



Combustion of SRF: Technological Options and Operational Experience

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steag

STEAG group

STEAG Energy Services GmbH

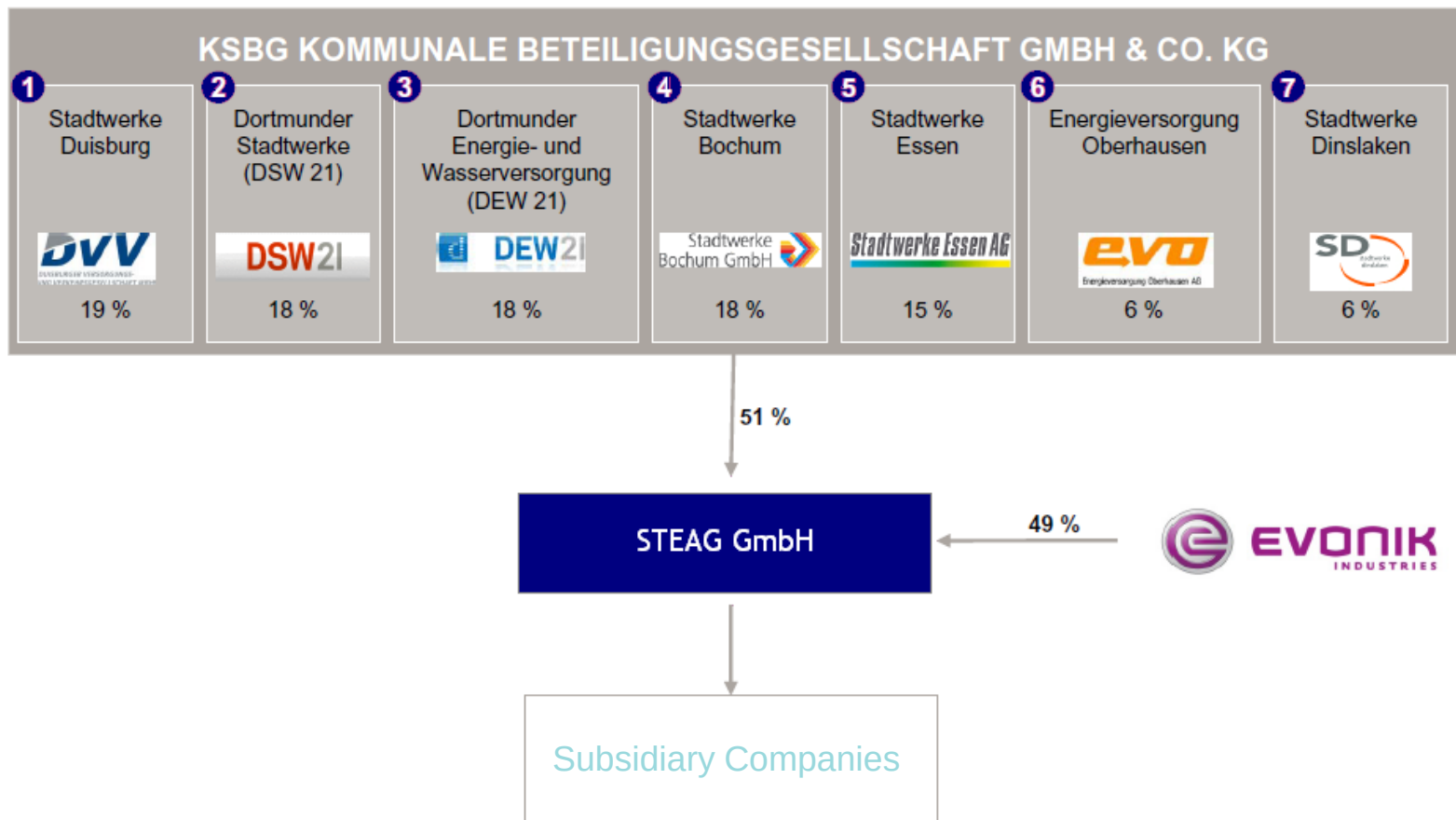
General View

Current Projects

- Essential Waste to Energy Projects
- Refuse Derived Fuels (RDF) to Energy
- Biomass to Energy

Ownership Structure STEAG GmbH

Municipal Holding Company KSBG GmbH



Municipal
Utilities

STEAG – Operations full of energy

Planning – operation – supply – marketing – recycling



Project development,
planning, operation
and supply of power
plants...



... in Germany
and ...



... abroad



... on the basis
of fossil...



... and
renewable
energy sources.



Marketing of
electricity and district
heat, and...



...recycling of power
plant byproducts.

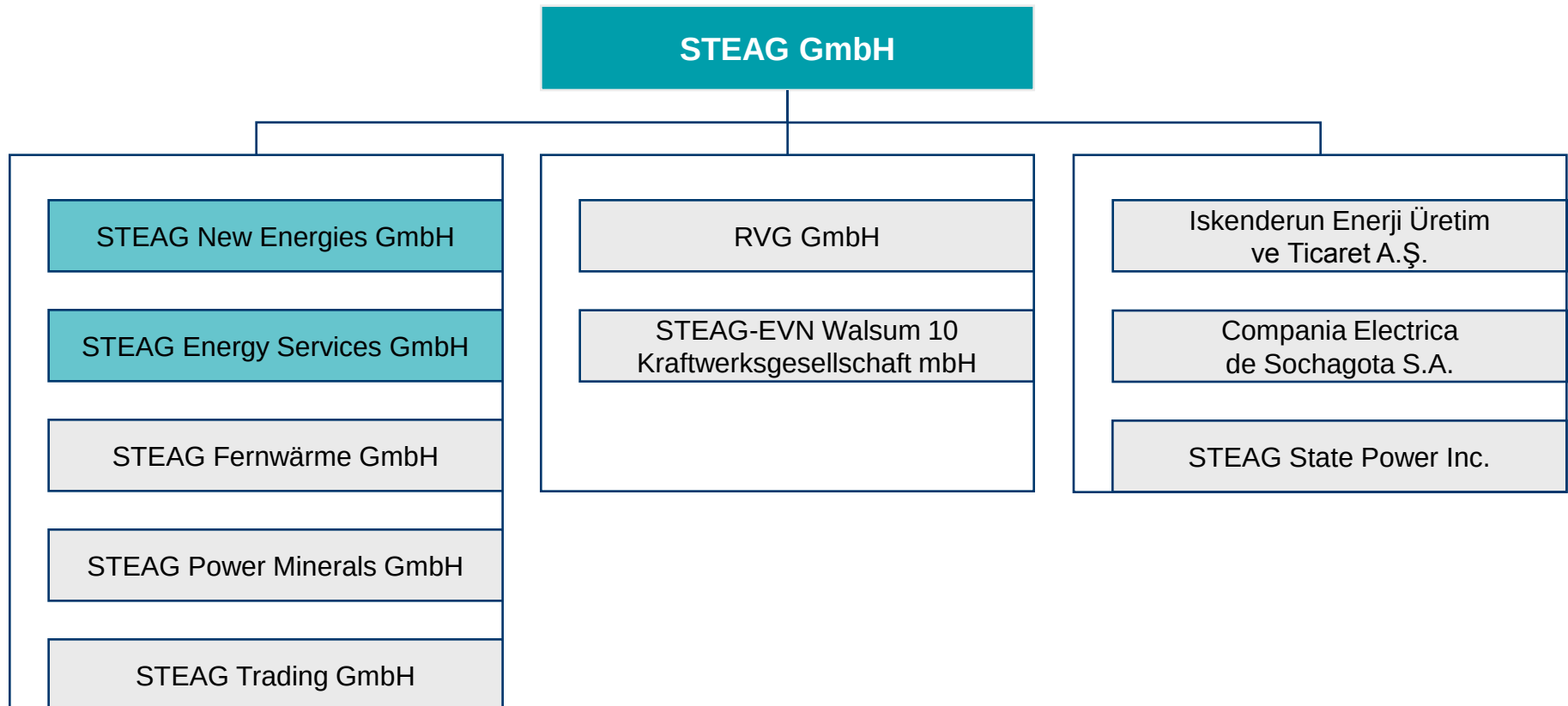
Key figures (as of Dec. 2010)

External sales **2,762 € m**

Capital expenditure on fixed assets **163 € m**

Employees **4,916**

The Business Area Energy unites all energy activities



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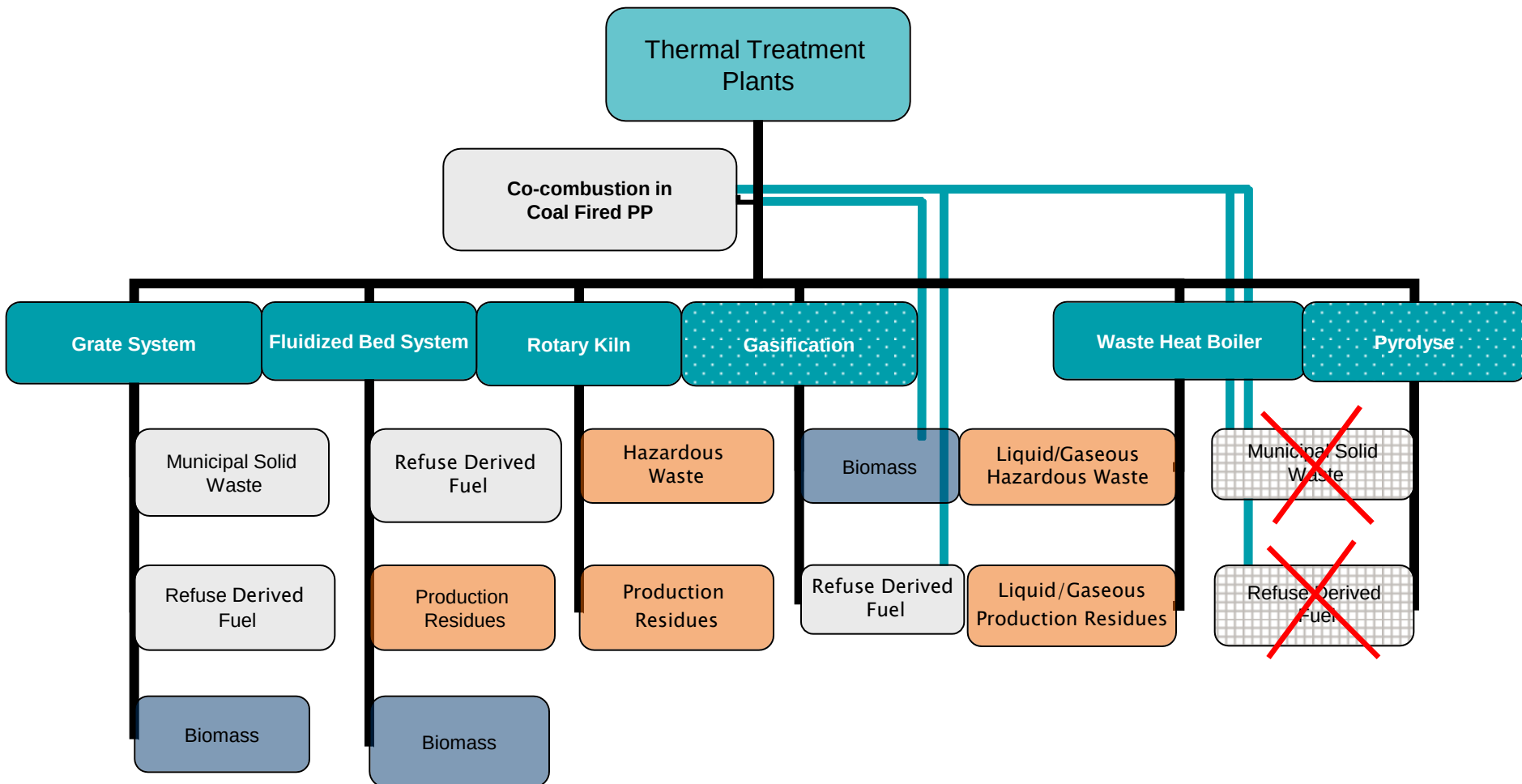
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Thermal Treatment and Combustion Technologies



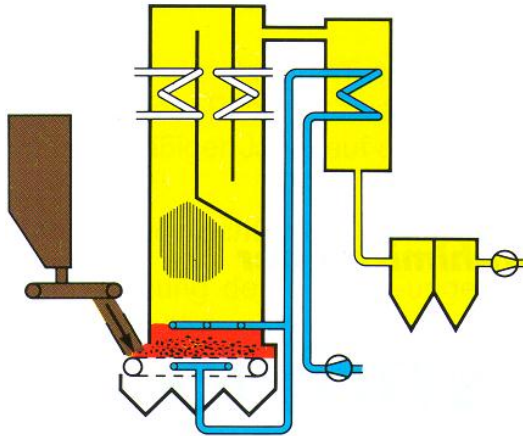
Co-combustion in Coal Fired PP

- Power plants in theory have had high throughput capacity of 40 Mio t/a at max. 25% of thermal heat capacity (THC)
- Co-combustion of
 - Sewage sludge
 - Production residues
 - Pet coke (= „design fuel“)
 - Meat and bone meal (decreasing)
 - Refuse Derived Fuel (RDF)
 - Solid Recovered Fuel (SRF)
 - Biomass and Wood
- In reality only 3 to 10 % of the thermal heat capacity will be utilized.
- Main selection criteria:
 - Logistics and handling (terms of payment and delivery)
 - Firing System (fouling boiler, corrosion, availability)
 - Flue gas cleaning (for example Mercury)
 - Residue utilization (ash with DIN EN 450)
 - No special credits or payments

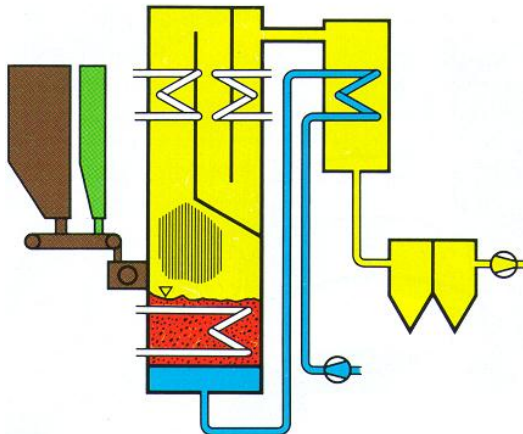
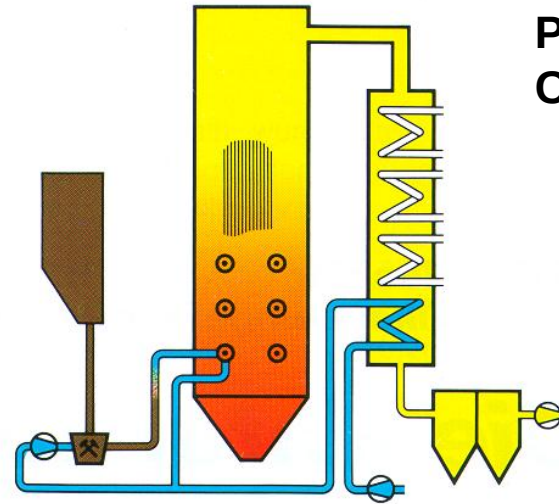


Furnace Types

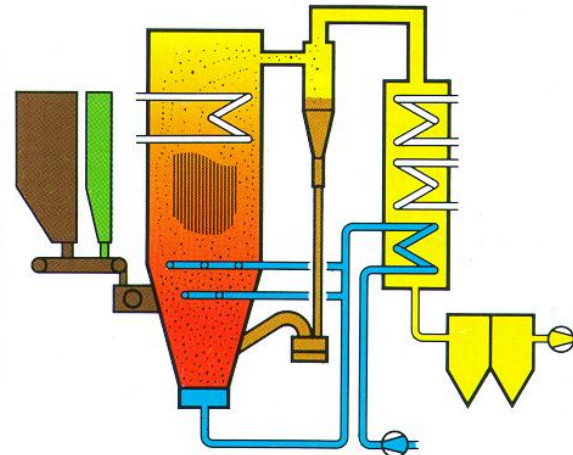
Grate Stoker



Pulverized Coal Combustion



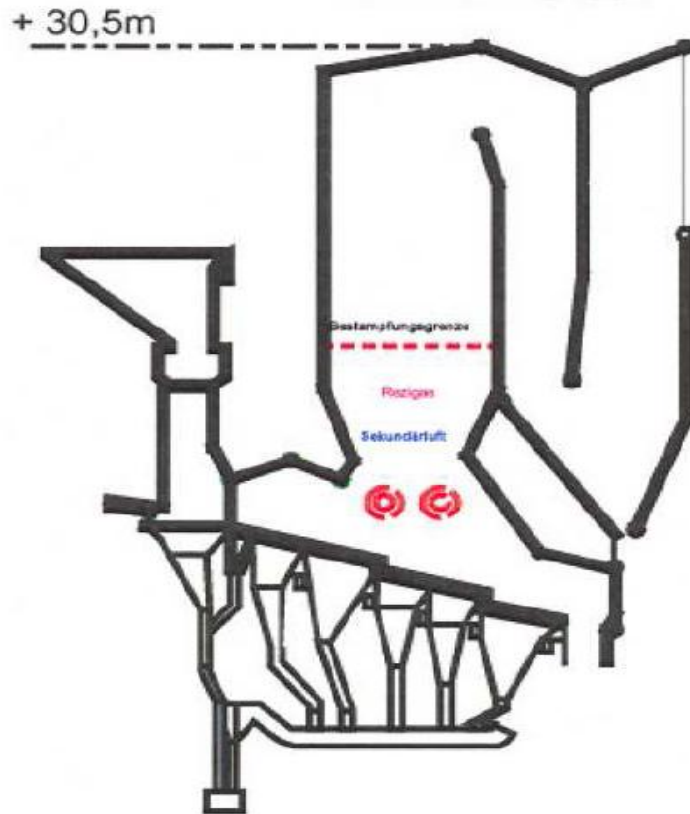
Stationary Fluidized Bed Combustion



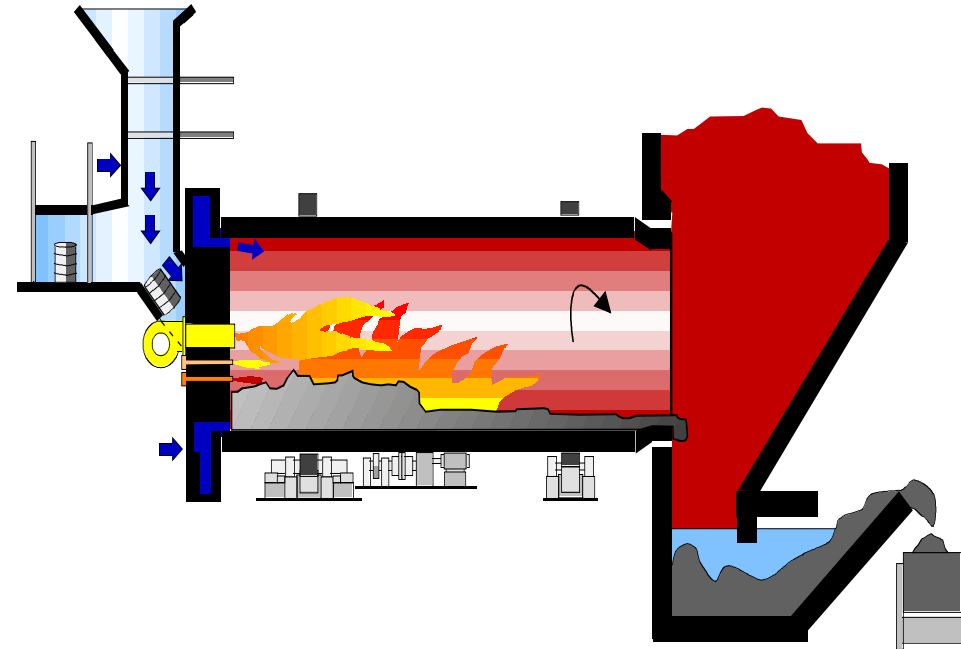
Circulating Fluidized Bed Combustion

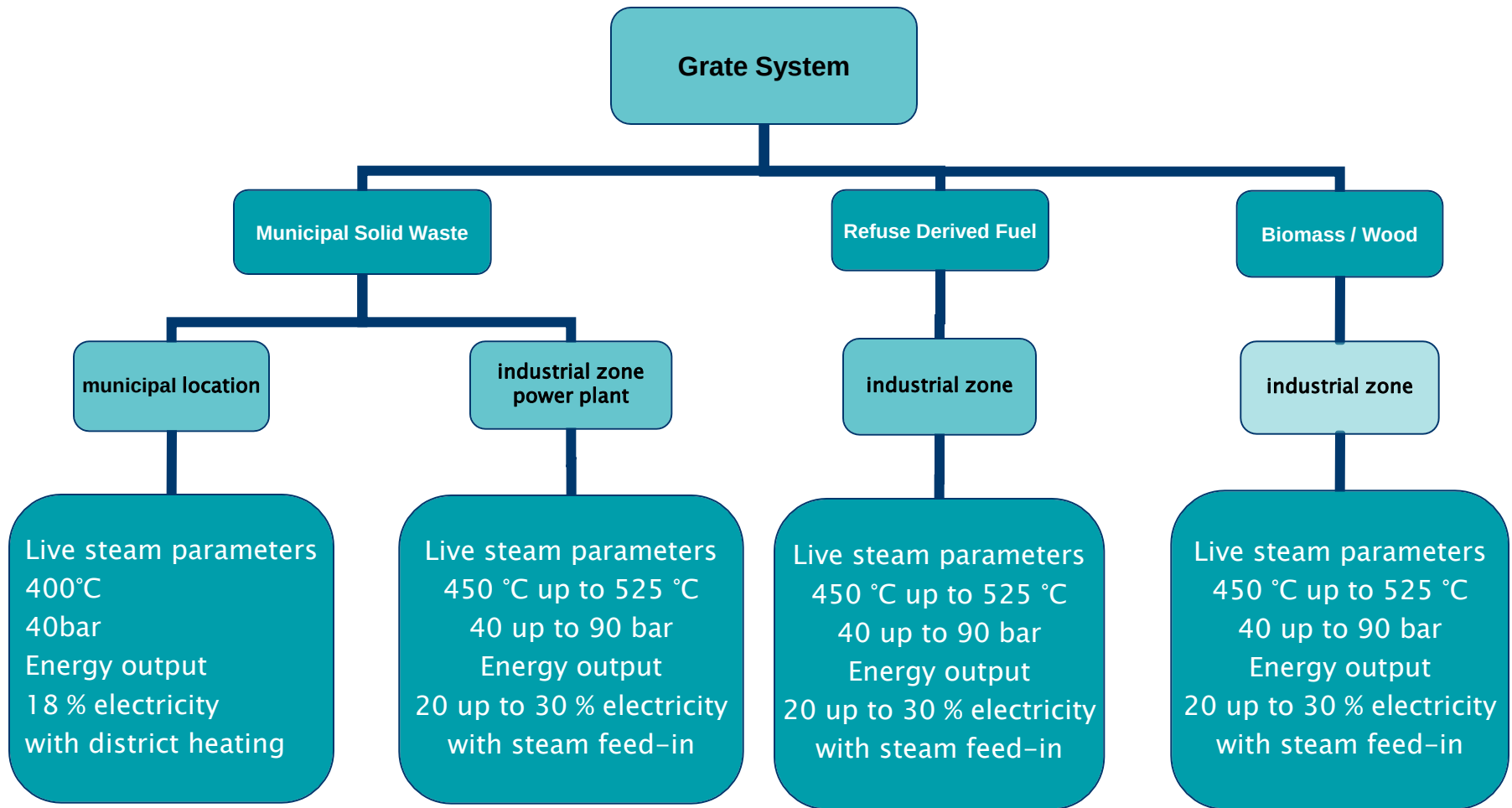
Furnace Types / Special Typ

Air-cooled / Water-cooled
Moving Grate Combustion



Hazardous Waste
Rotary Kiln





Municipal Waste Incineration Plants with Moving Grate

through put : 20 Mg/h at appx. 52,1 MW_{th}

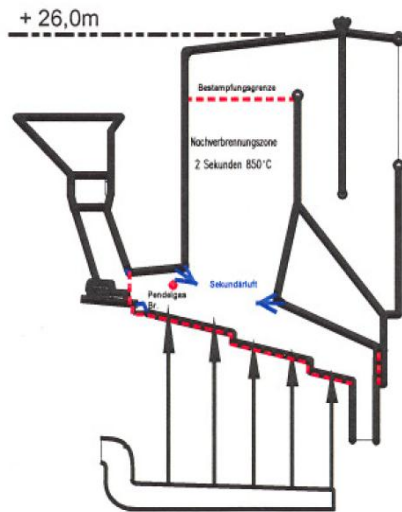
1980

1990

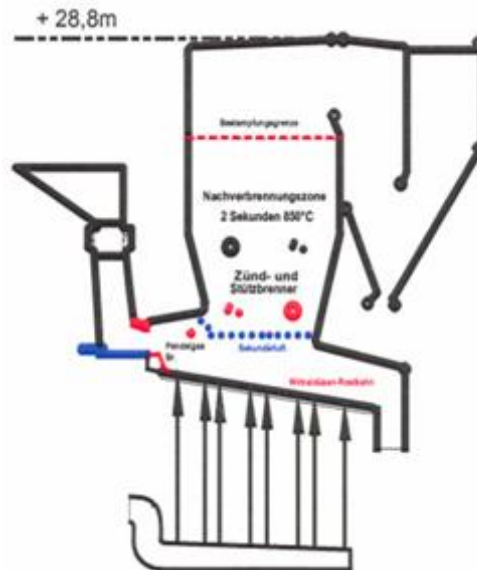
1995

2000

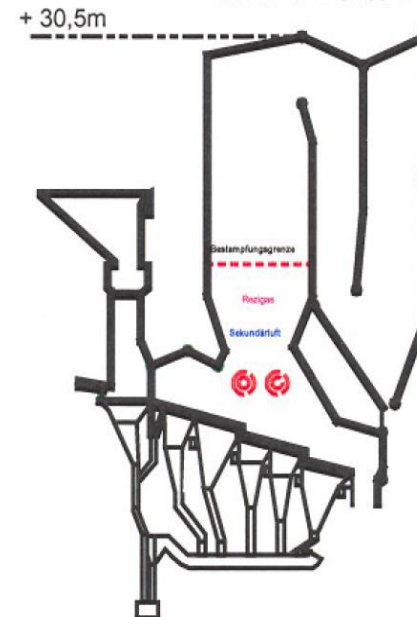
Boiler Height



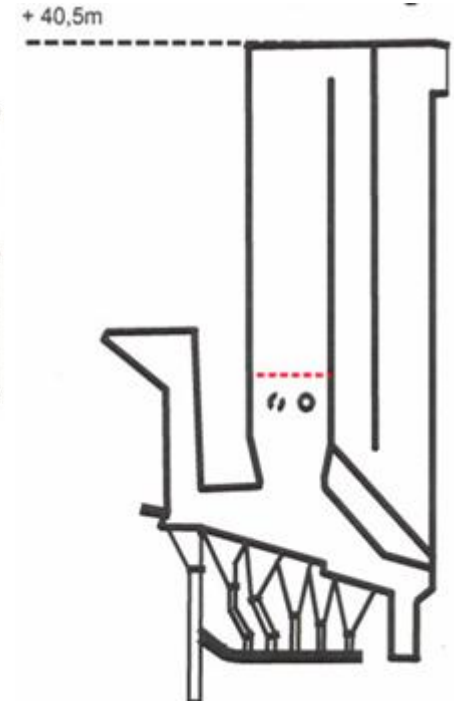
Grate Width 5 m



Grate Width 4,4 m



Grate Width 6,3 m

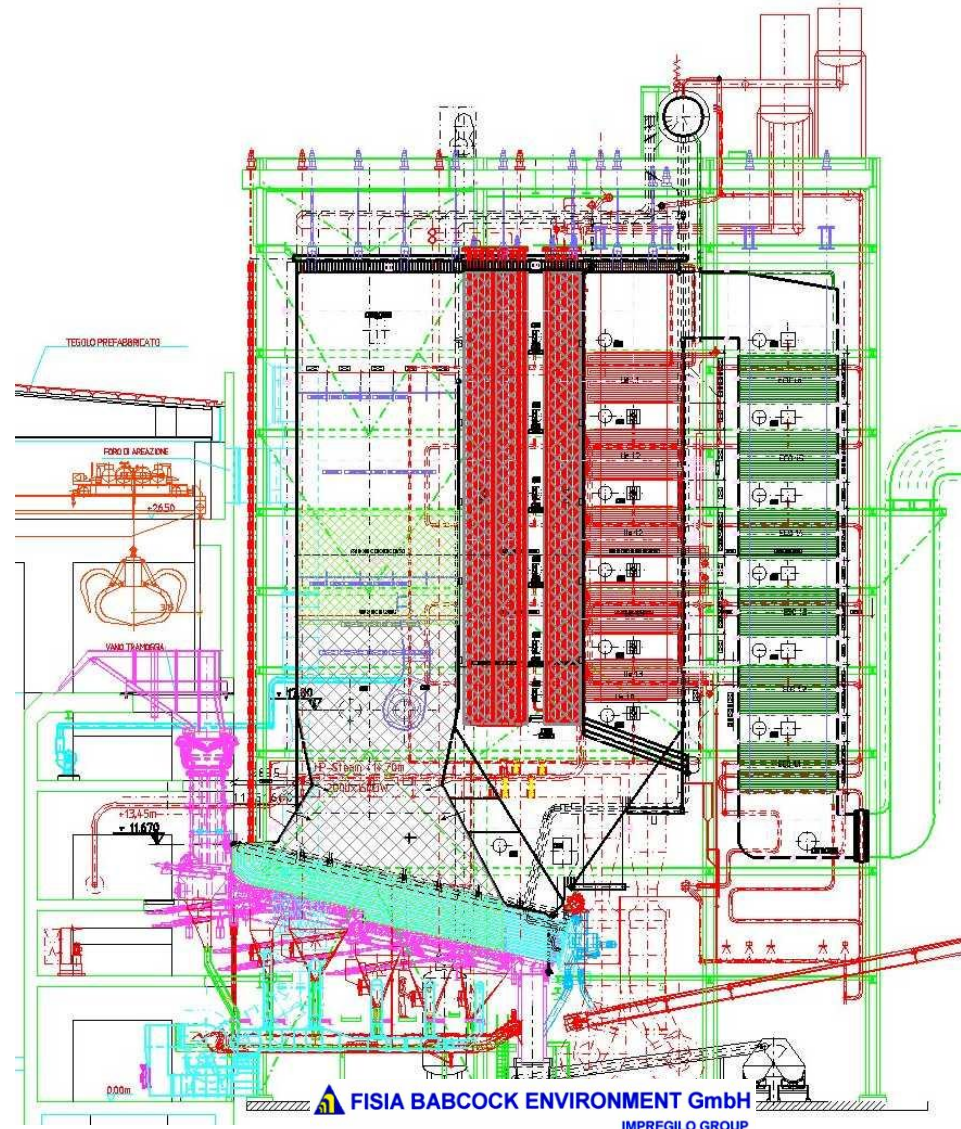


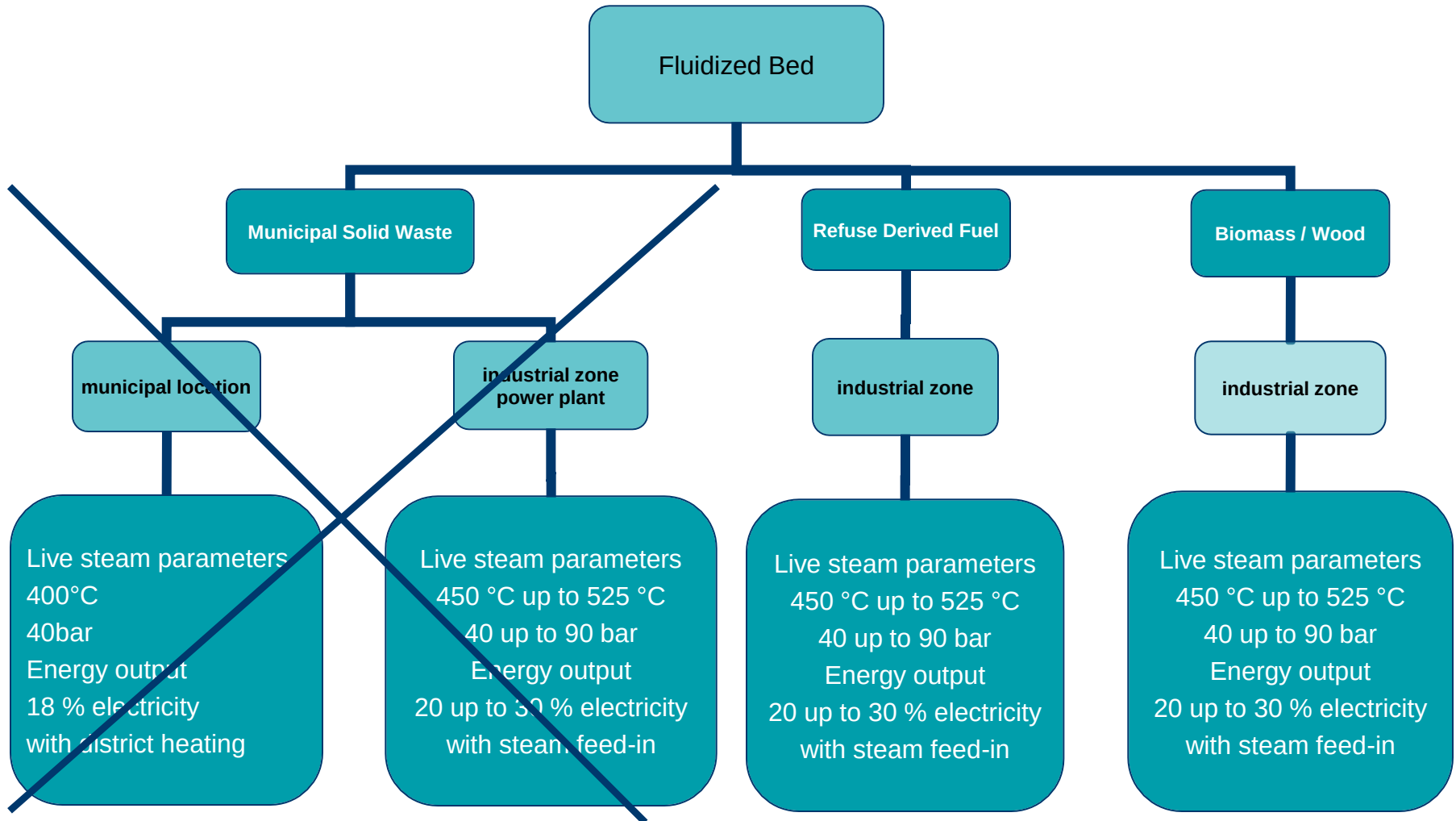
Grate Width 6,3 m

Grate Typ

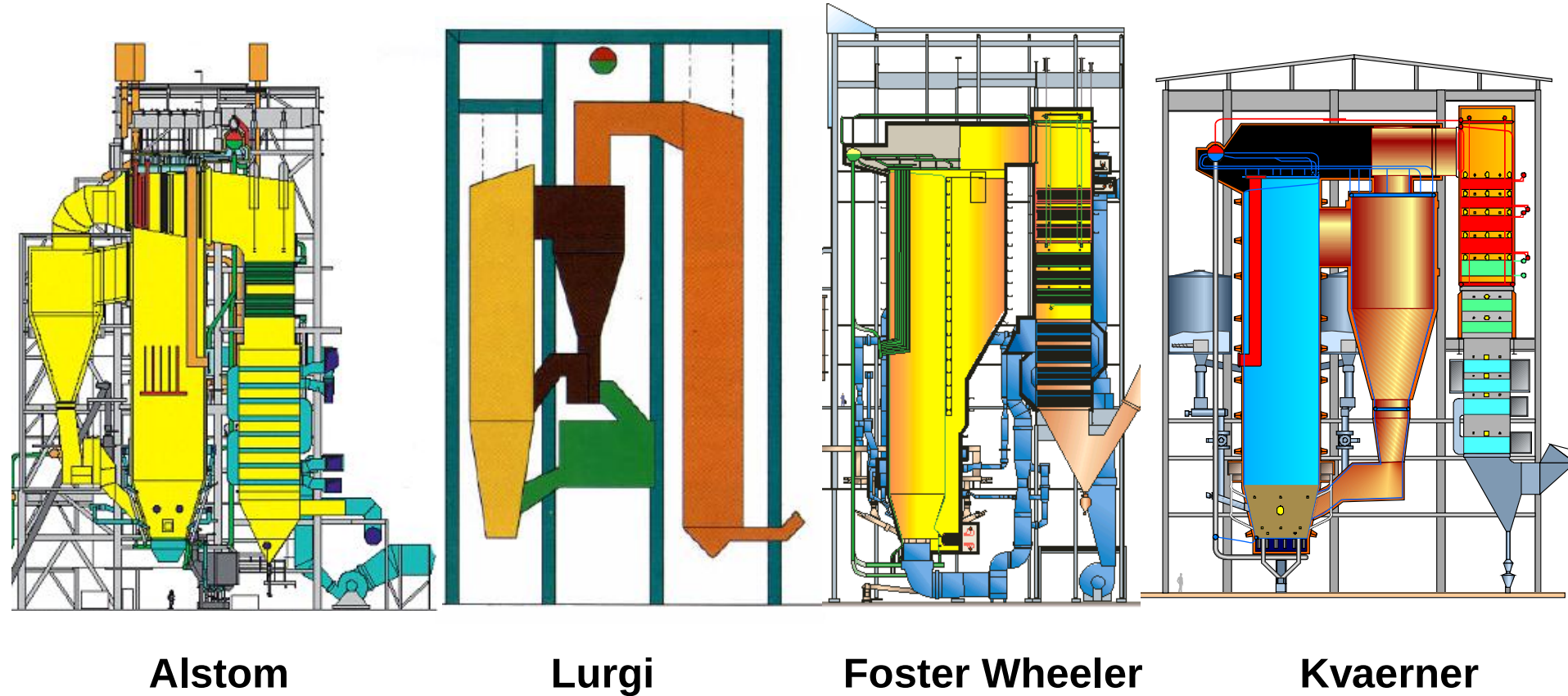
Waste and Biomass to Energy plant

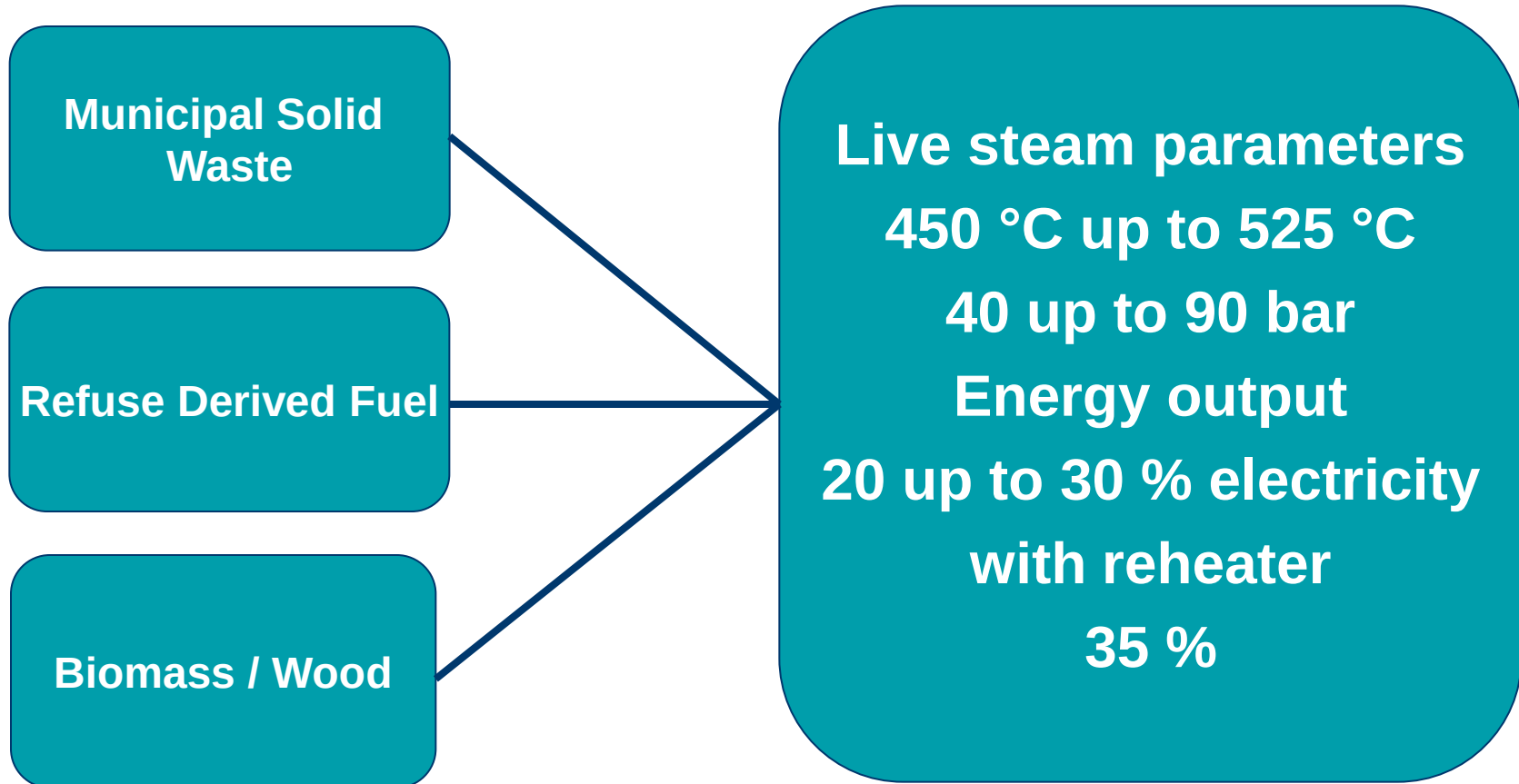
Operating pressure 90 bar
Operating steam temperature 500 °C
Steam mass flow 126,5 Mg/h



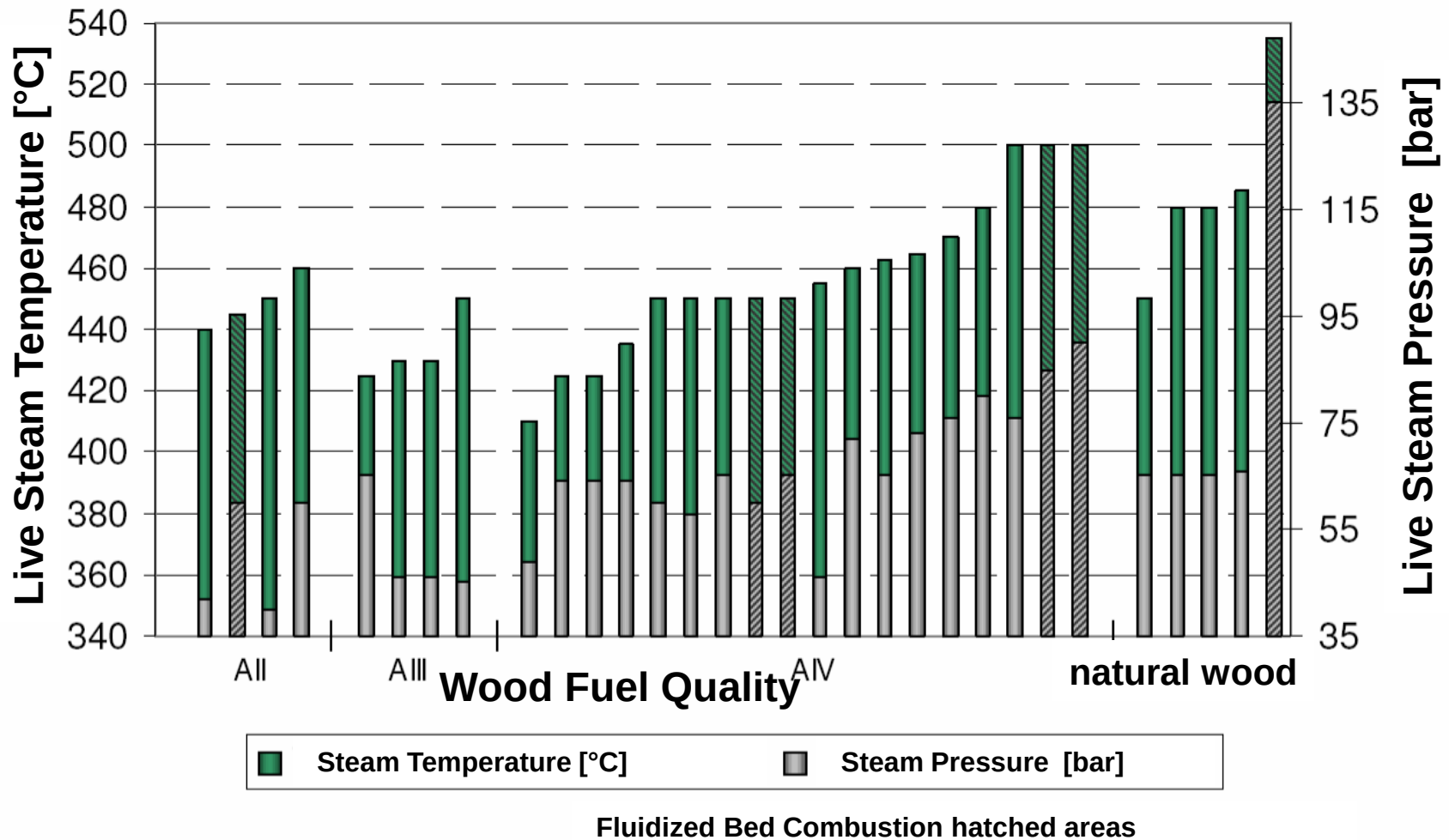


Comparison of CFBC Boiler Layout



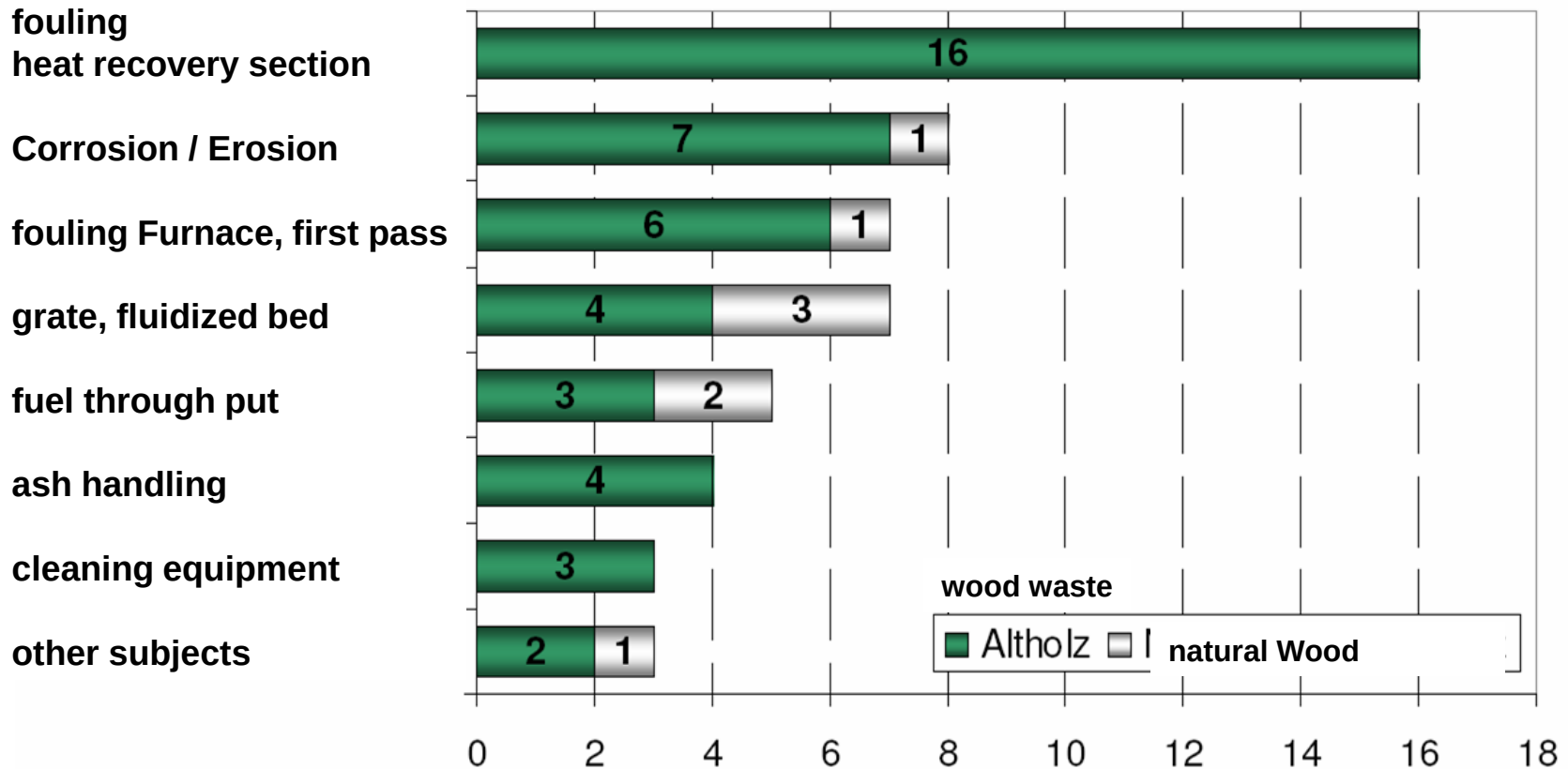


Main Steam Conditions and Fuel Quality



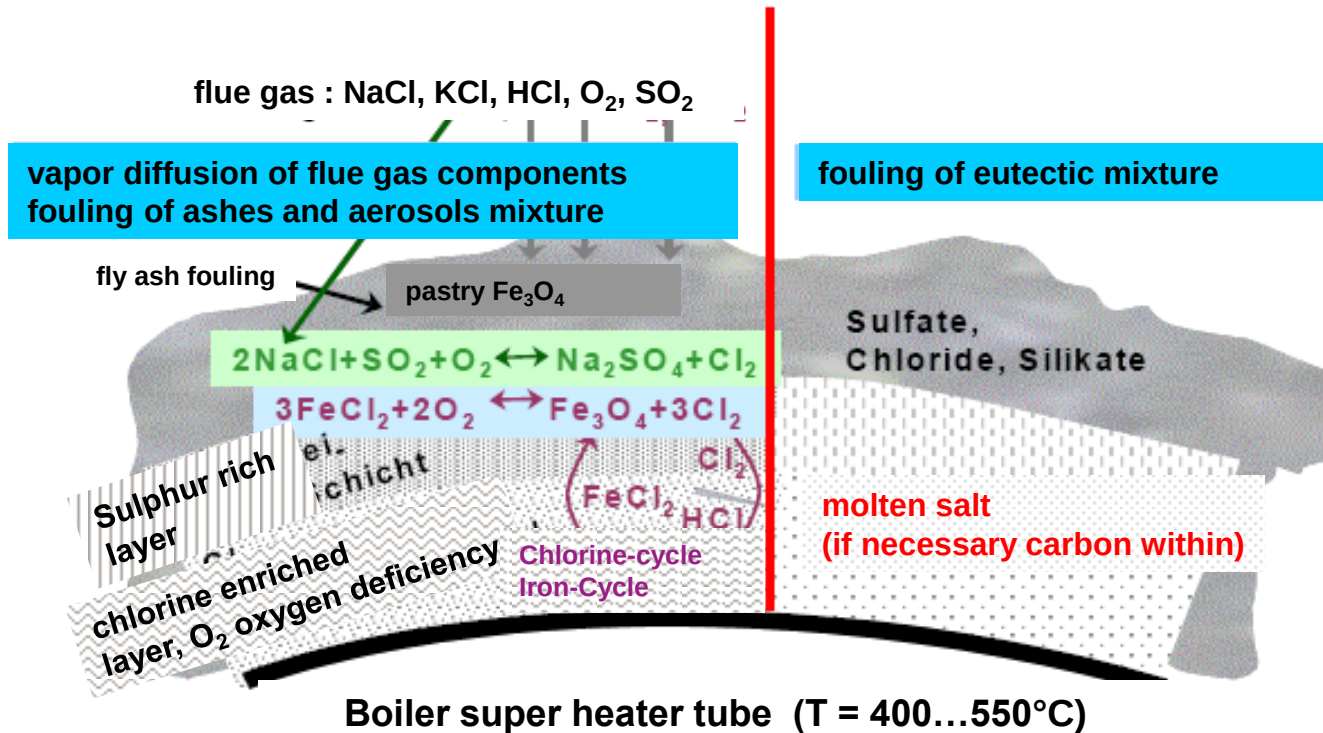
VGB Forschungsprojekt Nummer 302, Untersuchung von Biomasse- und Altholzheizkraftwerken im Leistungsbereich von 5 bis 20 MWel zur Verbesserung der Wirtschaftlichkeit (Teil I)

Reason for Stagnant Condition Periods



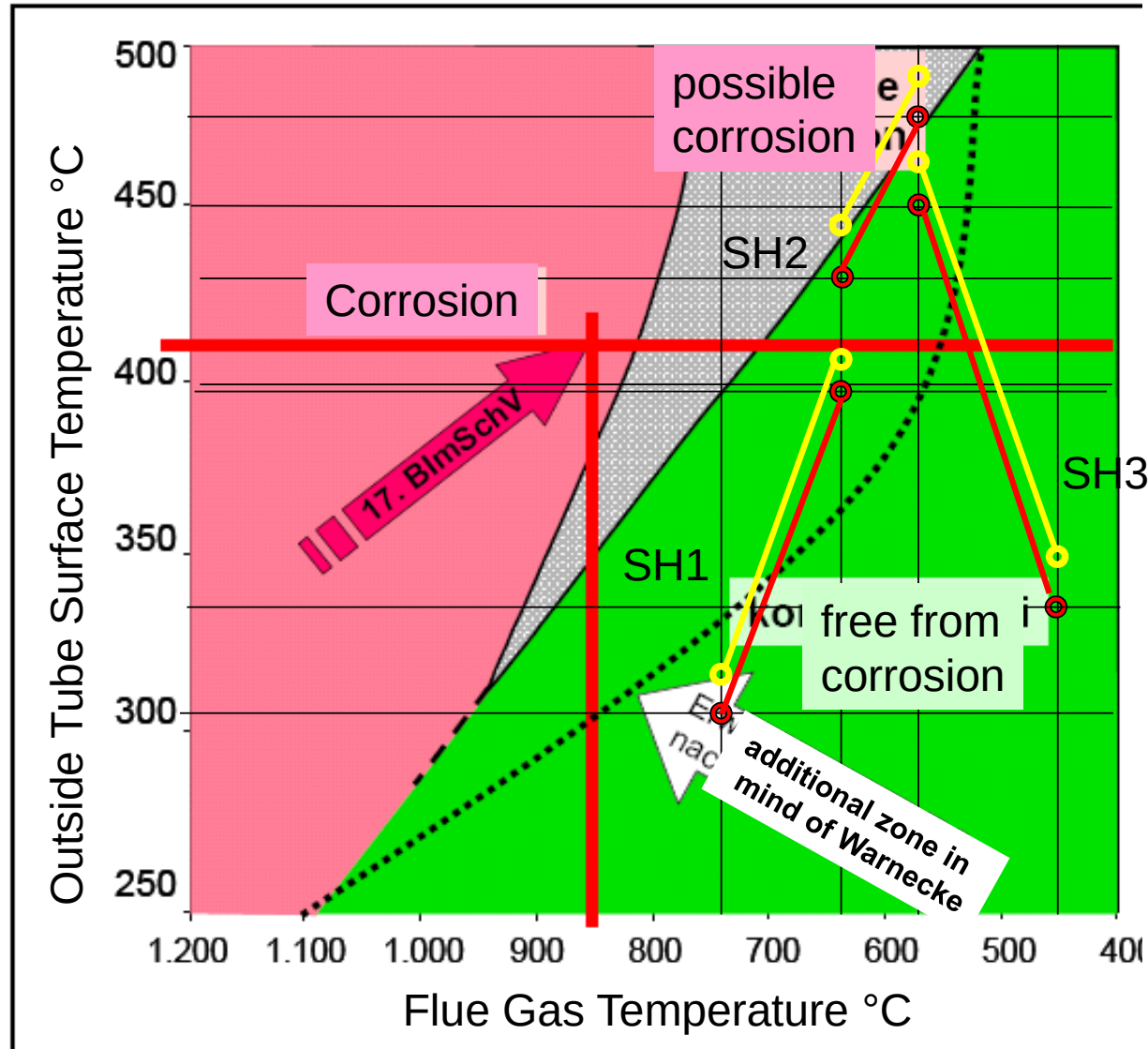
number of namings limitting continuous operating period

Chlorine Induced Active Oxidation Corrosion Mechanism



Modell der Korrosionsvorgänge unter Belägen [Born, 2004]

Corrosion Diagram Waste to Energy Plant



Fuel composition and fouling structure on boiler tube

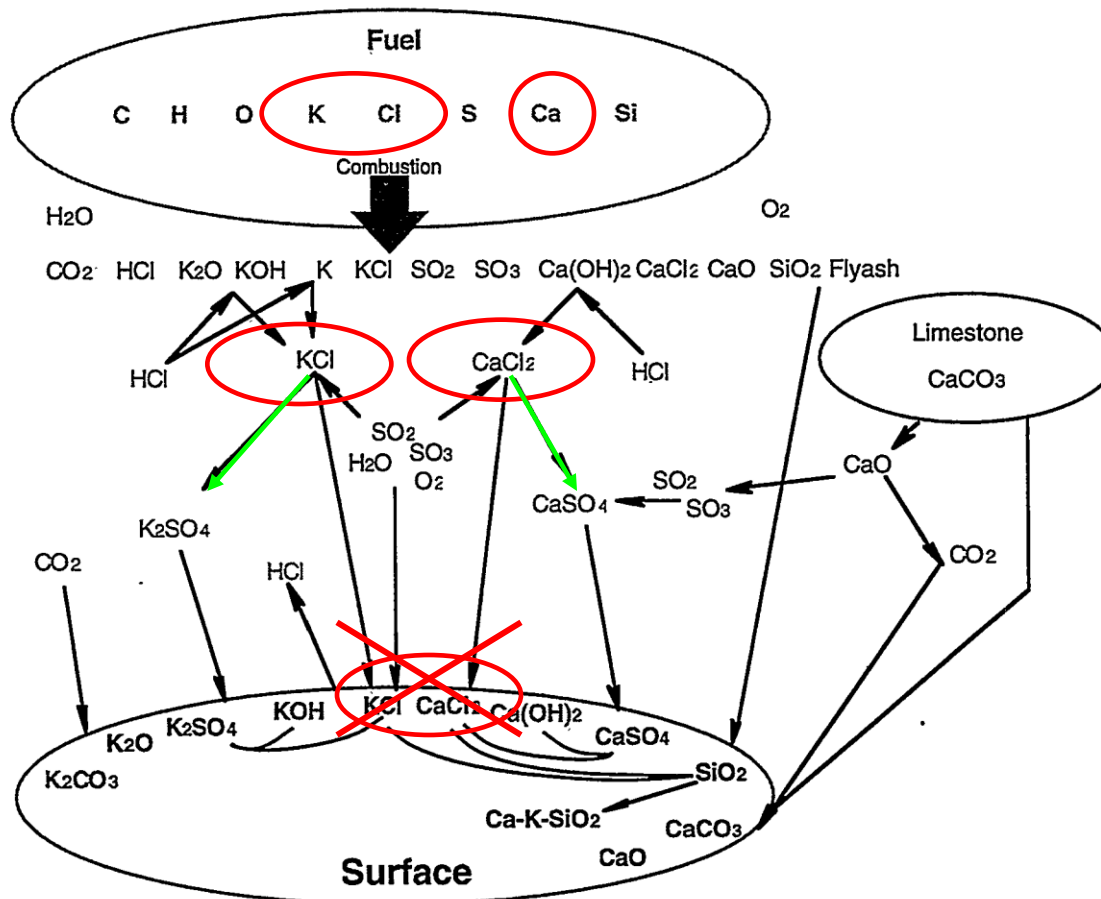
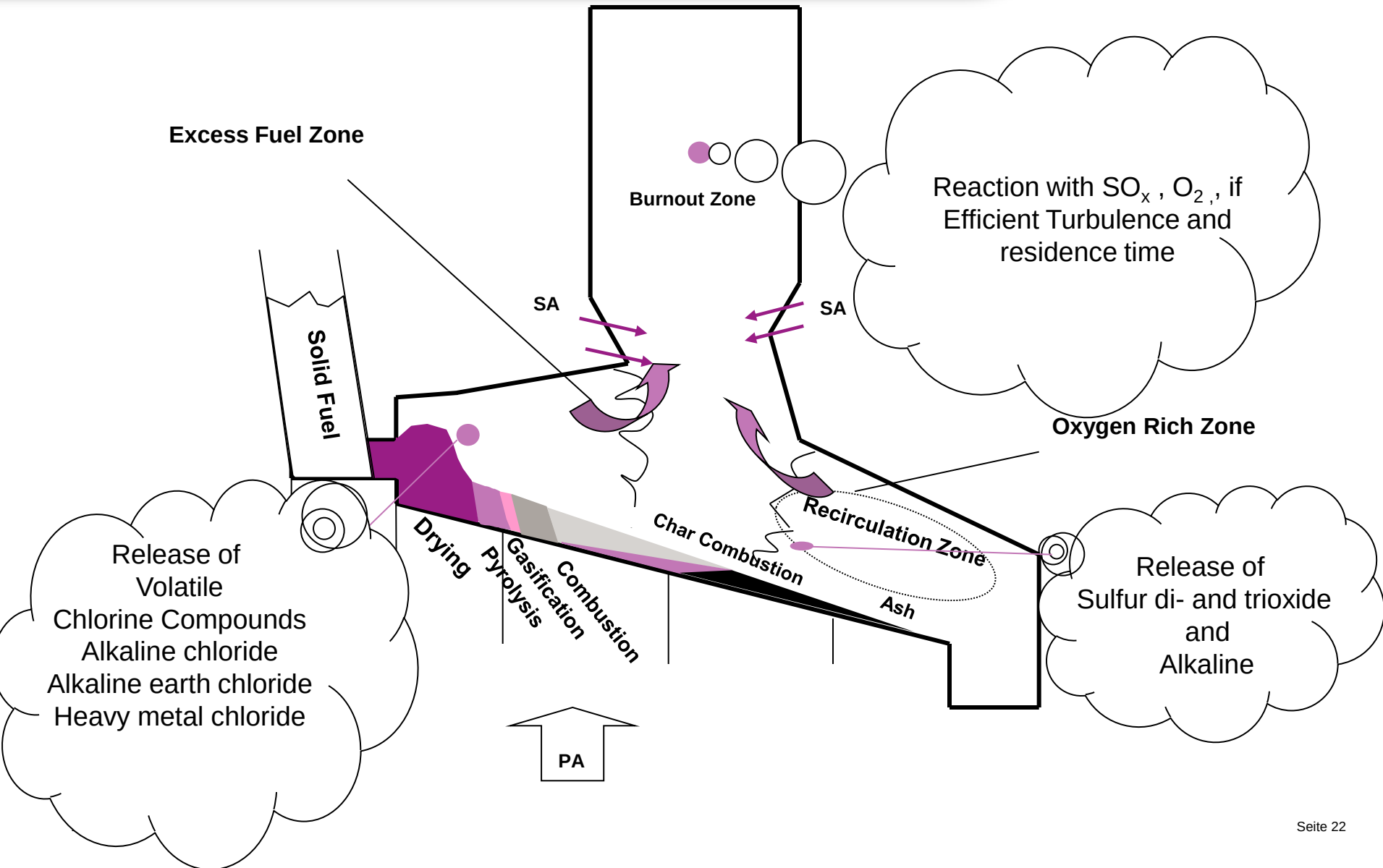


Figure 121 Simplified conceptual interactions among selected fouling elements in biomass.

Combustion Model

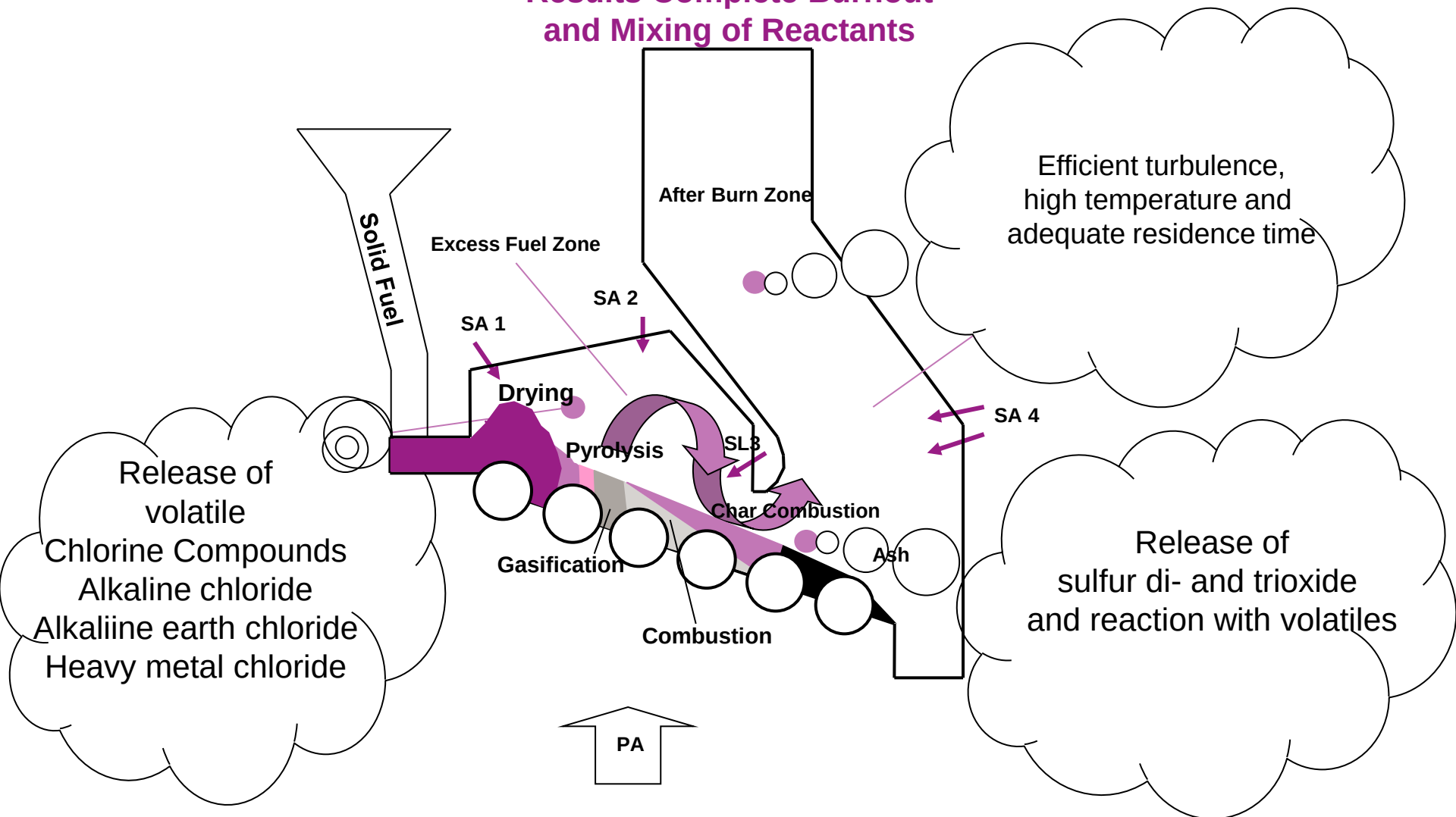
Centre Flow Combustion



Combustion Model

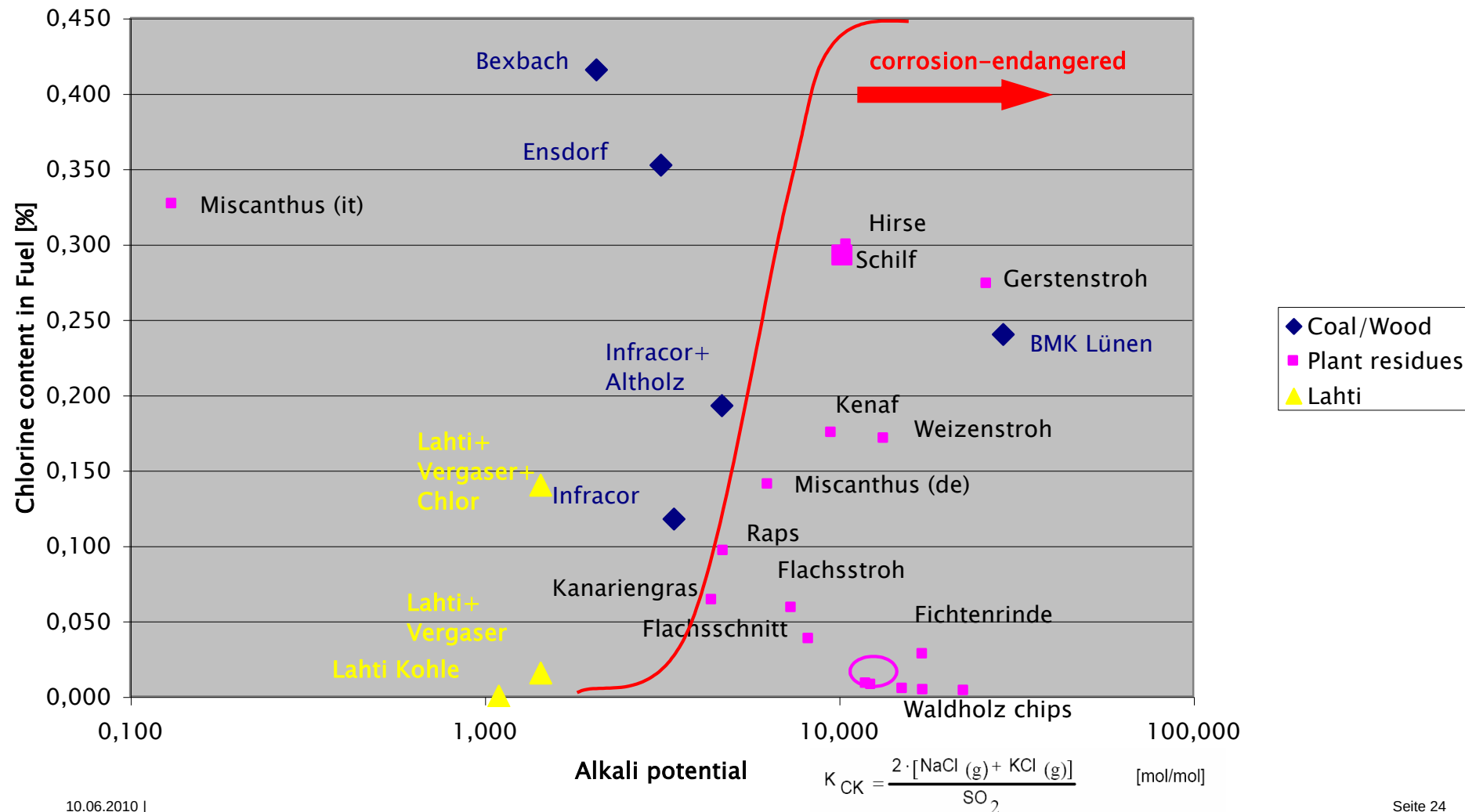
Parallel Flow Combustion

Results Complete Burnout and Mixing of Reactants



Alkali potential on fuel

Corrosions number II



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Waste to Energy

T.A. Lauta

Essential Plant Data

■ Waste throughput	Mg/a	225.000
■ Combustion units	unit's	2
■ Thermal heat throughput (per unit)	MW _{th}	37,5
■ Waste throughput (per unit)	Mg/h	15
■ Design calorific value (Hu)	MJ/kg	9,0
■ Calorific value range (Hu)	MJ/kg	7 - 12
■ Power output	MW _{el}	ca. 20
■ Plant power consumption	MW _{el}	ca. 4
■ Waste bunker capacity	m ³	ca. 11.000



The diagram illustrates the integrated process of a waste-to-energy plant. It begins with an **Unloading area** where waste is moved into a **Waste bunker**. From there, waste enters the **Boiler house**, which contains a boiler. The boiler is connected to a **Turbine** housed in a **Turbine house**, which drives a **Generator**. The turbine is cooled by an **Air-cooled condenser**. The boiler also produces **Steam**, which is sent to a **Steam gas heater** and then to a **DeNOx plant** before being released through a **Stack**. The boiler's output also goes through a **Dry Scrubber** and a **Fabric Filter** to remove particulates. The **Fabric Filter** is supplied with **Compressed air** and **Water**. The **Recirculation silo** stores **Reaction products** from the fabric filter, which are then sent to a **Residual silo for reaction products**. The **Activated coke filter** and **Activated coke milling** units are part of the waste-to-energy process, with the **Activated coke storage facility** providing the raw material. The **ID Fan** (Induced Draft Fan) is used to draw air through the system. The **Unit transformer** is connected to the generator to manage the plant's electrical output. The **Ash handling facility** manages the waste residue from the boiler.



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Current Projects

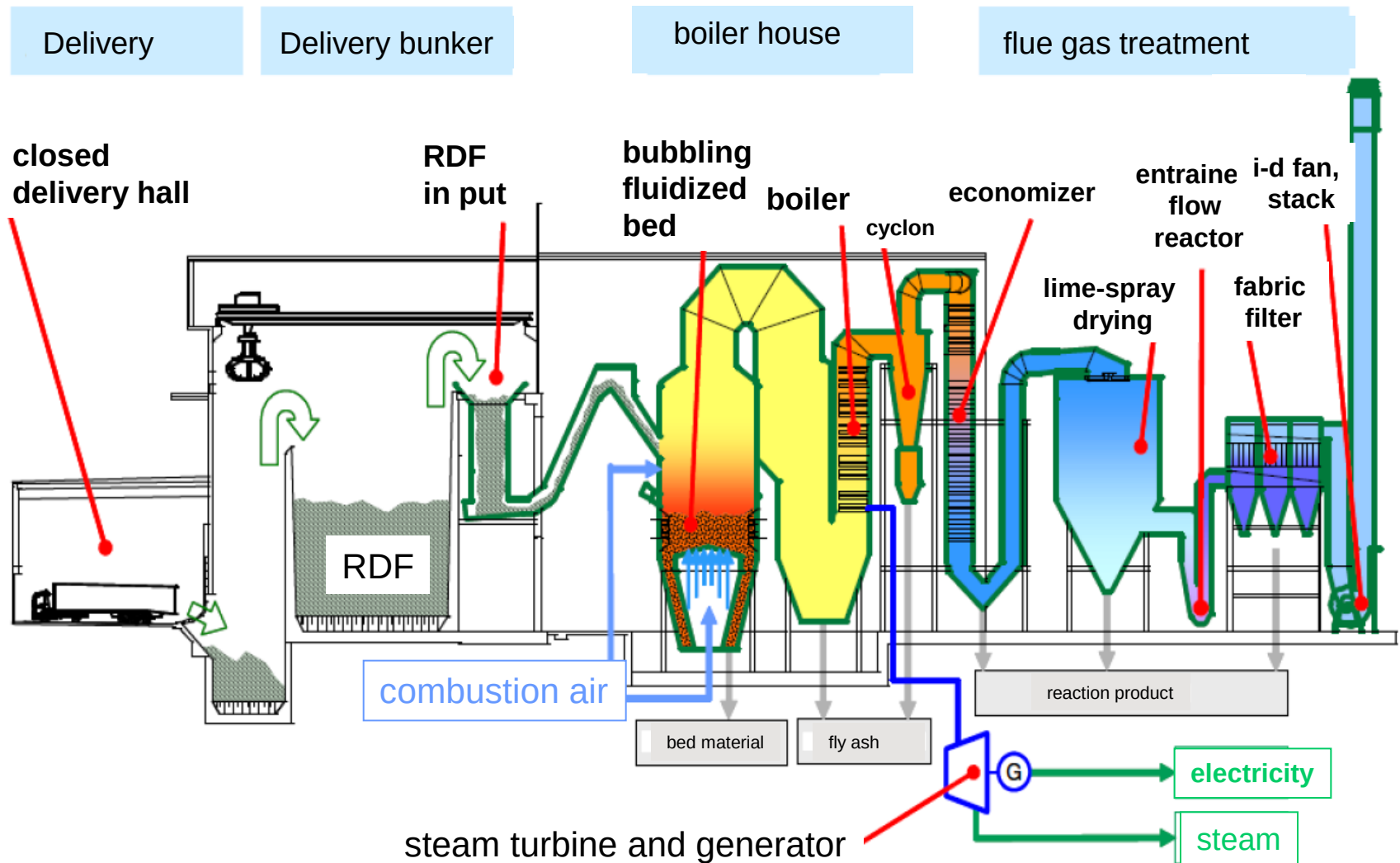
- Essential Waste to Energy Projects
- Refuse Derived Fuels (RDF) to Energy
- Biomass to Energy

RDF to Energy, EVA Höchst, Infraserv Frankfurt

- Industriepark Höchst, Frankfurt
Site for chemicals, pharmaceuticals and biotechnology
- RDF-ICFB Combustion with capacity of 700.000 t/a
- 3 times 94 MW (thermal)
- 80 MW (electricity)
- Japanese EPC
- trial operation
at present

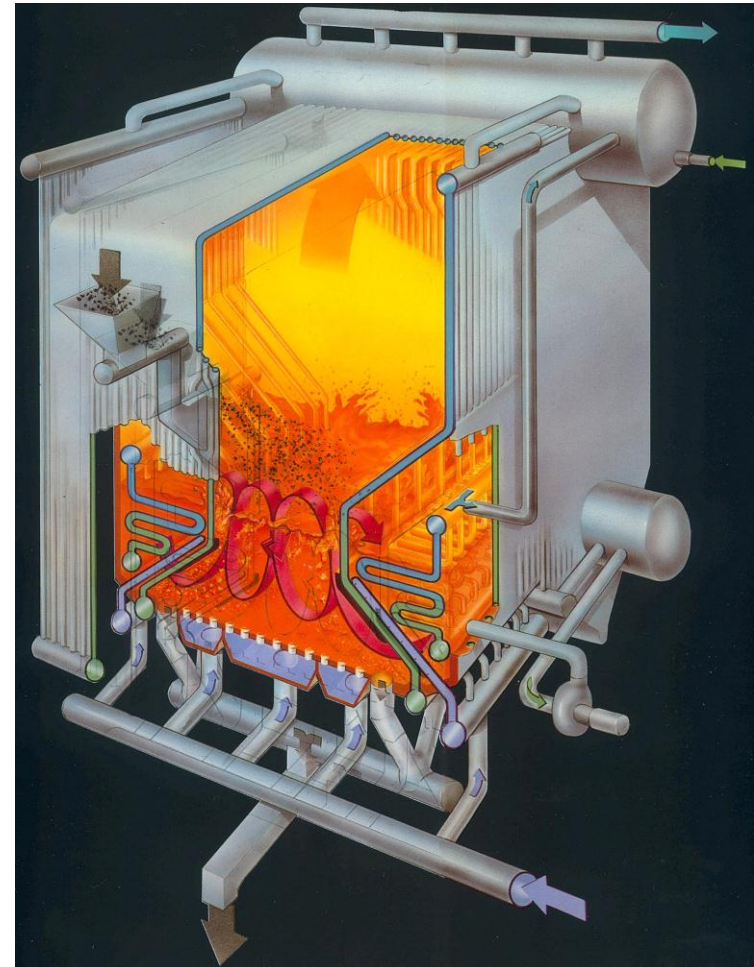


RDF / Waste Utilisation Infraserv Frankfurt



ICFB Combustion of Refuse derived fuel; Infraseriv Frankfurt

- Internal Circulating Fluidised Bed Combustion with Combustion inside the Boiler
- Stable Technology – without moving parts inside the Furnace
- wide range in respect of calorific value of fuel and waste
- Efficient in-bed heat-transfer
- Recycling of metals like iron, steel and non-ferrous metals



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- **Biomass to Energy**

STEAG New Energies

Biomass to Energy Plants

Plant	Start up	Wood Fuel	Through put (Mg/a)	Power out put (MW _{el})	District heating out put (MW _{th})
Großaitingen	2002	A I - A III	45.000	5	-
Buchenbach	2002	AI – AII	30.000	1,2	3,3
Neufahrn	2003	A I - A III	45.000	5,3	10
Werl	2003	A I - A II	10.000	0,48	3,3
Buchen	2004	A I - A IV	60.000	7,1	10
Dresden	2004	A I - A IV	55.000	7,1	10
Neuwied	2004	A I - A IV	65.000	7,6	18
Traunreut	2004	A I - A III	50.000	5	11
Ilmenau	2005	A I - A III	45.000	5,3	10
Lünen	2006	A I - A IV	140.000	20	-
Warndt	2009	Forest wood	40.000	1,8	8
Total amount	-	A I - A IV	595.000	66	84

- **Grain Size Distribution:**

High fuel fines increased fouling; risk of fuel segregation

- **Ash and Minerals:**

All-important for abrasion of mechanical handling equipment, for high disposal cost and for high corrosion potential

- **Chlorine Content:**

Risk of high temperature Chlorine corrosion; low ash softening temperature

- **Calorific Value:**

Define the fuel amount and fuel cost

- **Air distribution and burn out phase:**

Variable fuel will have variably burn out and different air distribution must be possible

Summary

Waste to Energy and Renewable Energies

- Energy from waste and biomass is state of the art, but technology of biomass to energy plants has to adapt to the different fuel qualities.
- Energy contracting and delivery for industry and real estate helps to environmental relief and reduction in energy costs.
- Fuel with different qualities leads, depending on fuel treatment extent and chemical composition, make changes at combustion system necessary.
- Control and regulate of the combustion and air distribution must be possible.
- High performance factors together with high plant availability rate shall be noted .



Take advantage of the potential of an interdisciplinary engineering company

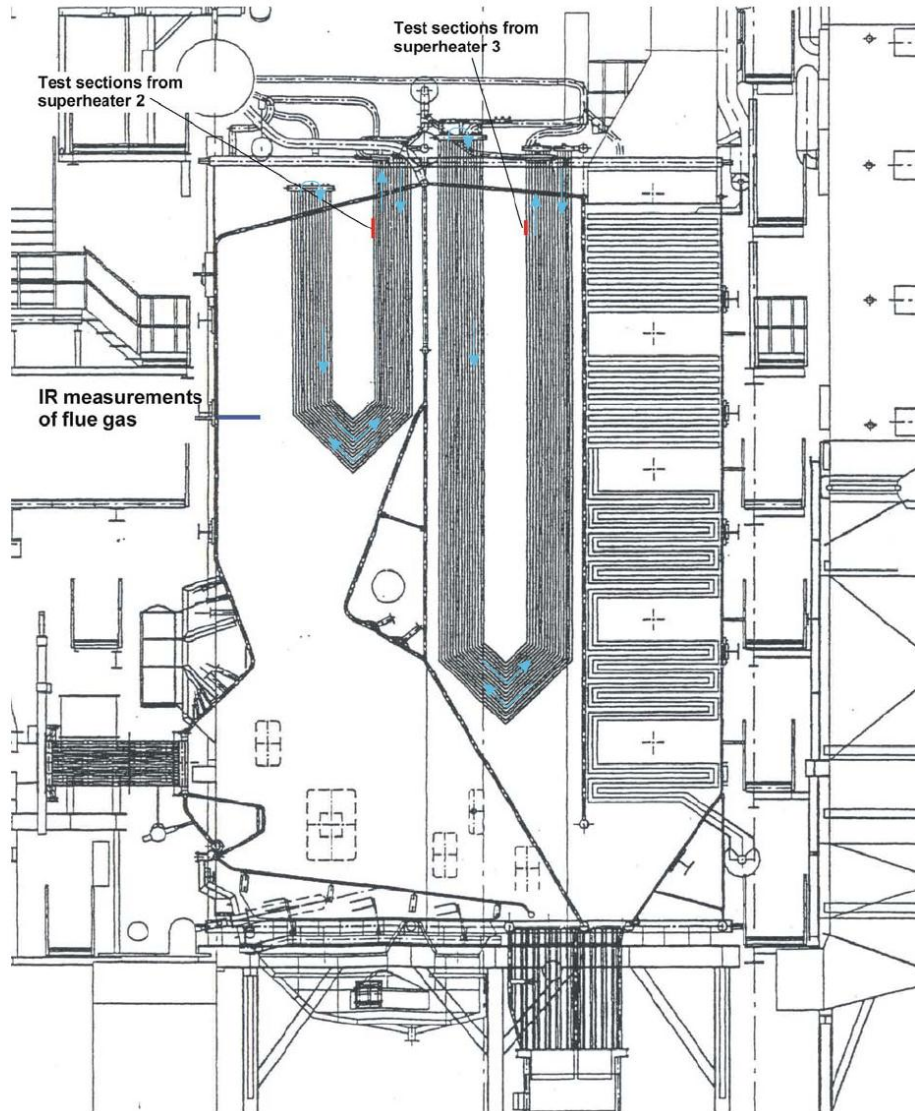


STEAG Group specializes in the engineering and O&M management of waste and biomass plants, focusing on thermal energy generation facilities for municipal solid wastes, biomass, refuse-derived fuels and energy sources of the future.

- Project Development
- Project Planning and Engineering
- Permitting Management
- Project Management
- Site Supervision / Commissioning
- Plant Operation
- Plant Optimization

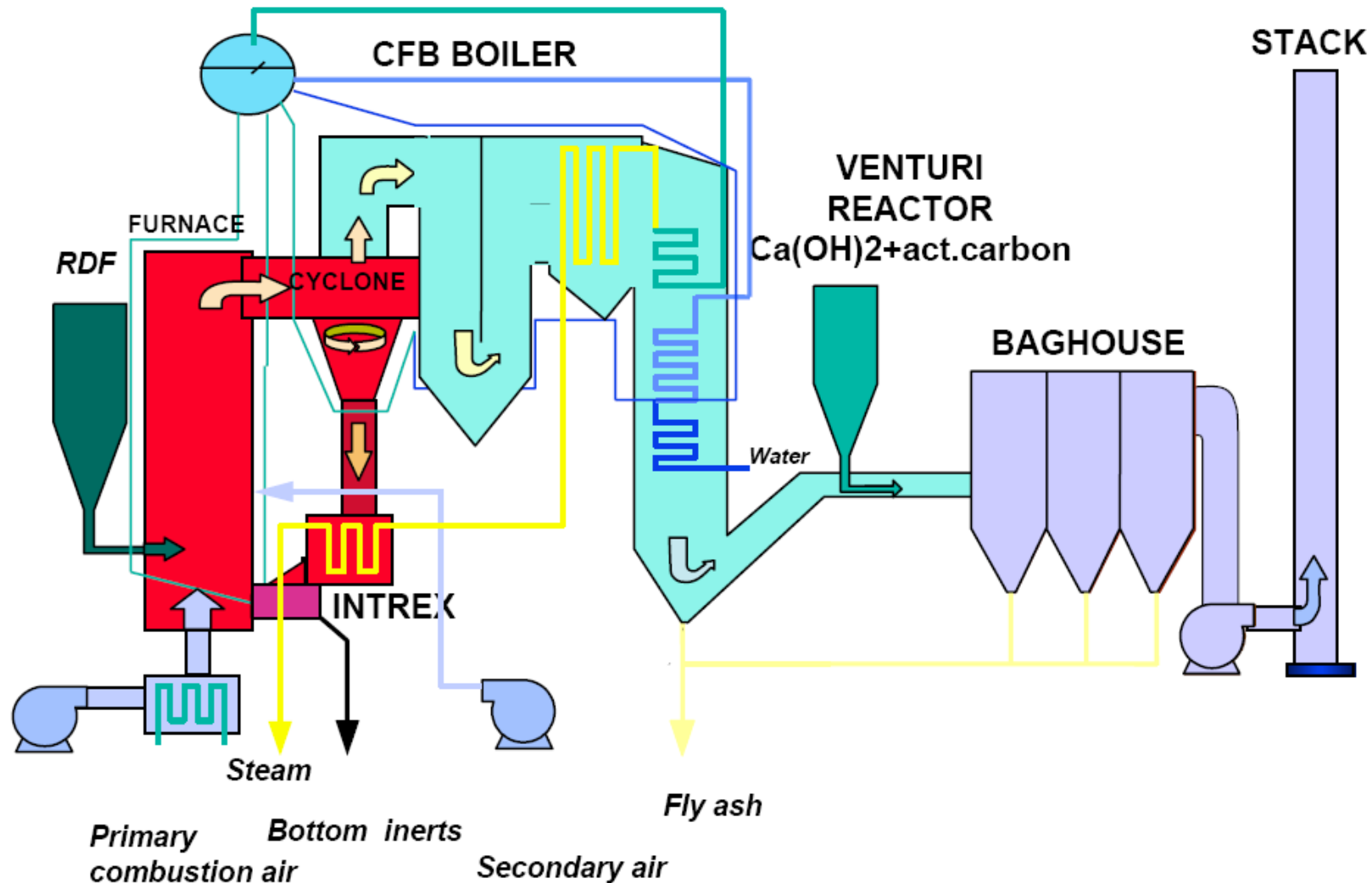
stead

Specific Boiler Design Super Heater at high Flue Gas Zone

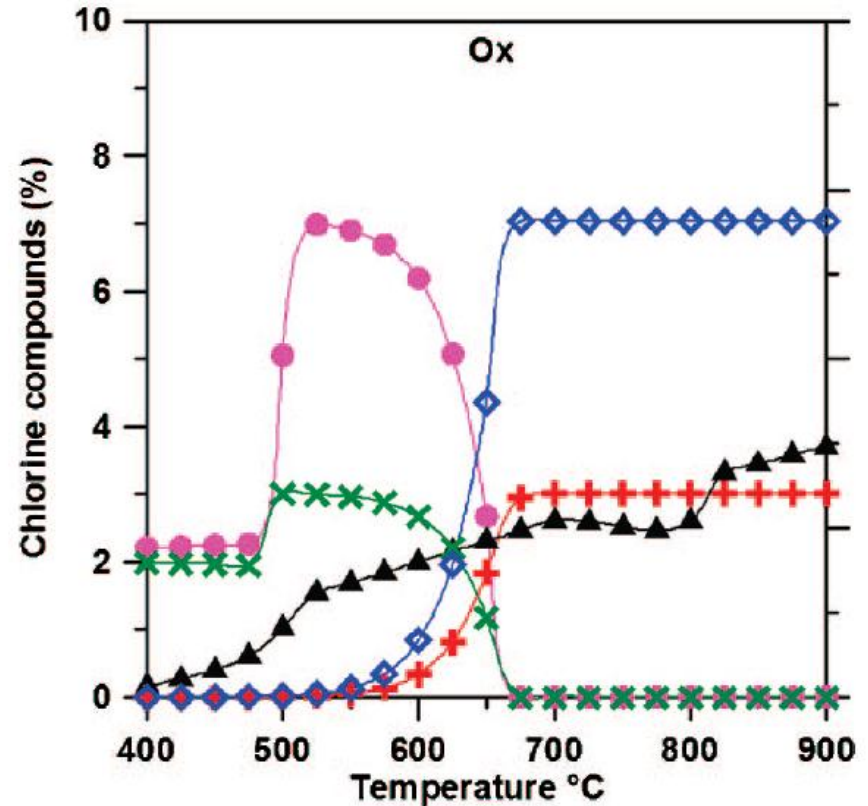
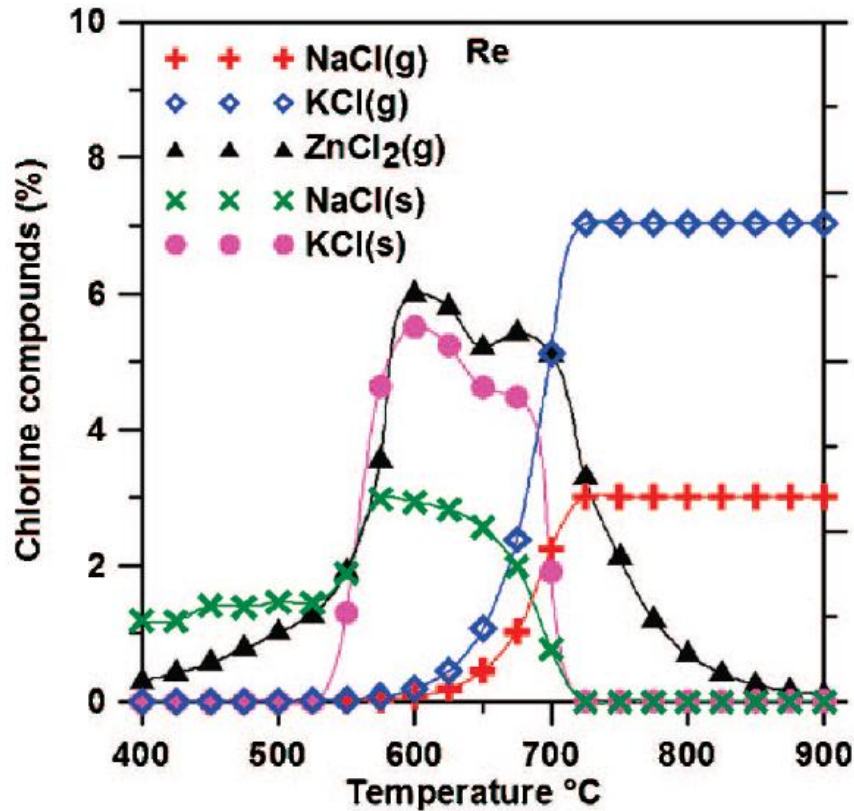


Schematic diagram of Maribo Sakskøbing CHP Plant showing position of superheater sections investigated. The arrows show the flow for the banks 2-7 in superheaters 2 and 3.

RDF and Biomass to Energy Plants



Chemistry of Potassium, Sodium, Zinc and Chlorine

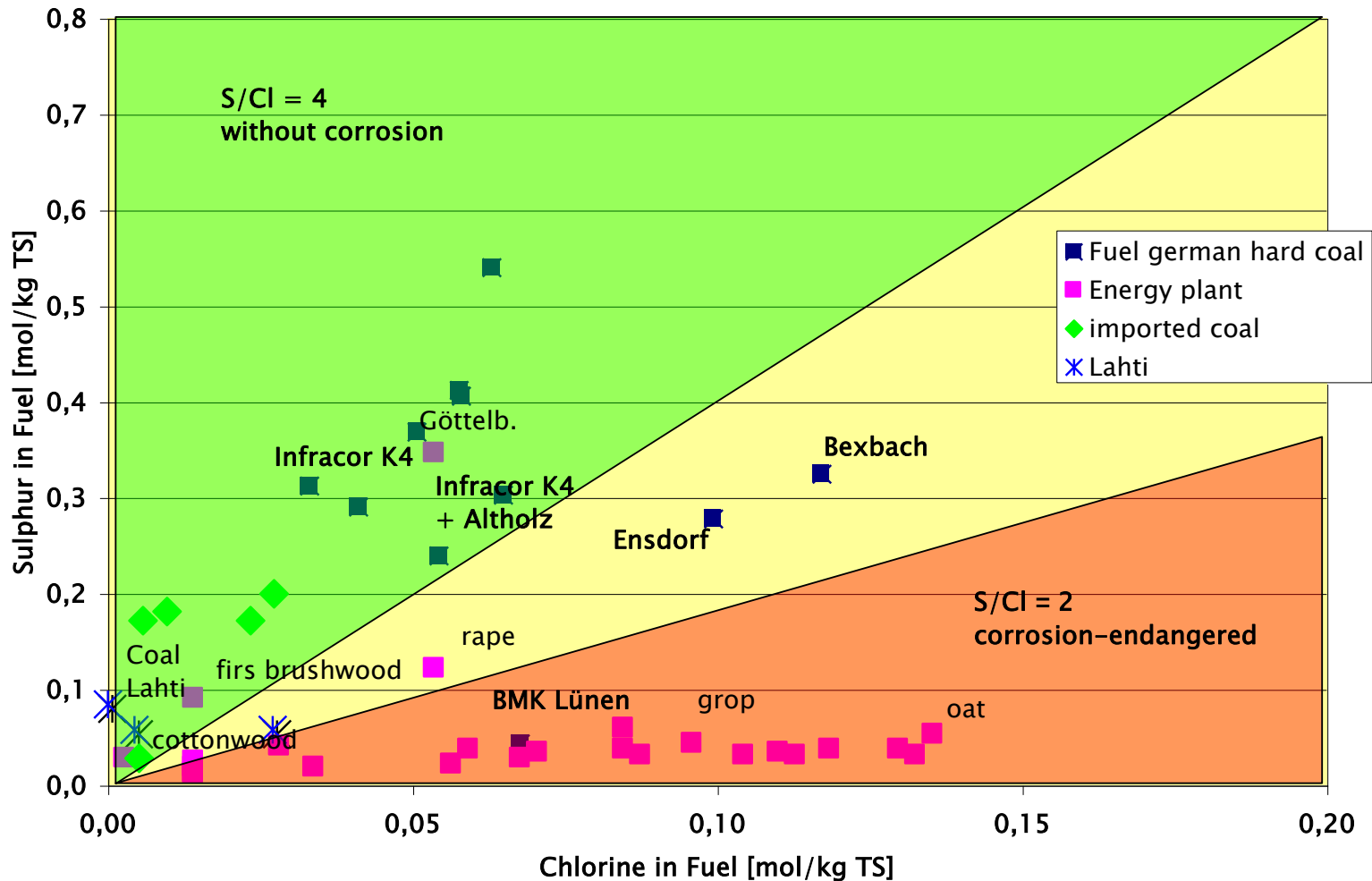


Chlorine compounds at reducing and oxidizing conditions for the case Cl/Zn = 11. Remaining chlorine (80%–90%) was found in the flue gas mainly as hydrogen chloride.

When chlorine is present at lower concentrations than potassium, it reacts with potassium and forms solid potassium chloride which starts to volatilize at 500 °C. At 700 °C potassium chloride is completely volatilized and present in the flue gas.

Sulfur / Chlorine ratio

Corrosion number S/Cl Ratio



Waste to Energy

Essential Waste to Energy Plants of STEAG-Group
with participation in build, finance and operation management

Plant	Start up	Through put (Mg/a)	Performance STEAG-Group
RZR Herten	1982	250.000 ⁽¹⁾ 60.000 ⁽²⁾	design, operation
MHKW Burgkirchen	1994	200.000	design, operation
AVA Augsburg	1994	220.000	design, build, operation, finance
AEZ Kreis Wesel	1997	250.000	design, build, operation, finance
AVA Velsen	1997	210.000	operation
MHKW Pirmasens	1998	170.000	design, build, operation, finance
AHKW Neunkirchen (Neubau)	2001	120.000	design, build, operation, finance
MVA Madeira	2002	130.000	operation
T.A. Lauta	2004	225.000	design, build, operation, finance
TREA Breisgau	2005	150.000	design, build, operation, finance

(1) municipal solid waste (2) hazardous waste

Waste derive wood fraction

