

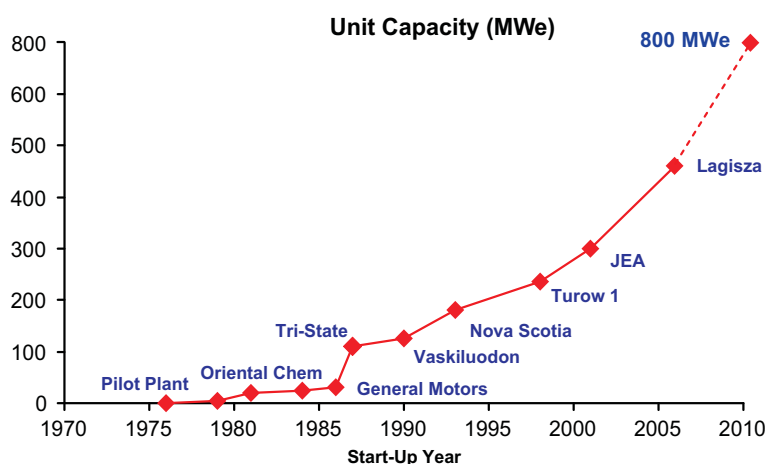


## UTILITY SCALE CFB FOR COMPETITIVE COAL POWER

# CFB800

01/09/05 – 31/08/08

The project aimed to scale-up Circulating Fluidized Bed combustion (CFB) technology to 800 MWe size. Scaling up the technology to 'real' utility scale (600-800 MWe) with a net efficiency of 45% or more was needed to fulfil the future requirements of utility operators. During the project a viable CFB plant design in size of 800 MWe was developed.



CFB technology is scaling up from the latest high-efficiency SC-OTU-references Lagisza (460 MWe) up to 800 MWe size.

During recent years, supercritical once-through (SC-OTU) CFB technology has been developed, enabling the next stage in CFB development to proceed to medium-scale (<500 MWe) commercial projects such as Lagisza, with gross efficiencies near 45%. The Lagisza boiler (460 MWe) utilizes local low grade coals and is capable to co-fire biomass in the future.

The character of CFB technology with fuel and operational flexibility, and multifuel capability can give economical and environmental advantage also in utility scale and by this way improve operators' competitiveness at deregulated energy markets.

During the project a viable CFB plant design in size of 800 MWe was developed. The calculated net plant efficiency of the CFB800 was 45% (600°C/300 bar). The design resulted in a furnace cross-section of 40 x

12 m, and a furnace height of 50 m. The furnace dimensions are clearly larger than those found in existing units. The water and steam side of the design is based on low mass flux BENSON once-through technology. This technology is ideal for CFB conditions, as it utilizes vertical furnace tubes rather than the spiral-wound tubing used in many other once-through designs.

A cost structure of the CFB800 concept was determined for the complete power plant. Investment costs of the plant are on the same level with pulverized coal plants, and the slightly higher operating costs can be compensated by the possible use of cheaper fuels (e.g. low grade coals). Price of the electricity shows a competitive value for CFB800 compared with other generation technologies especially when opportunity fuels are used.

Comparison of furnace dimensions.

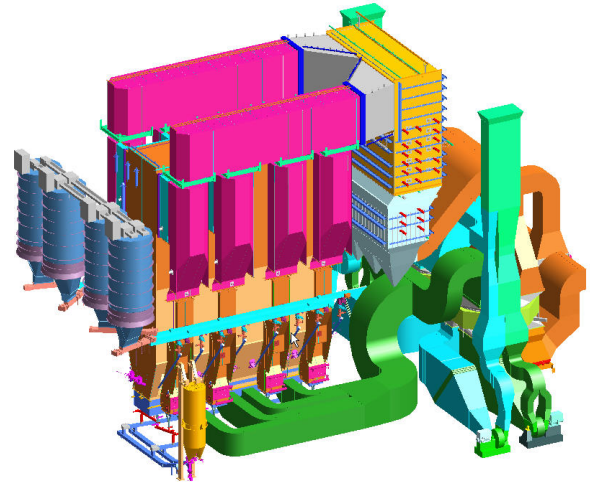
	CFB800	Lagisza	Turow 4-6	JEA	Turow 1-3
Furnace					
- Width m	40	27.6	22.0	26.0	21.2
- Depth m	12	10.6	10.1	6.7	9.9
- Height m	50.0	48.0	42.0	35.1	43.5

## CFB800 boiler arrangement

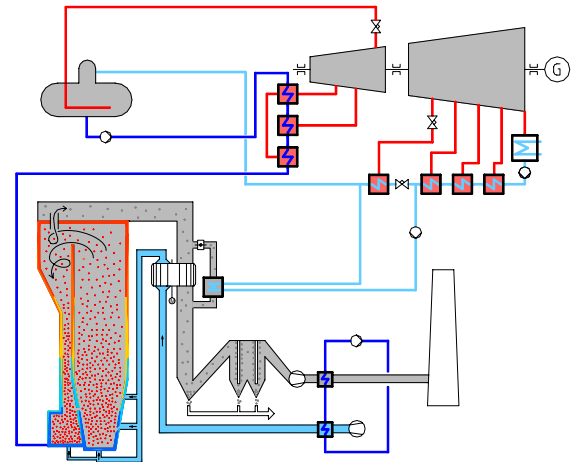
The furnace has one fluidizing grid, below which there are four separate air plenums for introducing primary air to the furnace. Using a single continuous fluidizing grid makes for simple control, as well as stable and uniform operation of the furnace. The lower furnace is tapered, and the grid area is approximately 50% of the cross-section of the upper furnace. This provides high internal turbulence for the fluidized bed and ensures efficient mixing of the fuel and secondary air.

290°C was selected for the feed water temperature of and the main steam conditions were set 600°C and 300 bar. A single reheat stage with steam conditions 620°C and 50 bar were defined for the steam cycle. The design is based on eight (8) solids separators arranged in parallel, four on either side of the furnace. INTREX™ is a fluidized bed heat exchanger that extracts heat from the hot circulating bed material that is collected in the solid separators. The CFB800 boiler design incorporates a total of 16 INTREX heat exchangers. Twelve of the INTREX heat surfaces serve as superheaters (the third and final stage), and four as final reheaters.

One of the important features for CFB800 is located in the cold-end boiler. The flue gas heat recovery system (HRS) improves the efficiency of the boiler and power plant by reducing the flue gas temperature to 90°C. The system recovers heat from the flue gases, which results in an improvement of about 0.8% in total plant efficiency. The HRS operates under clean gas conditions, after the ESP and ID fans. Cooling takes place in a heat exchanger made of PF plastic tubing to avoid corrosion problems.



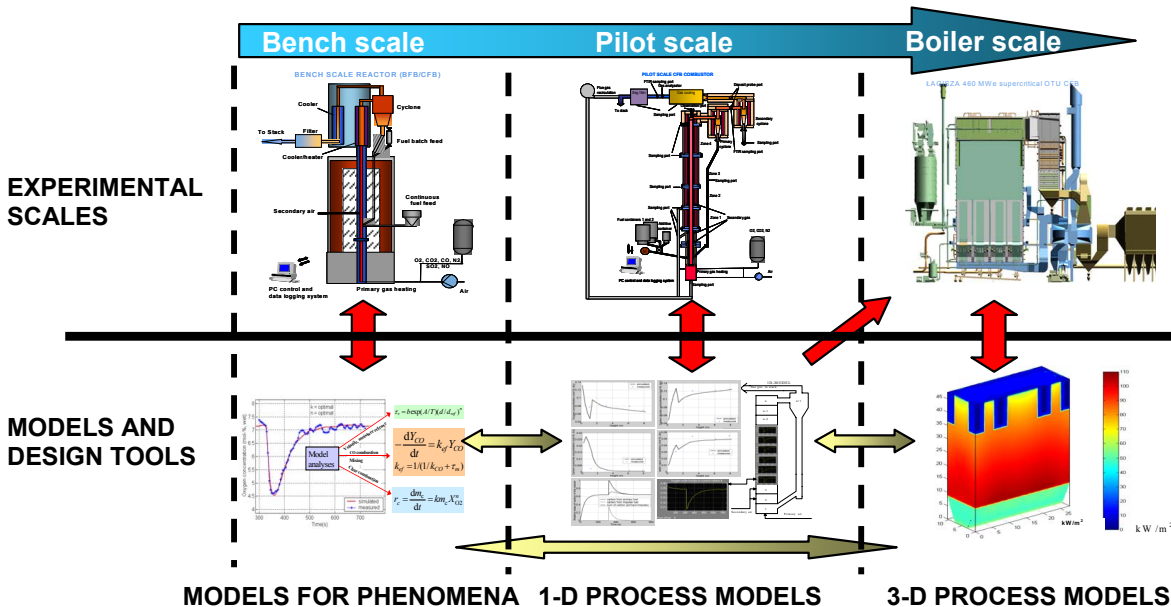
CFB800 boiler arrangement.



The Flue Gas Heat Recovery System.

## Development in multiple scales

To meet the requirements of utility size power plant including the requirements of electrical network a comprehensive understanding of scaling up issues must be accomplished and a good understanding on the behavior of the boiler is needed under various operation conditions. During the CFB800 project different submodels were developed for bench, pilot and full scale models (1D and 3D –models) in order to improve the existing prediction and design capability.



2.801.201.010TH.indd

## Contacts:



**Jouni Hämäläinen**  
VTT, coordinator  
jouni.hamalainen@vtt.fi  
Tel. +358 20 722 2529

**Antti Tourunen**  
VTT, assistant coord.  
antti.tourunen@vtt.fi  
Tel. +358 20 722 2718



**Joachim Franke**  
Siemens Power Generation AG  
joachim.franke@siemens.com  
Tel. +49 9131 18 6234



**Juan Carlos Ballesteros**  
ENDESA  
juan.carlos.ballesteros@endesa.es  
Tel. +34 912 131 221



**Cristóbal Cortés**  
CIRCE  
tdyfqdb@unizar.es  
Tel. +34 976 762 034



**Nikolaos Koukouzas**  
CERTH/ISFTA  
koukouzas@techp.demokritos.gr  
Tel. +30 210 6546 637



**Ari Kettunen**  
Foster Wheeler Energia Oy  
ari.kettunen@fwfin.fwc.com  
Tel. +358 (0)10 3937977