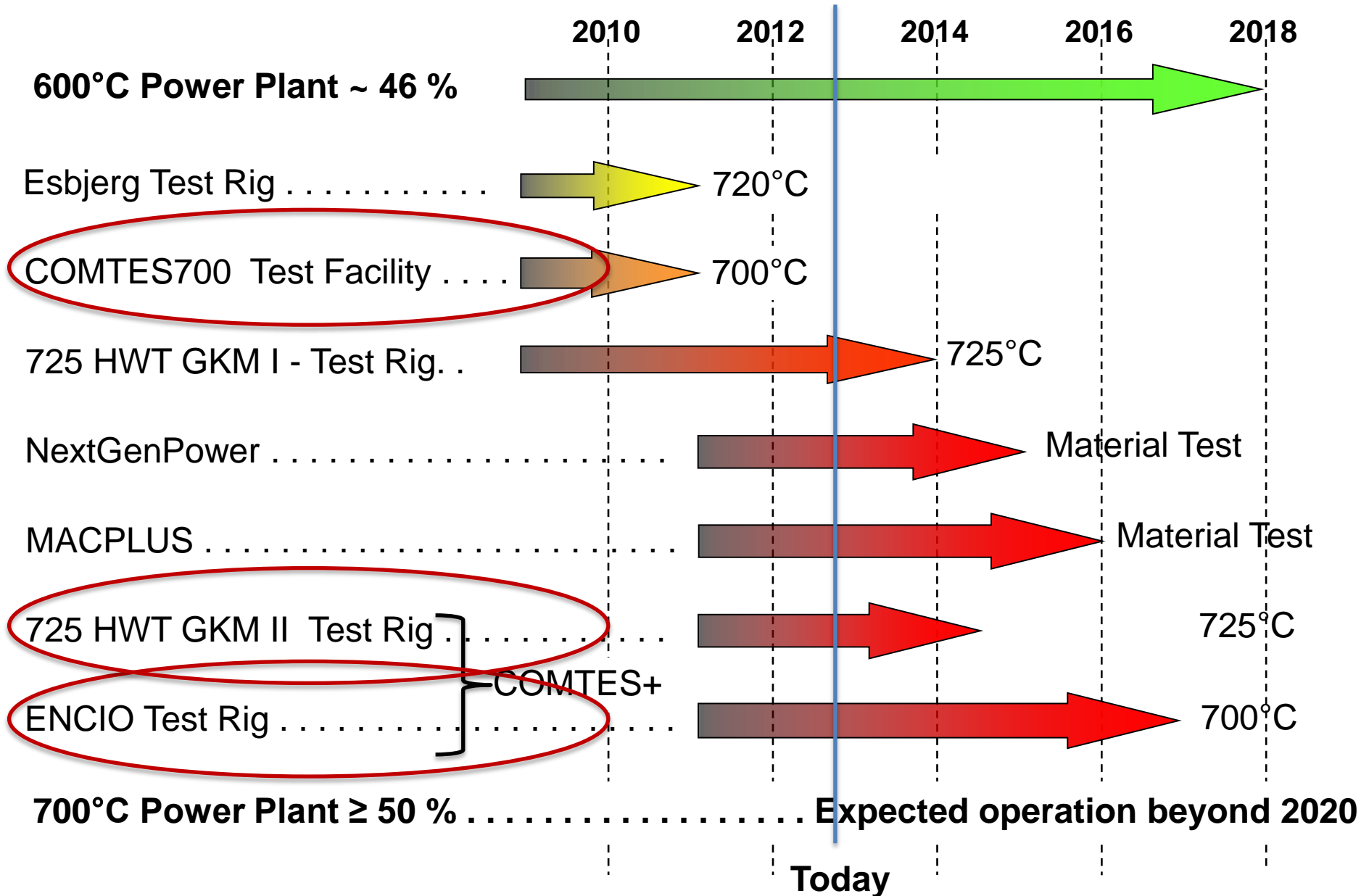
1) Average data for hard coal fired power plants



Increasing pressure and temperature can enhance efficiency by 3%

- Introduction
 - **Research Activities 700°C/720°C Technology in Europe**
 - COMTES700
 - HWT II
 - ENCIO
- } Comtes+

➤ Summary



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COMTES700
Component Test Facility for a 700°C Power Plant

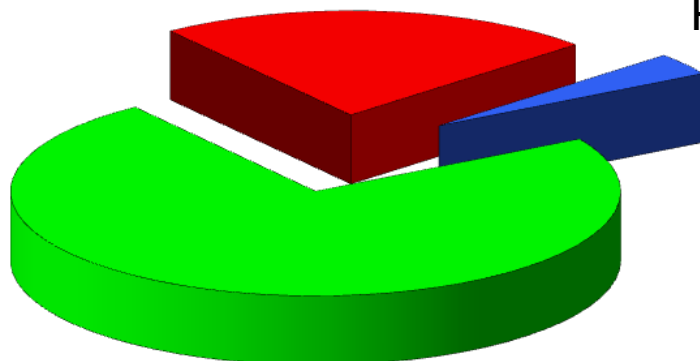
The COMTES700-project was financed by industrial and public funds. The project receives funding from the European Community's Research Fund for Coal and Steel (RFCS)



Project Budget: 26.1 m €

23% - (EC) RFCS 6.1 m €

4% - Industrial Partners 0.9 m €



73% - Generators 19.1 m €

Generators

- DONG Energy
- E.ON
- EdF
- Electrabel
- EnBW
- Enel
- PPC
- RWE
- Vattenfall Europe
- Vattenfall Nordic
- EVN
- Evonik Energie
- GKM

Industrial Partners

- Alstom
- BWE
- HPE
- Siemens

Co-ordination VGB

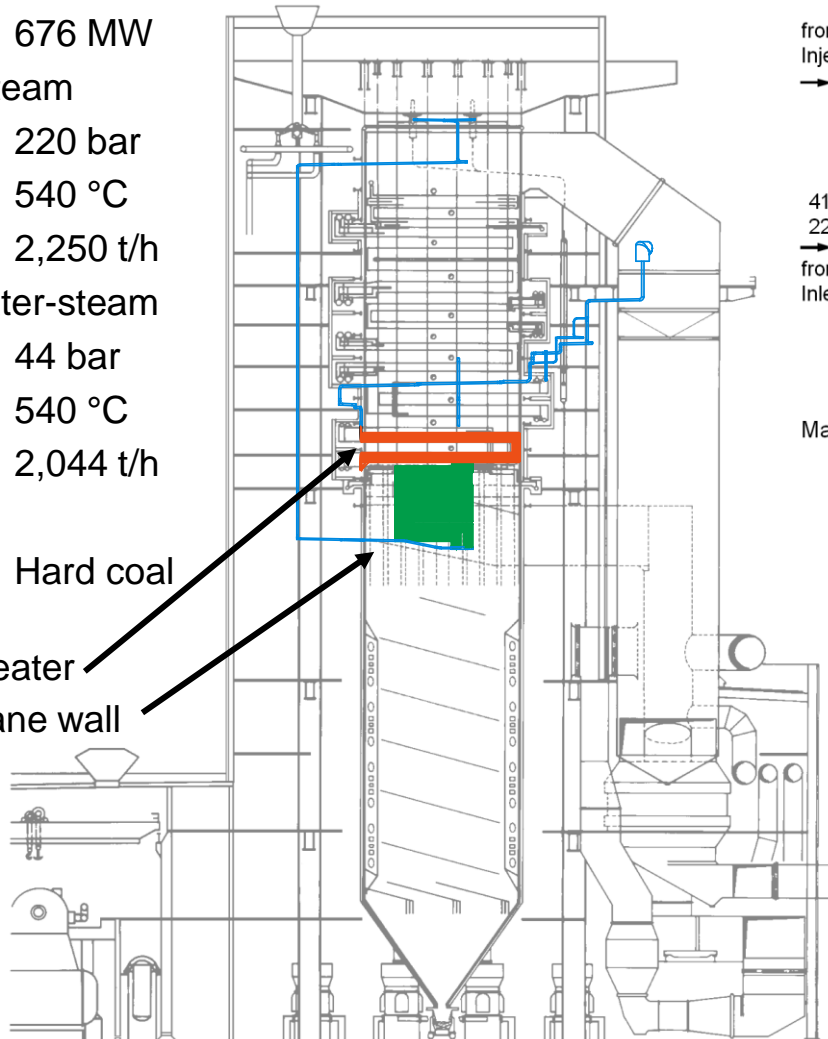
- **Manufacturing, bending and welding of the components in real plant dimensions** for a power plant with efficiency higher than 50%,
- **Operational behaviour** of all components especially operational testing of Ni-based alloys for tubes, pipes and valves,
- **Flue gas corrosion and steam oxidation** behaviour of the materials and erosion effects due to sootblowing,
- Operation started in summer 2005
- Approximately min. 20.000 operation hours, end of operation 2011

Host Plant - Scholven F, Germany, E.ON

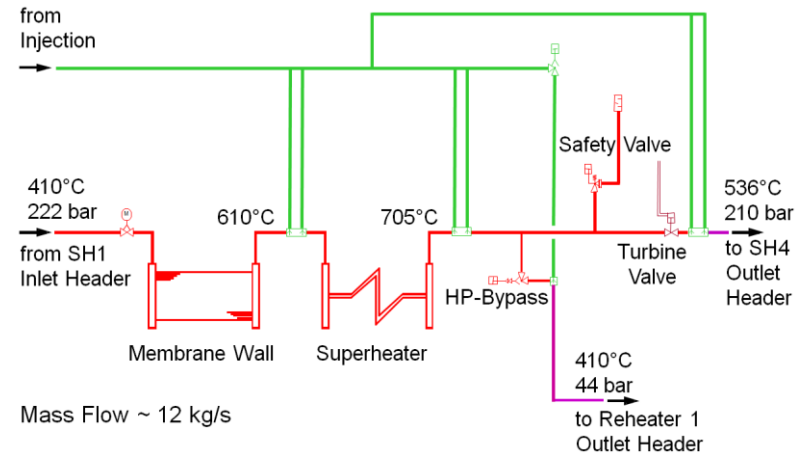
- ▶ Net output
 - 676 MW
- ▶ Live-steam
 - 220 bar
 - 540 °C
 - 2,250 t/h
- ▶ Reheater-steam
 - 44 bar
 - 540 °C
 - 2,044 t/h
- ▶ Fuel
 - Hard coal

Superheater

Membrane wall



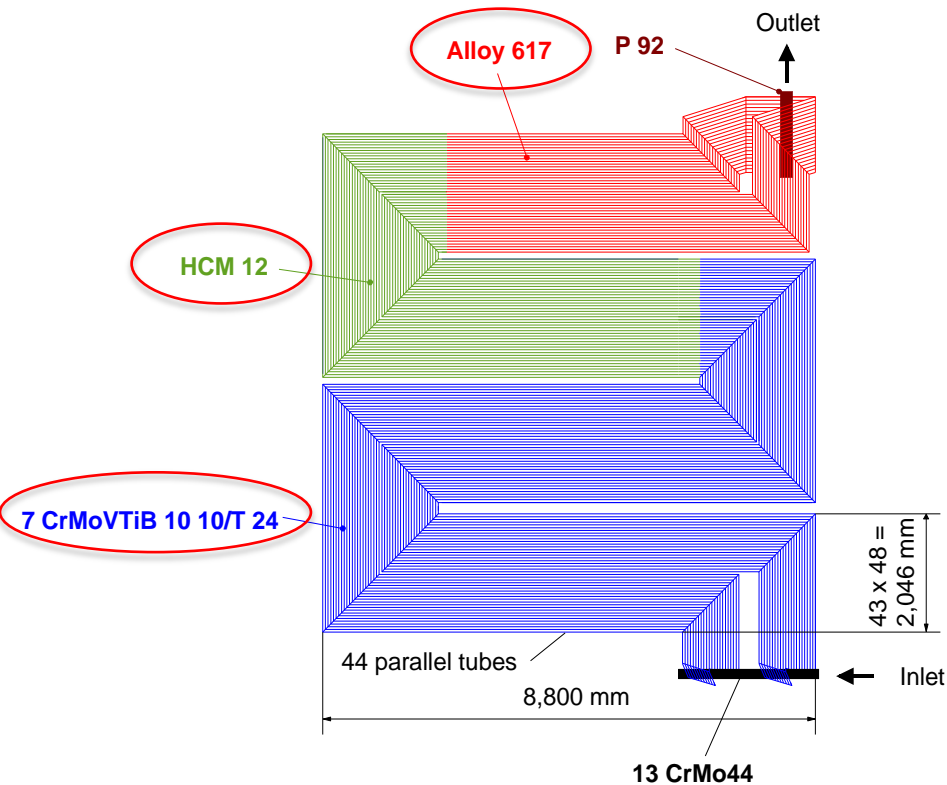
Flow scheme of COMTES700



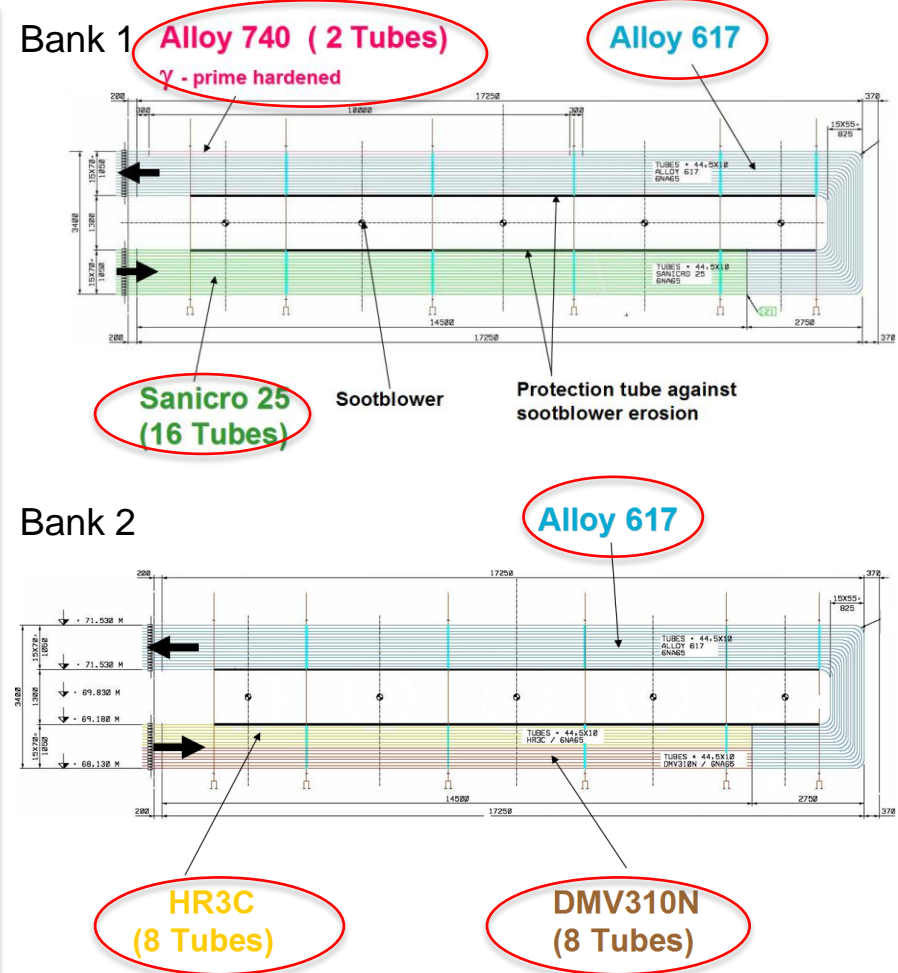
Aerial view of Scholven

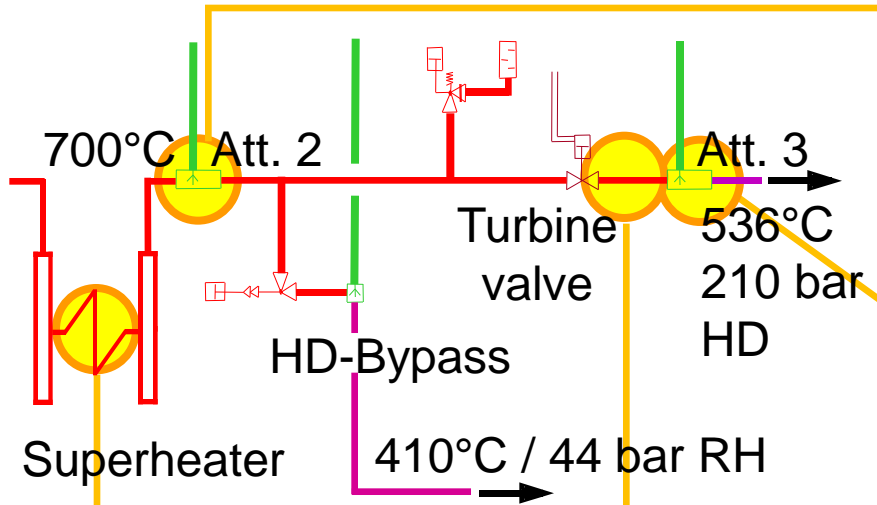


Membrane Wall (33,7 x 7,1 mm)



Superheater 1 & 2 (44,5 x 10 mm)

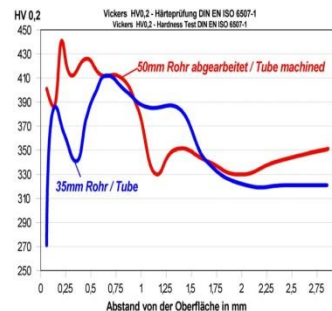
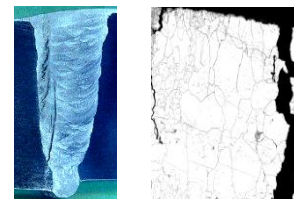
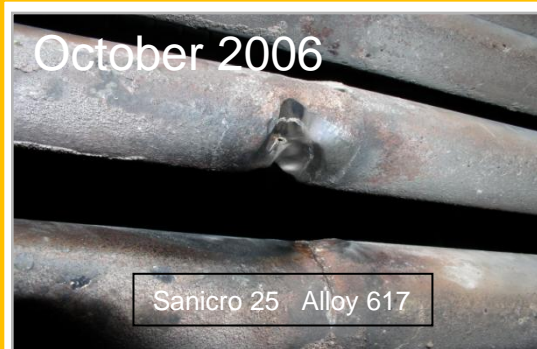




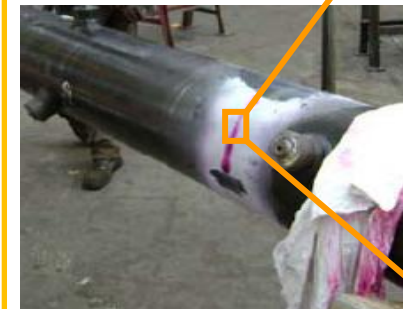
Reasons for damages:
Mainly stress relaxation cracking in weld seam through residual stress, high heat input and high hardness

⇒ **Development of a repair concept for Alloy 617 is necessary**

May 2007



May 2006
 February 2008

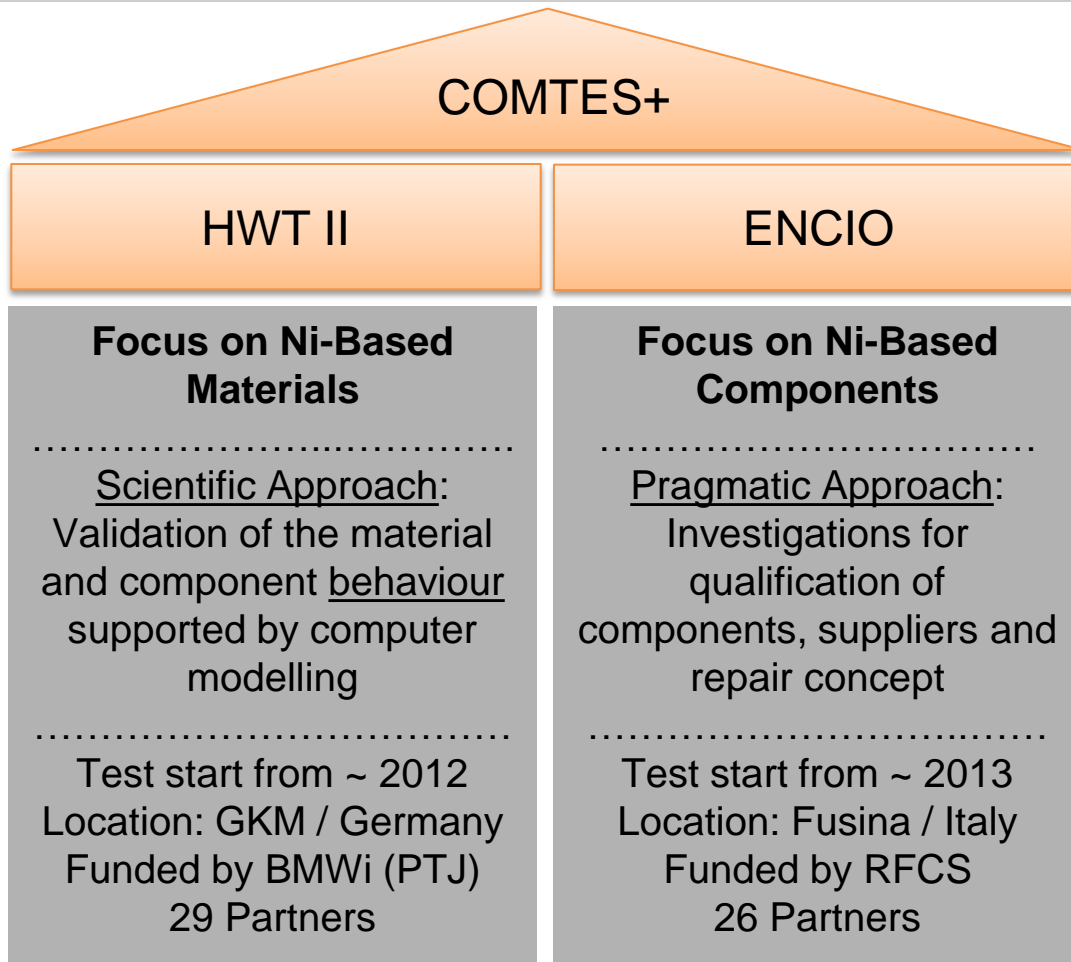


- All three tested materials of the **membrane wall** (T24, HCM12, Alloy 617B), erected without Post-weld heat treatment (PWHT), have shown failings. Further tests of materials for membrane walls are needed.
- The austenitic **superheater** material performed reasonable. Alloy 740 showed internal oxidation along grain boundaries and Alloy 617 showed local corrosion rates resulting in life estimation lower than 200.000 h.
- Post-weld heat treatment is mandatory for **thick-walled** weld sections due to stress relaxation cracking. Developed repair technologies must be tested.
- **Non-destructive testing (NDT)** has to be developed further. Thermal stress have to be avoided as well two-phase flow.
- **Valves** showed in general good results.

Open issues from COMTES700 to use as input for COMTES+:

- Continuation of further material tests for membrane walls
- Developing and testing of repair technologies
- Developing of Non-destructive testing (NDT)

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Involved Parties of COMTES+
1) CEZ a.s. *
2) EDF Electricite de France *
3) EnBW Kraftwerke AG *
4) ENEL Produzione S.p.A. *
5) E.ON New Build & Technologie GmbH *
6) ESKOM Holdings SOC Ltd. *
7) EVN AG *
8) STEAG GmbH *
9) GDF Suez *
10) GKM Großkraftwerk Mannheim AG *
11) RWE Power AG *
12) Vattenfall AB *
13) Vattenfall Europe Generation AG *
14) ENEL Ingegneria e Innovazione S.p.A.
15) VGB PowerTech e.V. – Coordinator

COMTES+ Overall Budget

ENCIO	23,3 Mio €	58% Generators Funding
HWT II	17,6 Mio €	30% Generators Funding
Risk Fund	2,6 Mio €	control of COMTES+
TOTAL	43,5 Mio€	

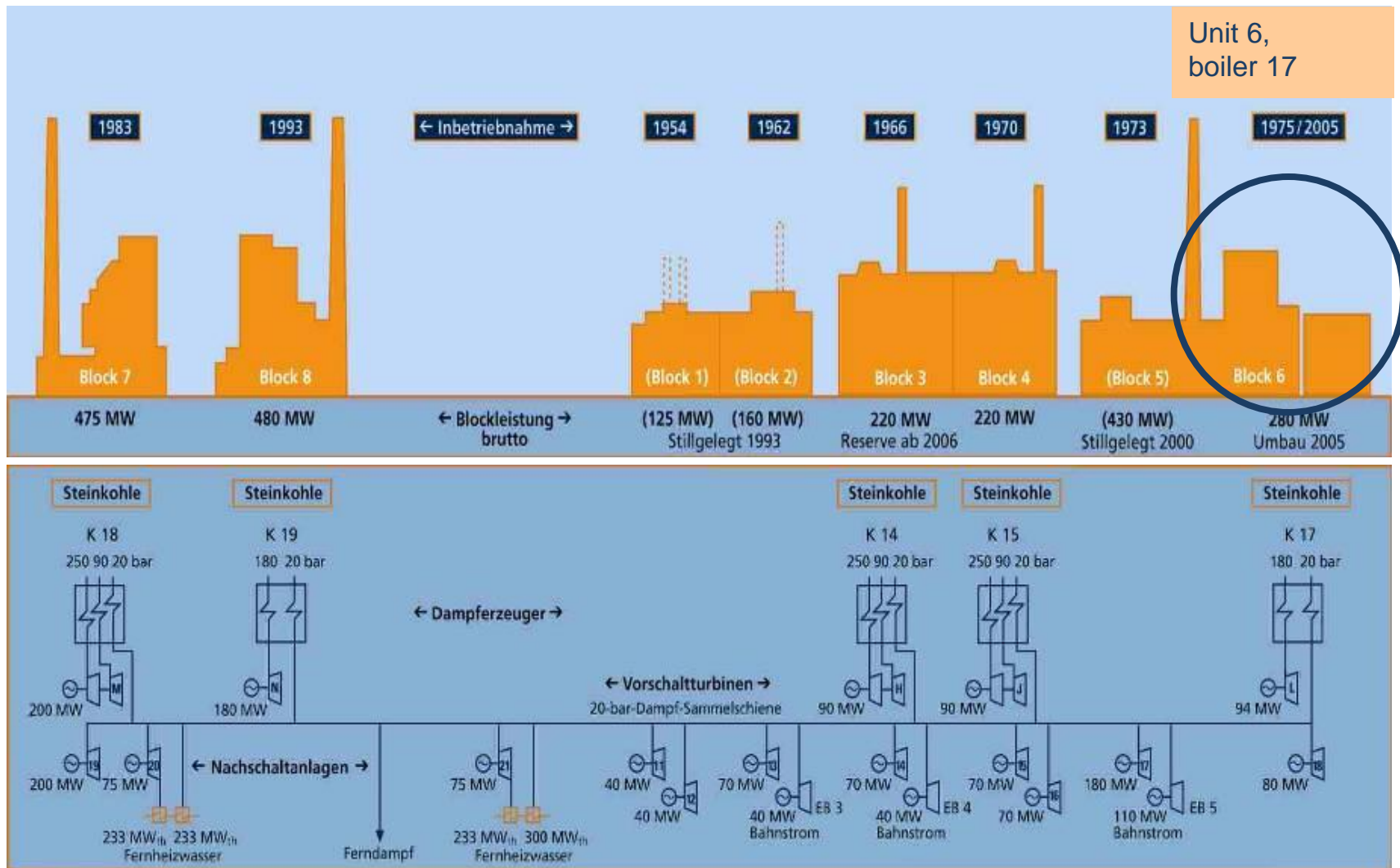


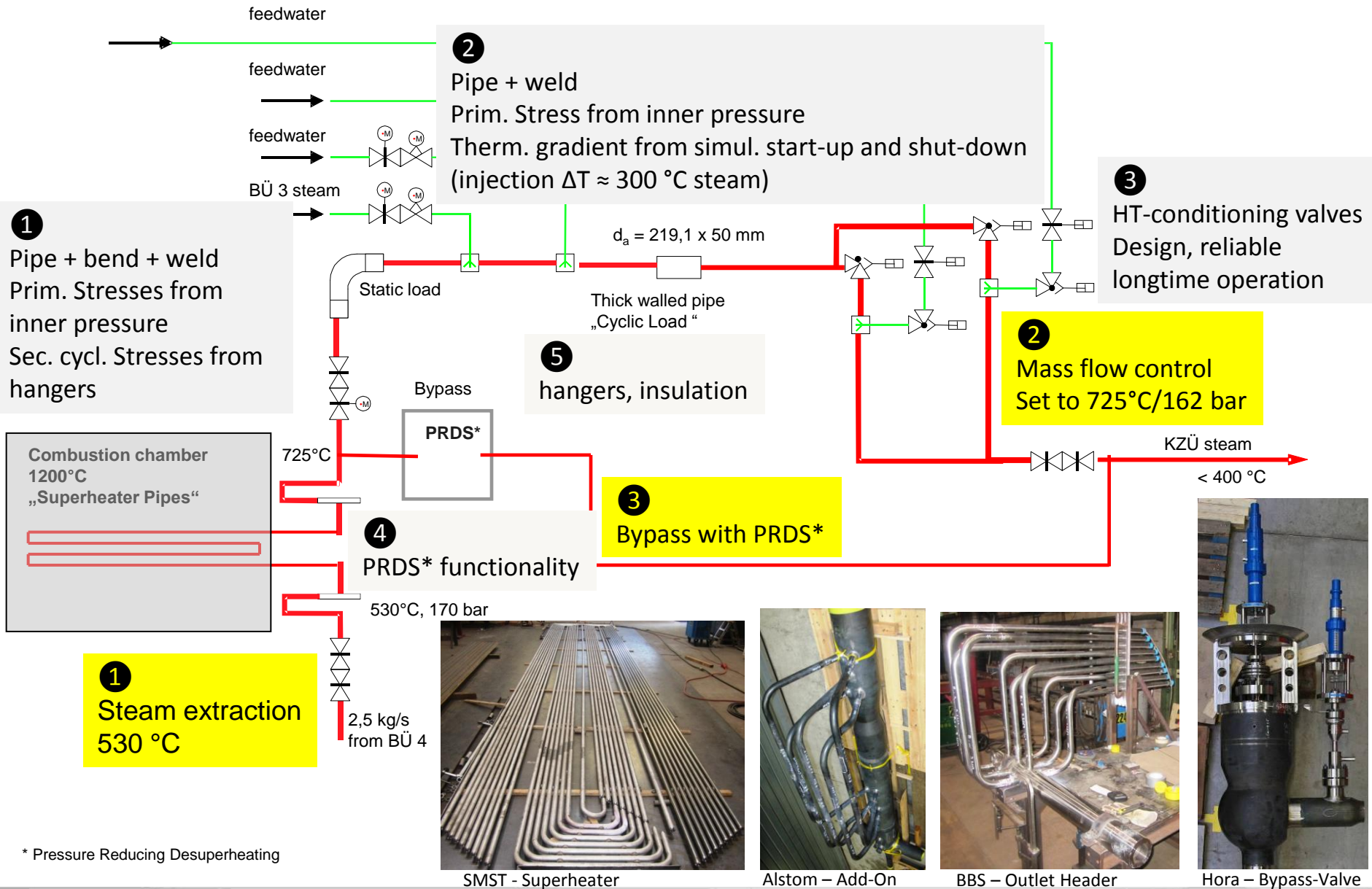
„Examination of In-Service and Damage Behaviour of Thick-Walled Components for High Efficient Power Plants“

HWT II

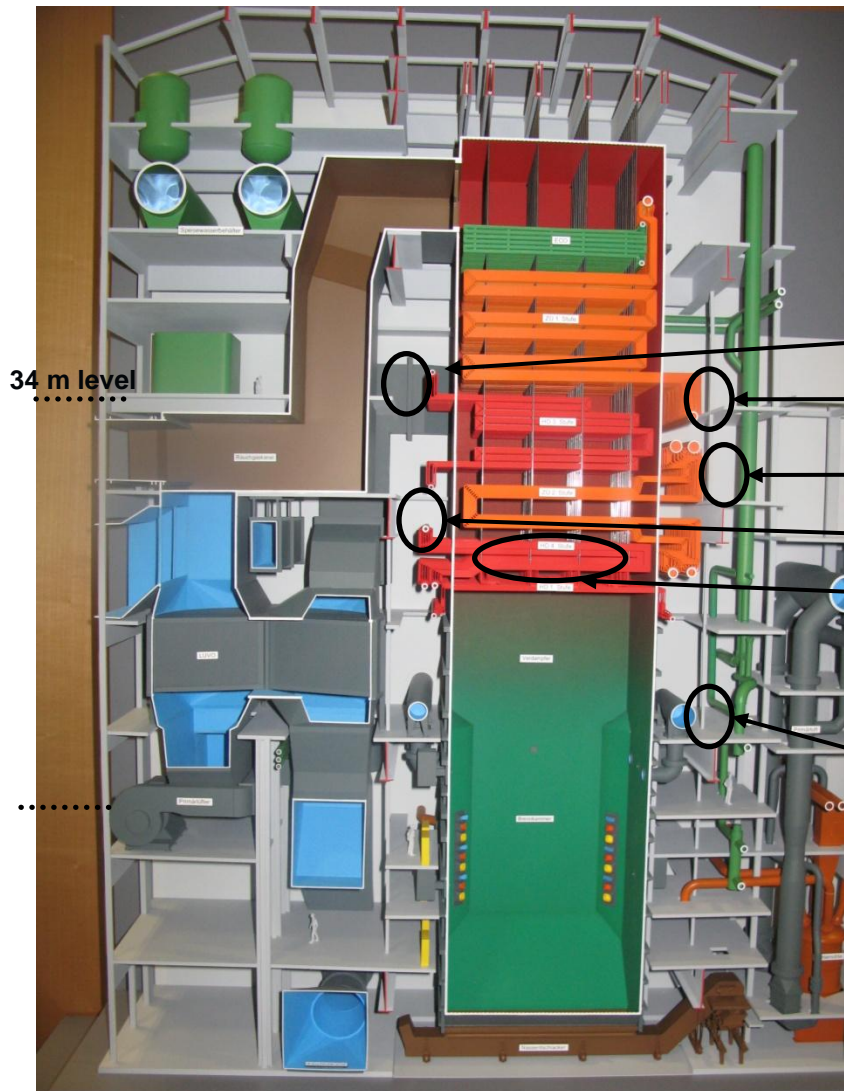
GKM
Grosskraftwerk Mannheim
Aktiengesellschaft

- Impact of non stationary load (thermal flexibility, fatigue) on base metal and weld on thick-walled components up to 50 mm at **725°C Steam**,
- Development of Ni-base control **valves** - Design, Optimization of gaskets, Coatings and material compounds,
- Basic examinations at probes **of thick-walled components**,
- **Optimization of design calculation** of thick-walled austenitic components under operational conditions,
- Influence of **welding conditions** and **heat treatment** on crack sensibility, determination of internal stresses,
- **Metallurgical description** of crack initiation and growth mechanism,





* Pressure Reducing Desuperheating



Key Components:

- High-Pressure Steam Conditioning Valve by E.ON
- Pipe Bend (static load)
- Injection Valves (Steam / Feedwater)
- 725°C Header
- 725°C Superheater in BÜ 4
- Thick Walled Test Track (cyclic load)
- High Temperature Pressure Conditioning Valves

Successfully executed on
1st of October

Workpackages	2011				2012				2013				2014			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
WP 1: Planning and erection of test rig																
WP 2: Set into operation and test operation																
WP 3: Test rig operation																
WP 4: Material qualification and characterisation																
WP 4.1: Lab tests																
WP 4.2: Identification and description of damage mechanisms																
WP 4.3: Numerical calculation of stress/strain and damage																
WP 5: Monitoring and optimization concepts																
WP 6: Project coordination and reporting																

Project Partners of Research Group HWT II

POWERTECH



VALLOUREC & MANNESMANN TUBES



Wrede & Niedecken



Industrie Service



RWE
EnBW
Vattenfall
Evonik
E.ON
...



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ThyssenKrupp VDM

Successful deployment of 700°C technology



- Provide proof of design and material behavior of **thick-walled components (<140mm)** under real operating conditions
- Solve main technical open items derived out of the comprehensive analysis of COMTES700 (**Repair technologies**),
- Test **new** developed **materials** and **manufacturing options** (e.g. post weld heat treatments) to improve the reliability of weldments made out of Ni-based alloys,
- Develop a **life-time** monitoring concept for pipes made out of Ni-based alloys,
- Explore materials and manufacturing options having the potential to reduce the investment cost of 700°C technology and improve the **load change behavior**,
- Verify the technical conditions for achieving **high efficiency** and better environmental figures (lower emissions).

Unit 4 of “Andrea Palladio” Power Station located in Fusina (Italy);
operated and owned by ENEL

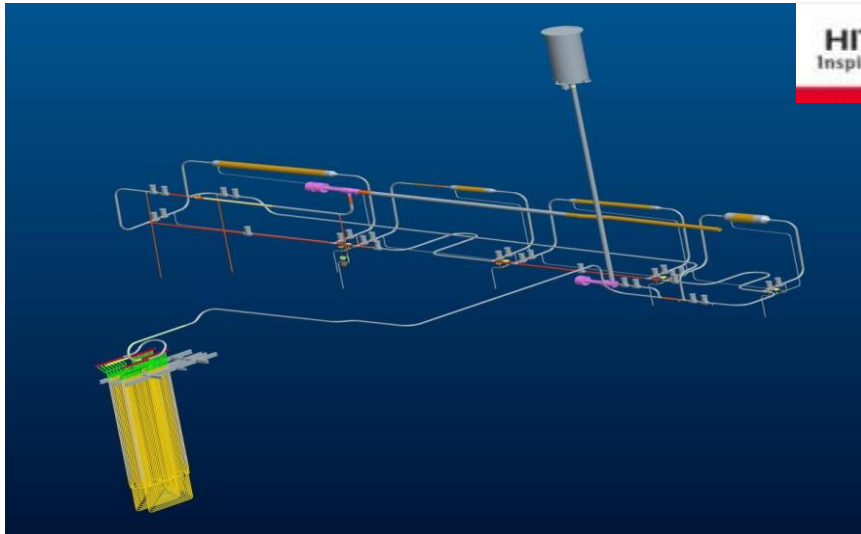


Photo: ENEL

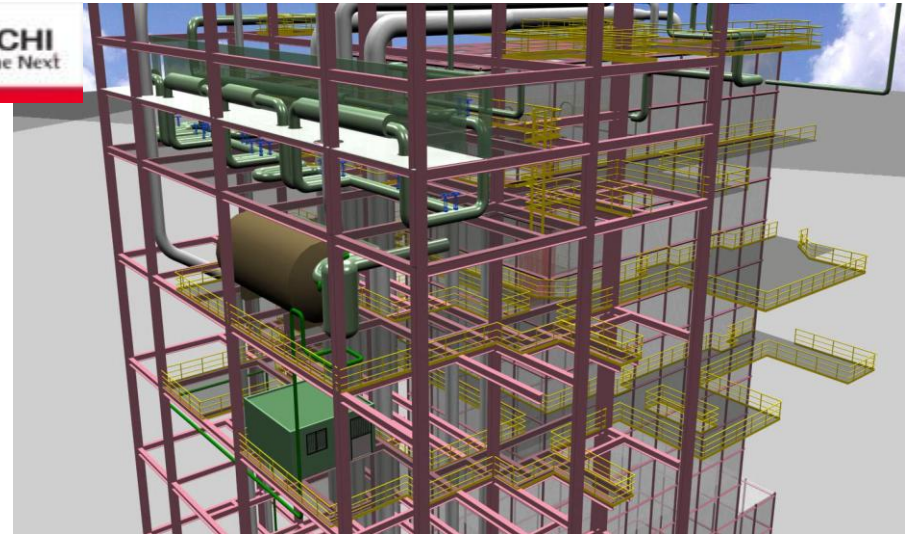
Technical Data of the HostPlant

Boiler type:	two pass boiler
Burner configuration:	tangential
Steam capacity:	1.050 t/h
Production capacity:	320 MWe
Fuel:	hard coal + RDF (Residual Derived Fuel)
Superheater steam temperature:	540 C
Superheater steam pressure:	177 bar

P&I Diagramm



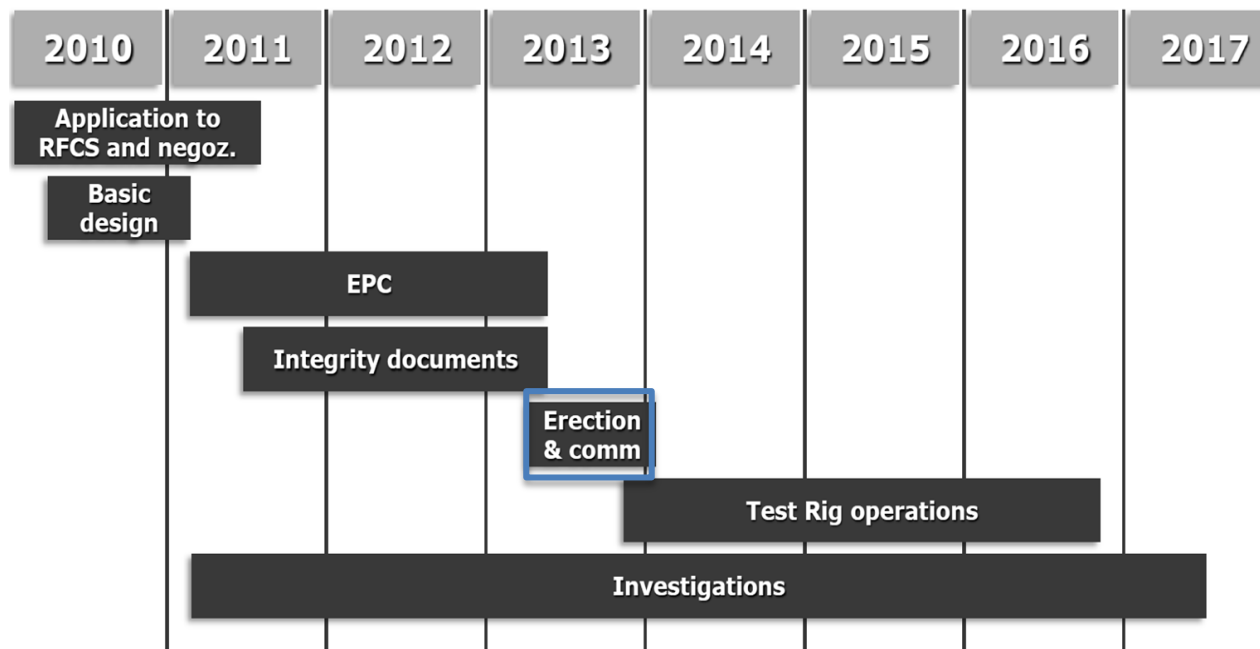
3D-View of the Test Facility



Test Loop	Scope
TL1	Development of pipe repair concept
TL2	Test of Hot Isostatic Pressing (HIP) parts and weldments as well as life-time monitoring
TL3	Test of different Ni-based alloys and weldments
TL4	Test of turbine cast material and weldments



The ENCIO-project will be financed by industrial and public funds. The project receives funding from the European Community's Research Fund for Coal and Steel (RFCS) under grant agreement n° RFCPCT-2011-00003.



The ENCIO started on 1 July 2011.

The overall project duration is six years (72 months), to allow enough operating hours, as well as related data collection, investigations and evaluation of results.

The leading ENCIO partners are:



Projectmanagement

The ENCIO partnership comprises the following companies, which are co-funding and supporting the project:



VALLOUREC & MANNESMANN TUBES

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Today

600/620°C Power Plant Concepts

- Reference efficiency > 45%
- Material concept realized
- High production requirements especially on site
- Intensive quality checks
- Investment ~ 1.200 €/kW

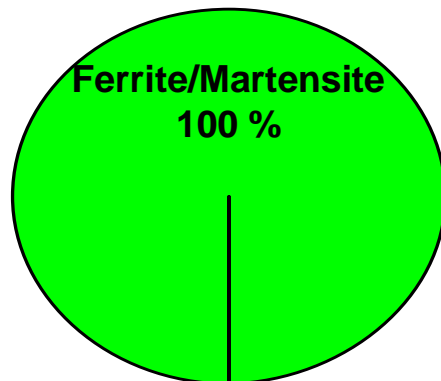
Tomorrow

700/720° C Power Plant Concepts

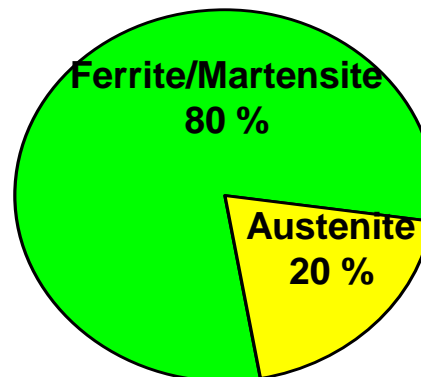
- Reference efficiency > 50%
- Material concept under develop.
- High specific costs for Ni alloys.
- High machinery time
- Further material development and component tests necessary
- Investment >> 1.200 €/kW

Material mix in modern power plants

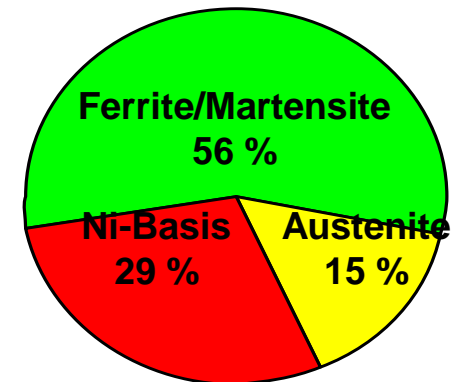
250 bar / 540°C / 560°C



280 bar / 600°C / 620°C



360 bar / 700°C / 720°C



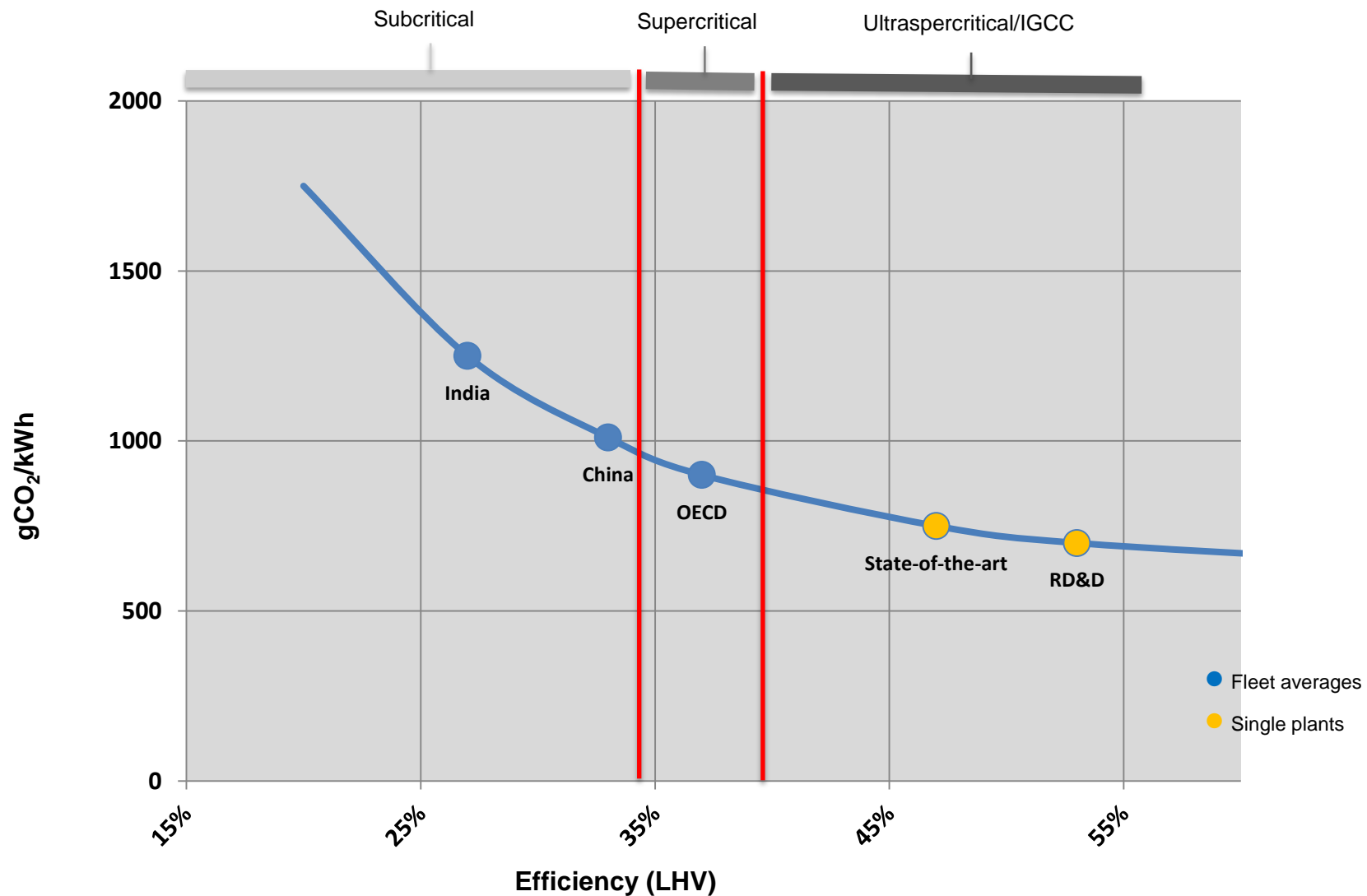
Thank you for your attention!



Web page: www.vgb.org

E-mail address: herbert.urban@vgb.org

Back-up 1



Source: World Coal Institute: Coal meeting the climate challenge

The screenshot shows the VGB website interface. At the top, there's a navigation bar with 'DEUTSCH | ENGLISH' and 'VGB'. Below it, a menu includes 'NETWORK', 'OPERATIONAL SERVICES', 'RESEARCH', 'MEDIA', and 'VGB GROUP'. The 'RESEARCH' section is active, displaying a list of research areas: Nuclear Power Plants, Fossil-fired Power Plants, Renewables/ Distributed Generation, Environmental Technology, Chemistry, Safety and Health, and Heinrich-Mandel Prize. The 'Fossil-fired Power Plants' section is expanded, showing a table of projects.

PROJECT-NO.	BRIEF DESCRIPTION	DURATION
355	ENCIO	2011-2018
354	HWT II	2011-2014
348	New 12% chromium steels	2011-2013
347	Annealing studies of P91/92	2011-2012
345	System stability of electricity supply	2011-2013
339	Microstructure of Alloy 263 under Long Term Creep Loading	2010-2011
337	Condensing Wet Electrostatic Precipitator	2010-2012
334	Strength and Deformation Behaviour of Alloy 740 Tubes	2010-2013
333	Impact of Large-scale Wind Farms on the German Generation System, Part II	2009-2012
332	Practical Realization of Measures to Reduce Power	2009-2010

On the right side of the screenshot, there is a 'CONTACT' section with information for Sabine Polenz and Guido Schwabe, including phone, fax, and email addresses. Below that is a 'MEMBER-LOGIN' section with fields for Username and Password, and a 'Log-on' button.

- VGB offers a neutral platform for joint research of the member companies.
- R&D-projects are steered by the experts organised in the VGB Committees.
- VGB Committees define the need for research in the respective fields of activity and supervise the project and the transfer of results.
- About 90% of the R&D projects are relevant for all member companies.