Combustion of SRF: Technological Options and Operational Experience

Kai Keldenich
Dublin 20. October 2011

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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

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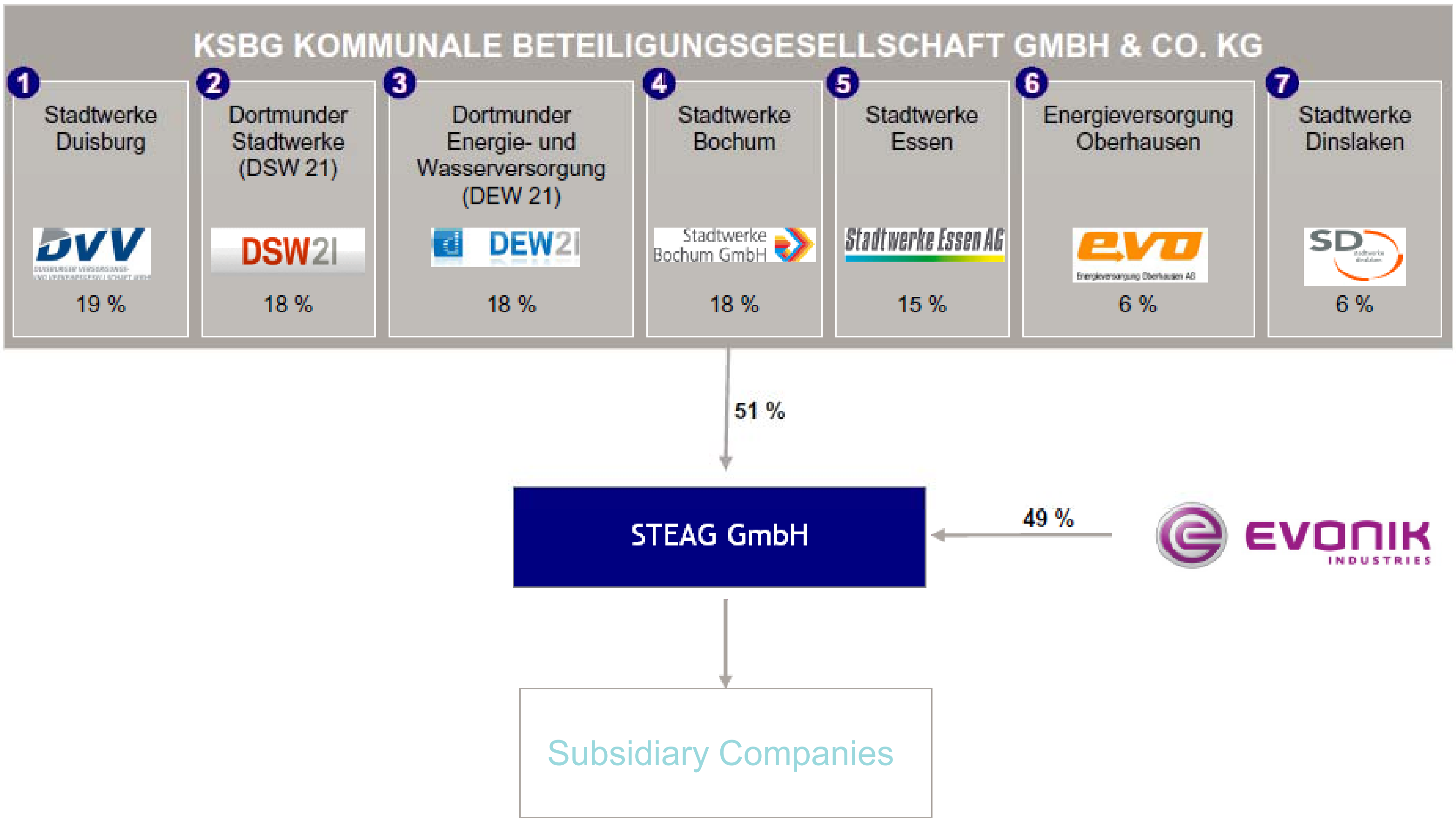
Municipal Holding Company KSBG GmbH

Municipal Utilities



STEAG – Operations full of energy

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Planning – operation – supply – marketing – recycling

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

… in Germany and …

… abroad

… on the basis of fossil…

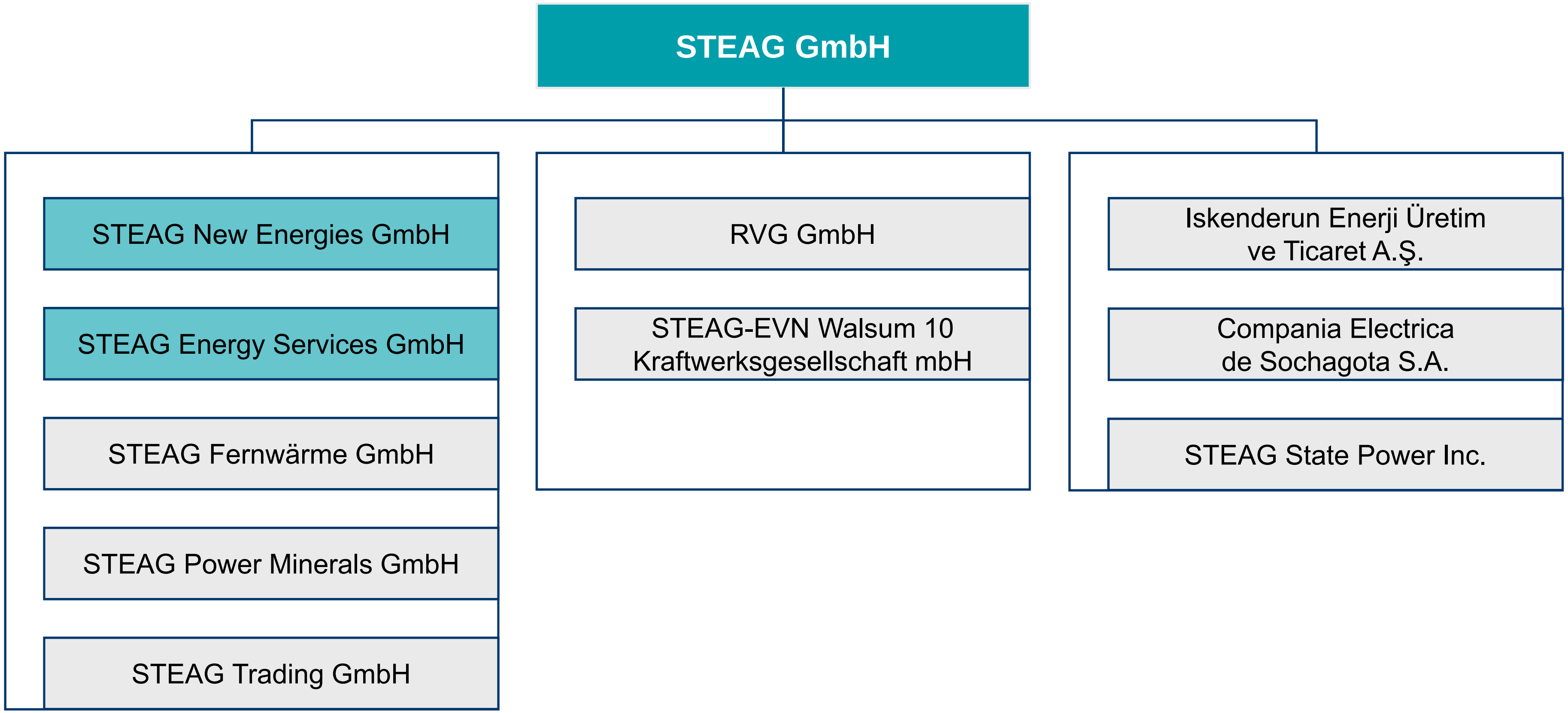
… and renewable energy sources.

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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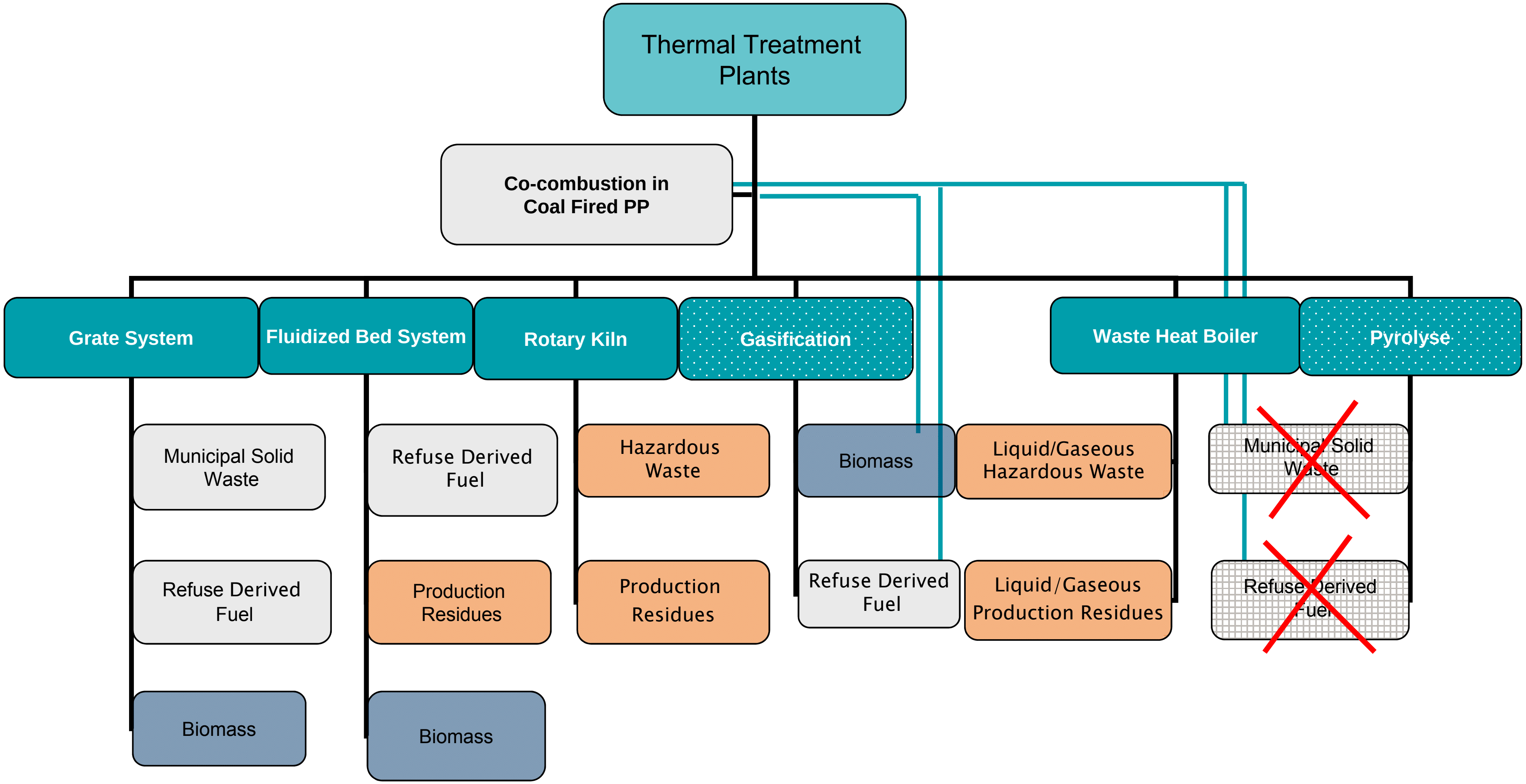
Thermal Treatment and Combustion Technologies



Co-combustion in Coal Fired PP

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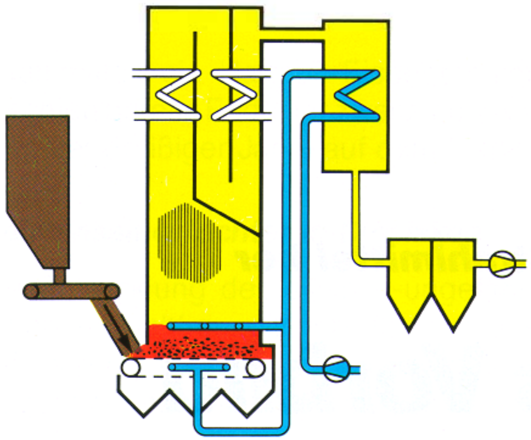
- Power plants in theory have had high throughput capacity of 40 Mio t/a at max. 25% of thermal heat capacity (THC)
- Co-combustion of
  - Sewage sludge
  - Production residues
  - Pet coke (= „design fuel“)
  - Meat and bone meal (decreasing)
  - Refuse Derived Fuel (RDF)
  - Solid Recovered Fuel (SRF)
  - Biomass and Wood
- In reality only 3 to 10 % of the thermal heat capacity will 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



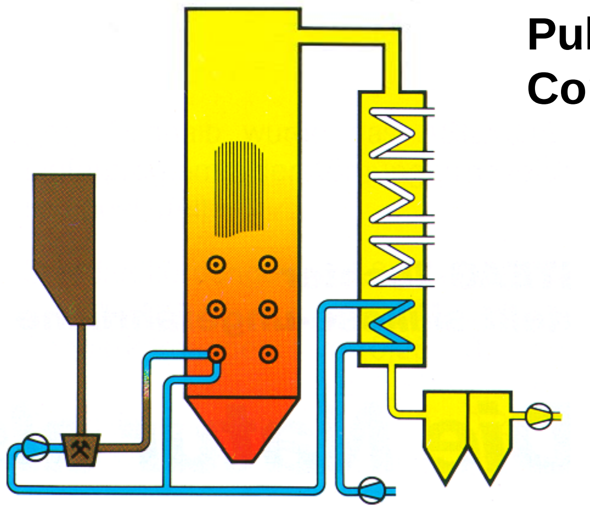


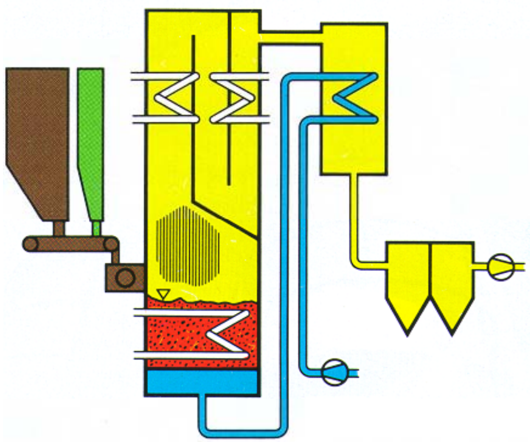
Furnace Types

Grate Stoker

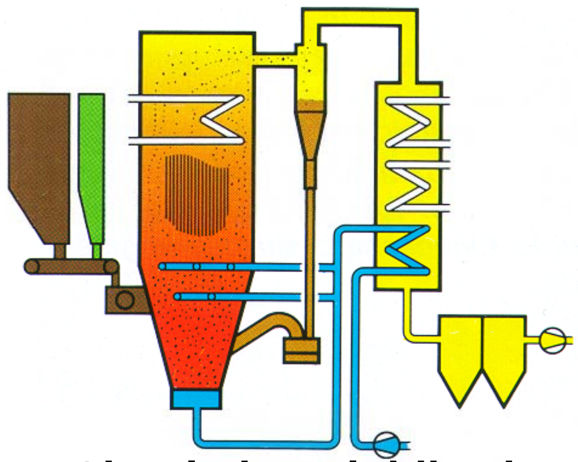


Pulverized Coal Combustion





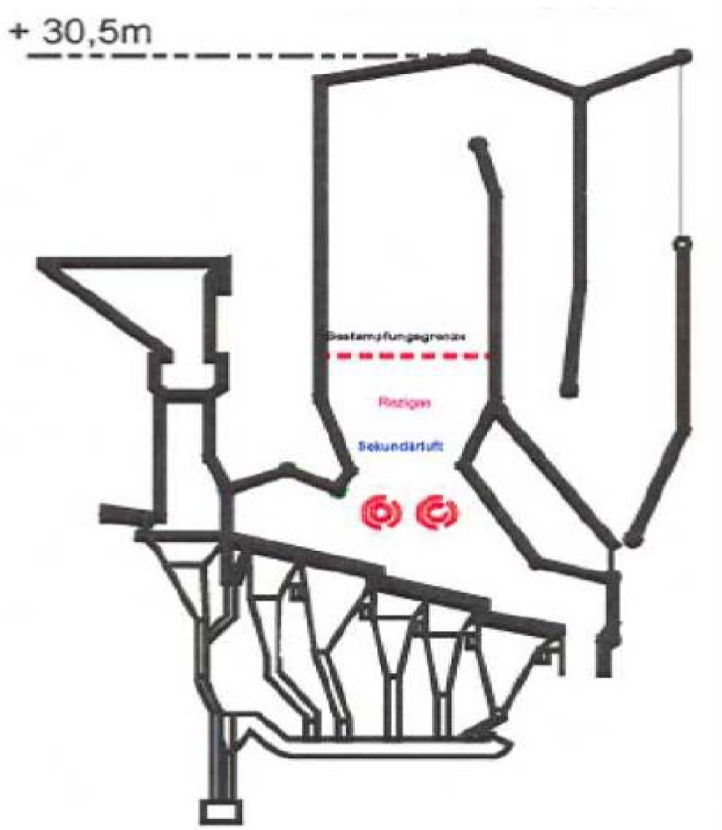
Stationary Fluidized Bed Combustion



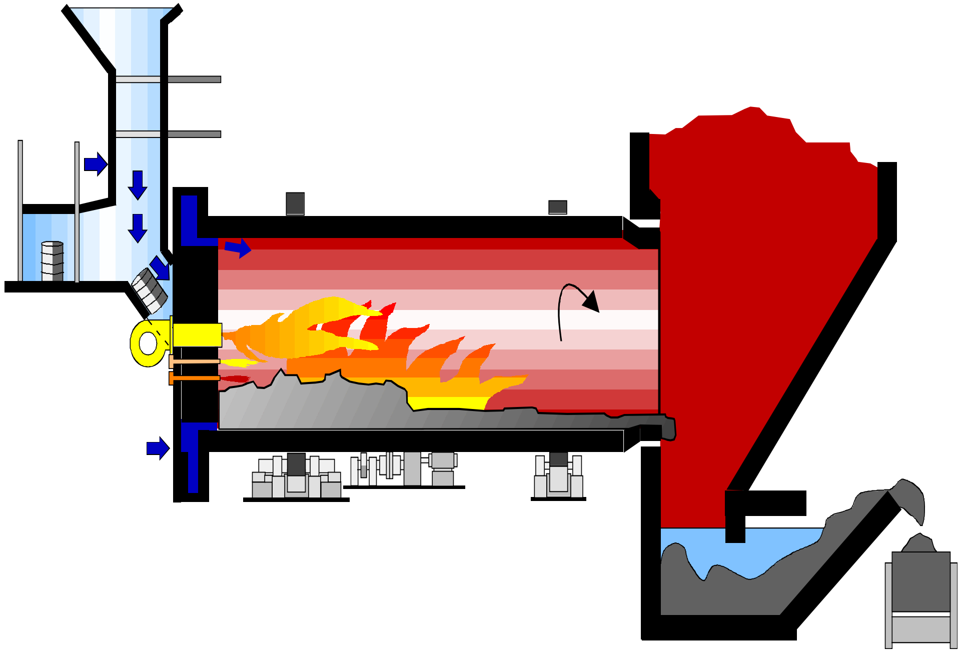
Circulating Fluidized Bed Combustion

Furnace Types / Special Typ

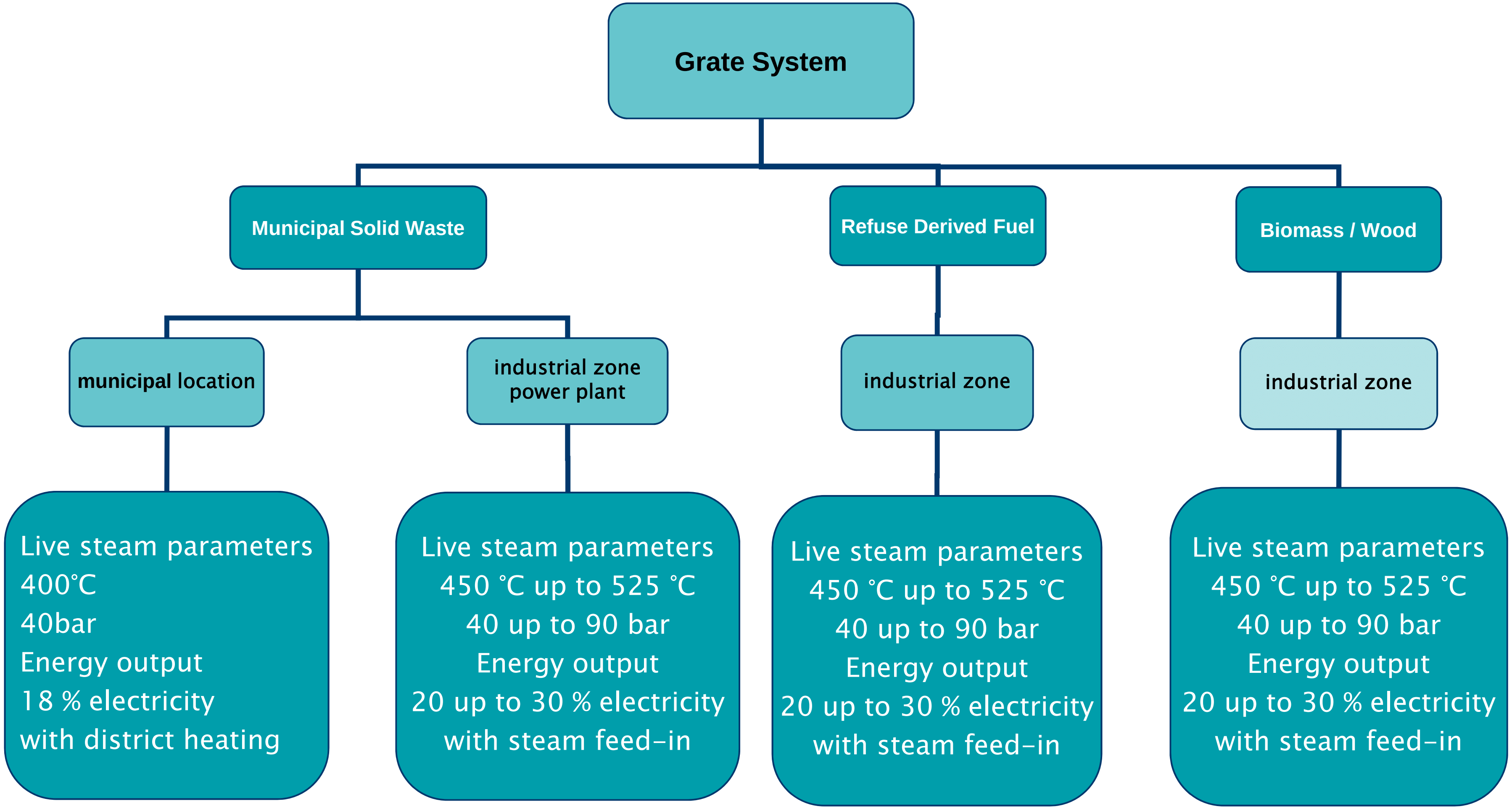
Air-cooled / Water-cooled
Moving Grate Combustion



Hazardous Waste
Rotary Kiln



Boiler Technology



Municipal Waste Incineration Plants with Moving Grate through put : 20 Mg/h at appx. 52,1 MW_{th}

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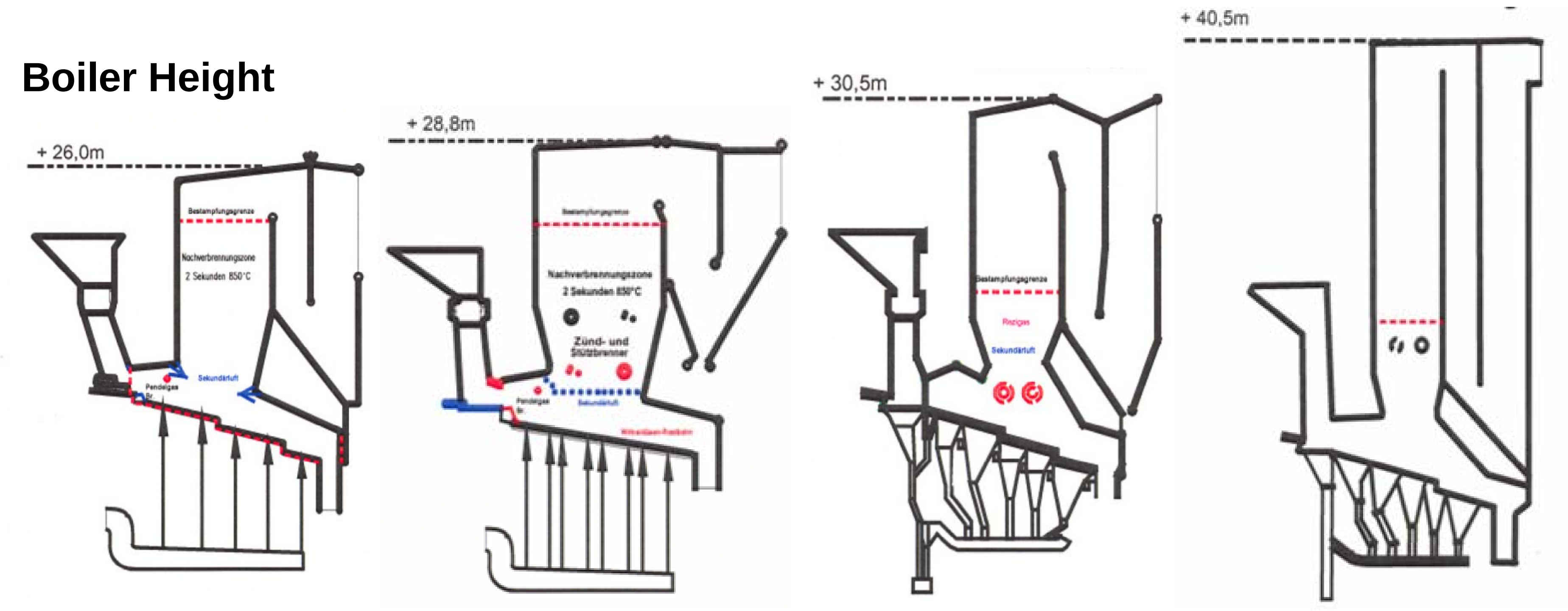
1980 | 1990 | 1995 | 2000



Grate Width 5 m | Grate Width 4,4 m | Grate Width 6,3 m | Grate Width 6,3 m

Quelle: EuPla 2000

Grate Typ
Waste and Biomass to Energy plant

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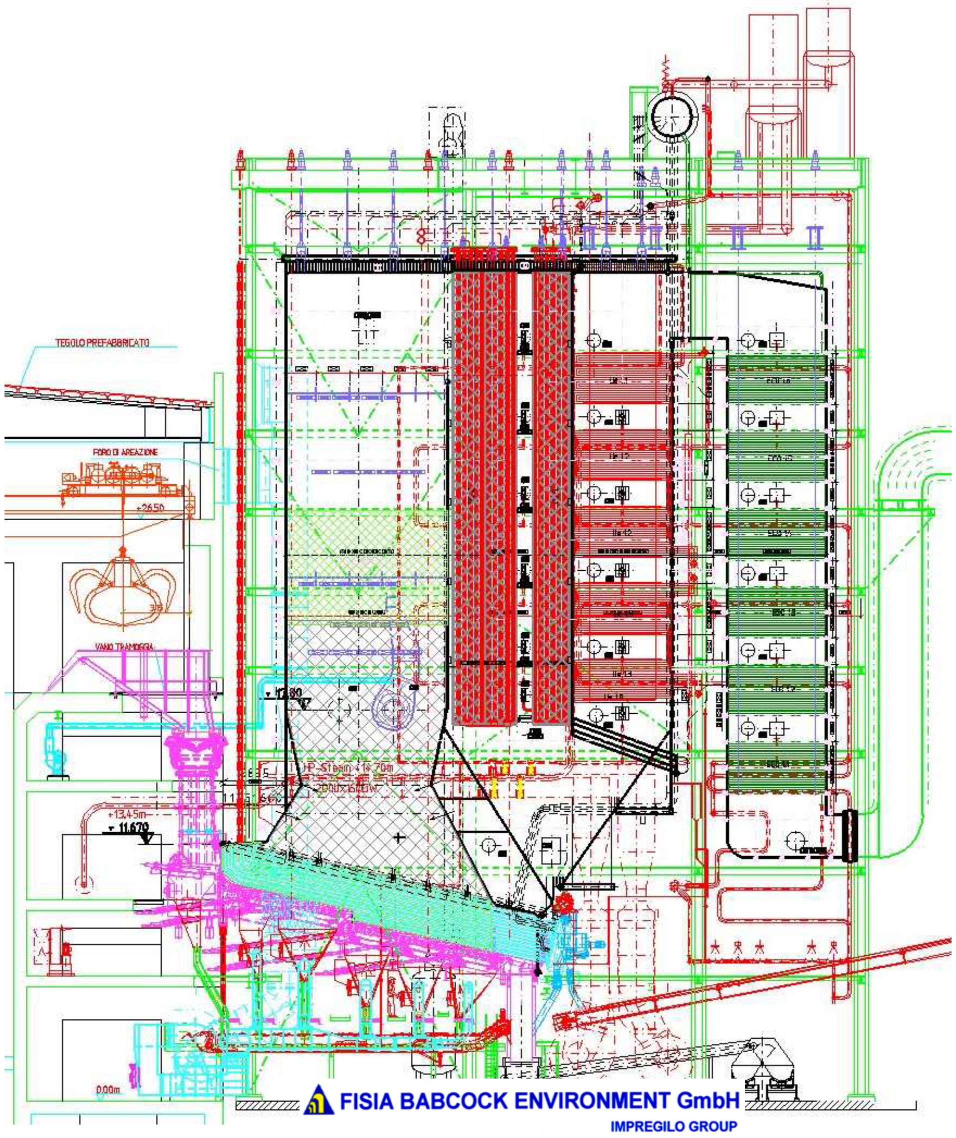
Operating pressure	90 bar
Operating steam temperature	500 °C
Steam mass flow	126,5 Mg/h



Boiler Technology

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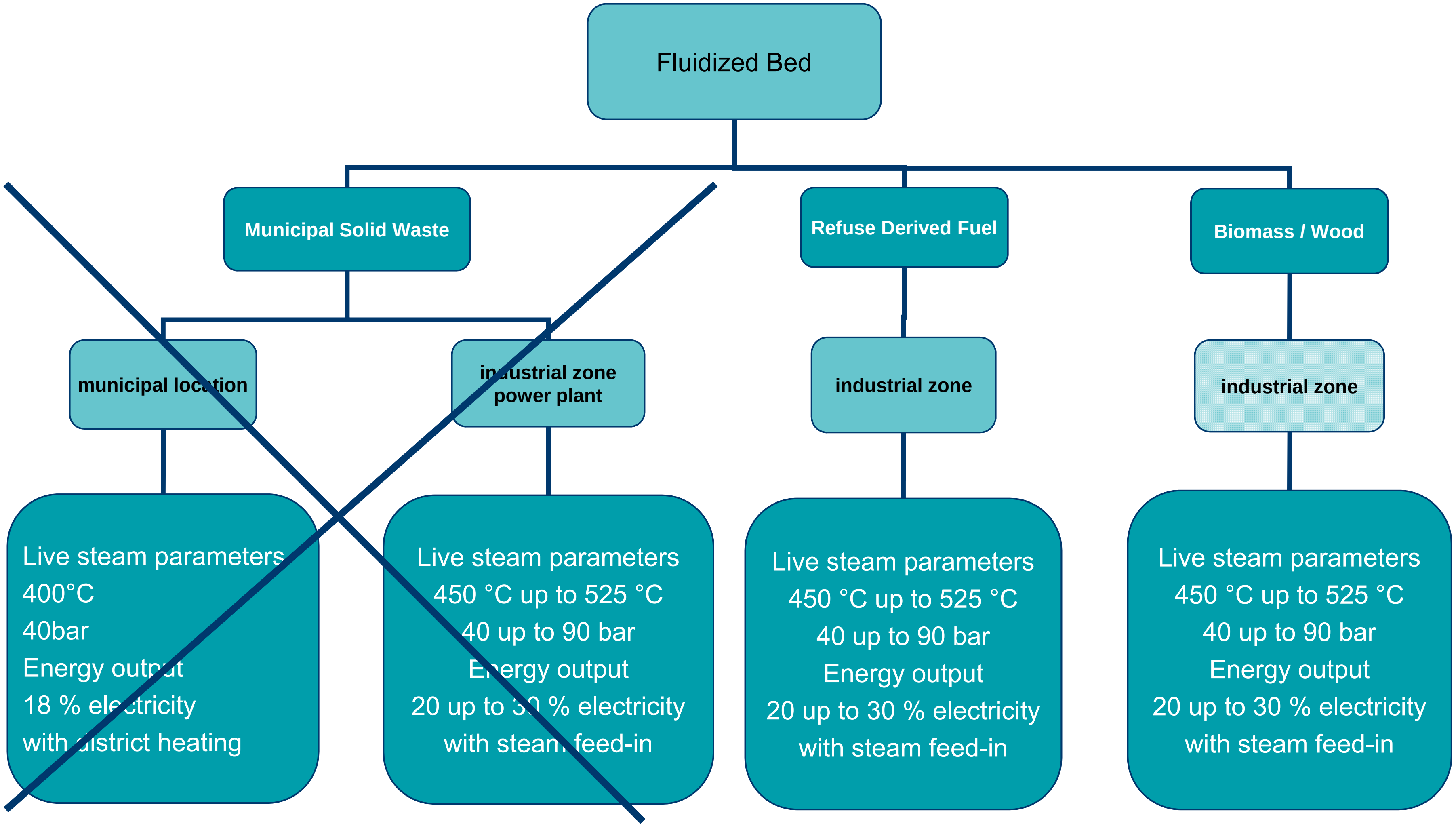
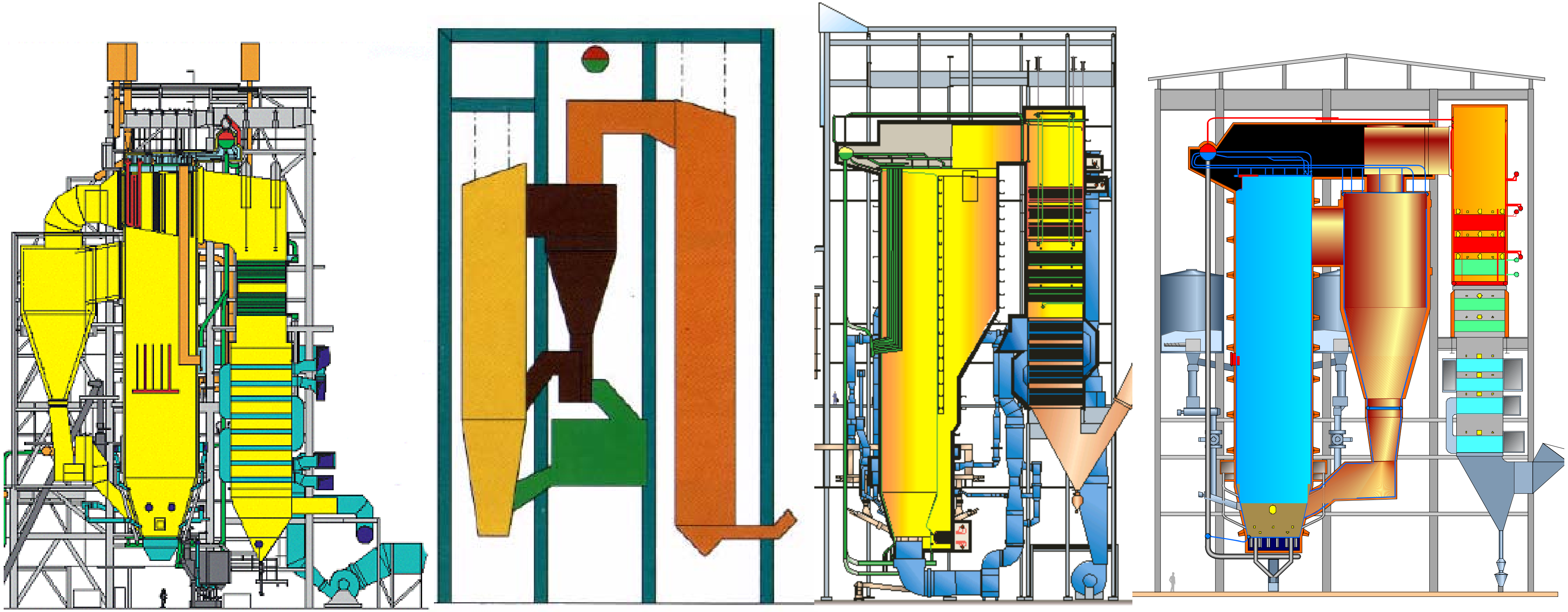


Comparison of CFBC Boiler Layout



Alstom	Lurgi	Foster Wheeler	Kvaerner

Live steam parameters and corrosion mechanisms

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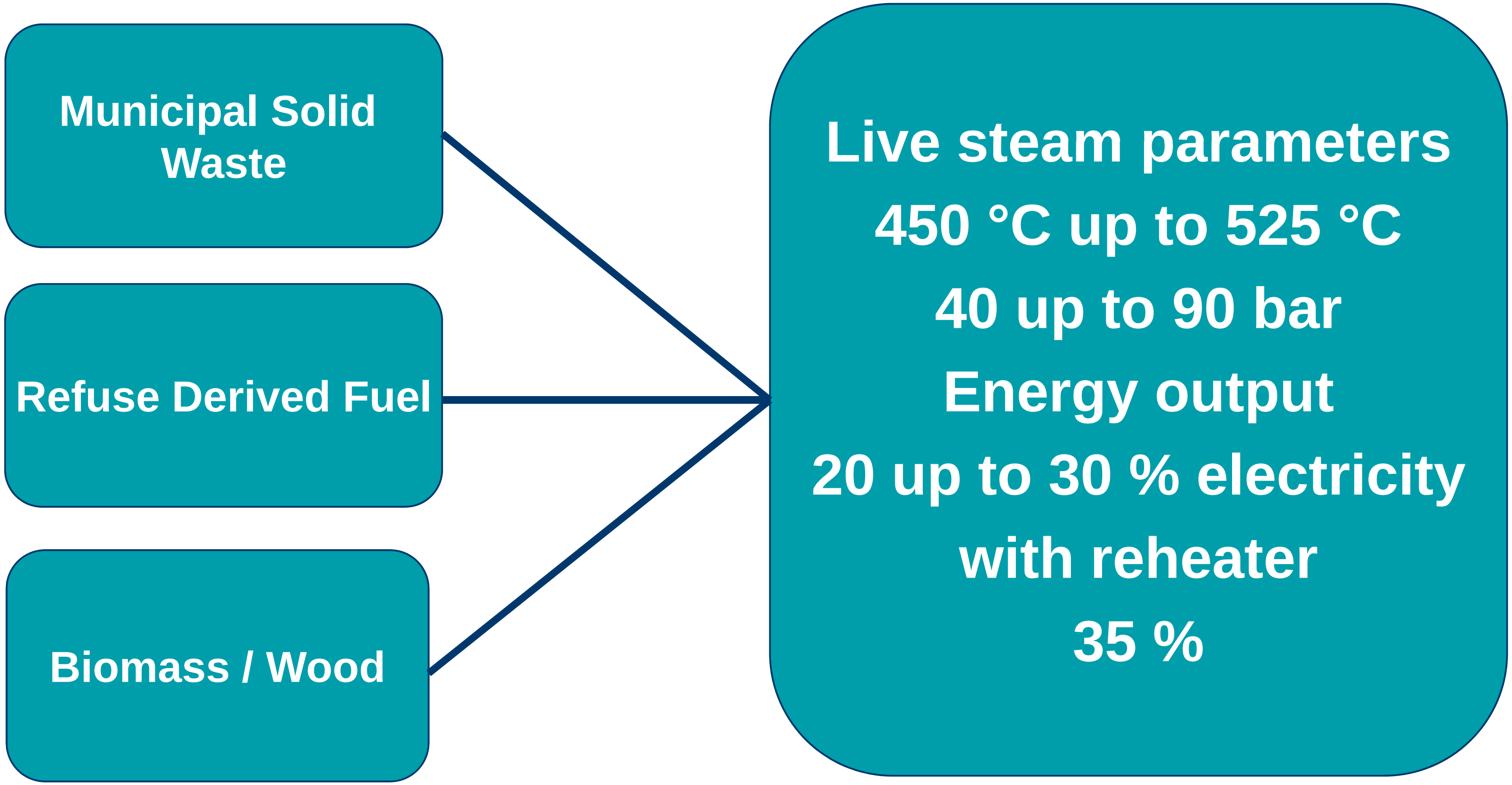
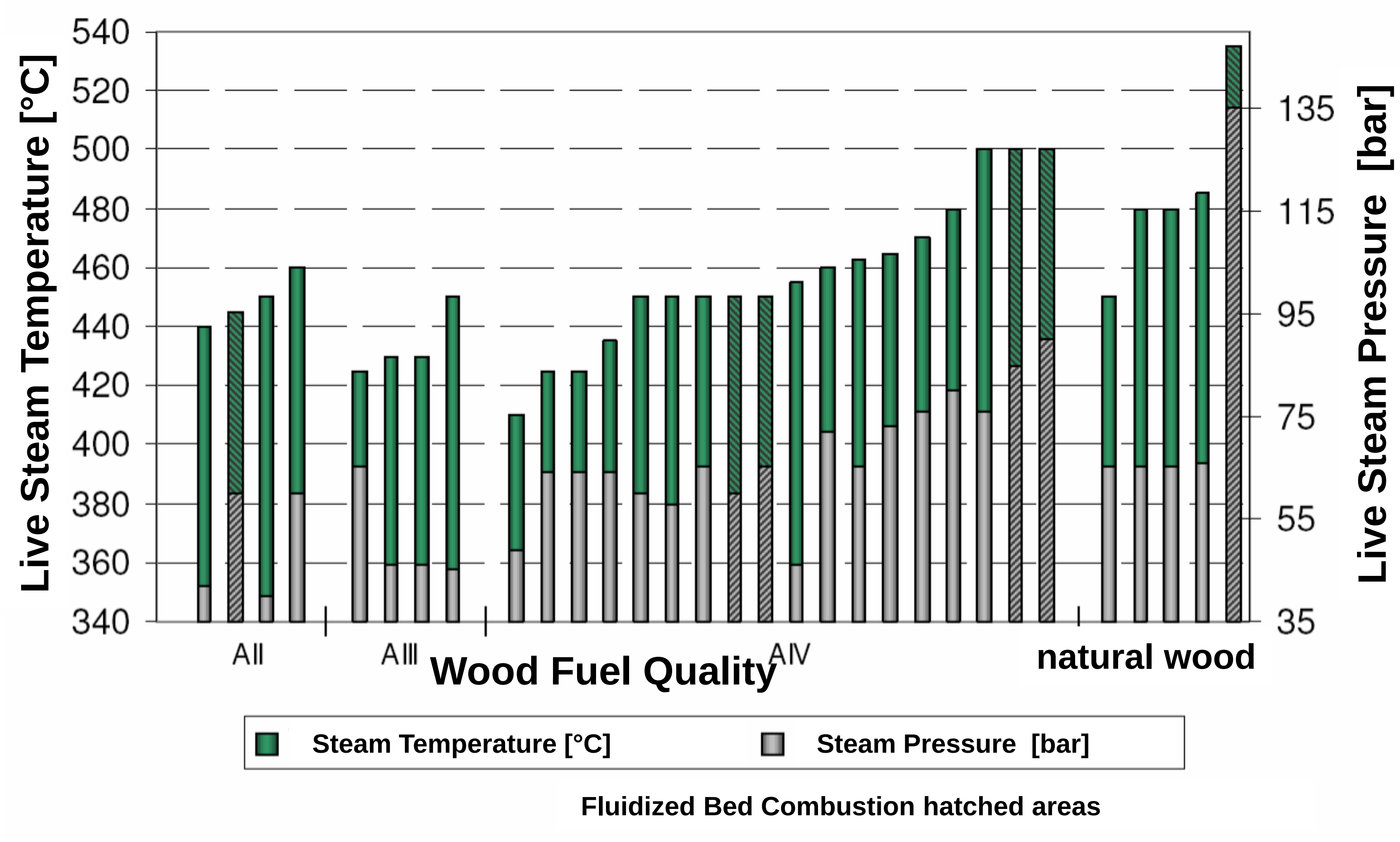
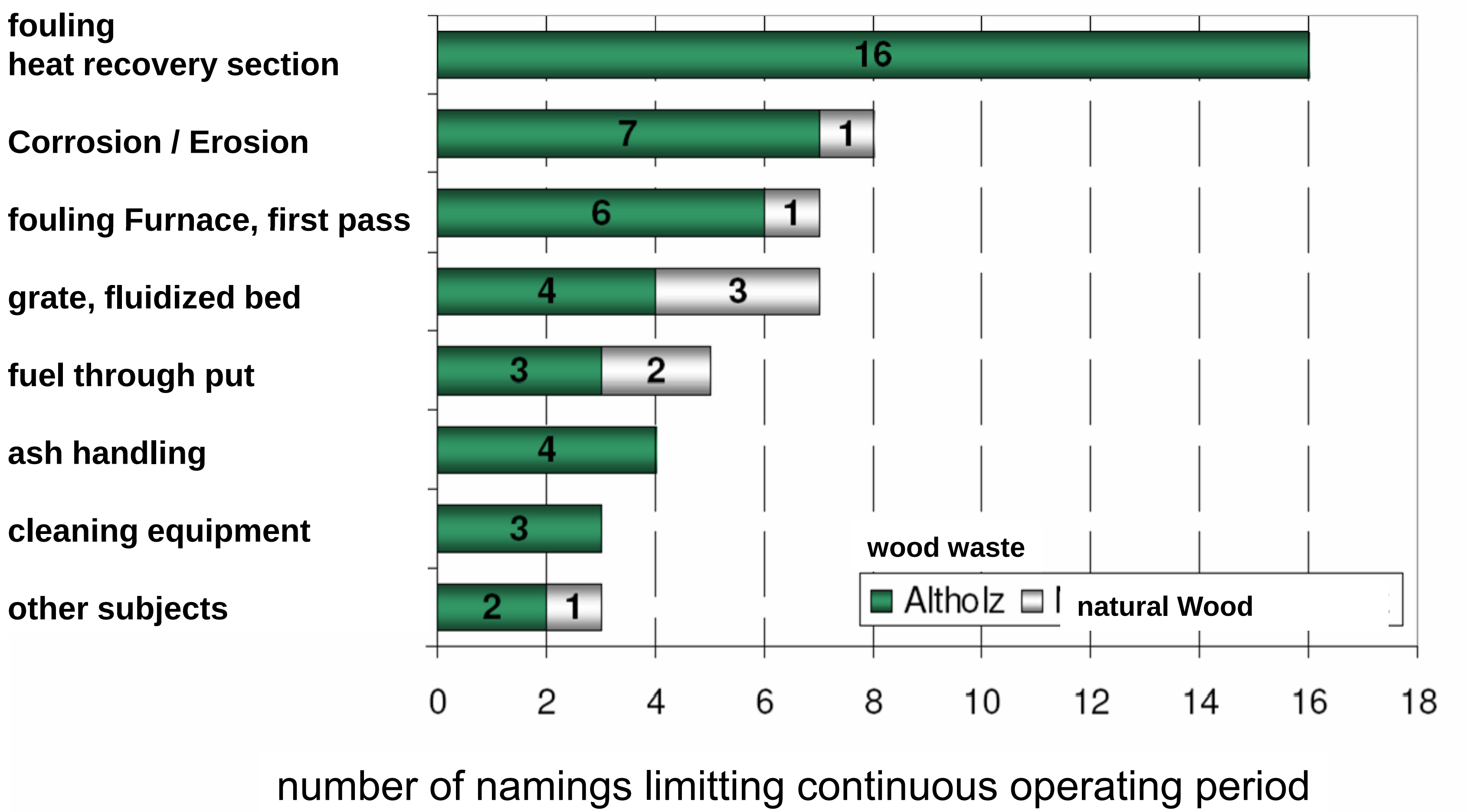


Main Steam Conditions and Fuel Quality



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



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

Chlorine Induced Active Oxidation Corrosion Mechanism

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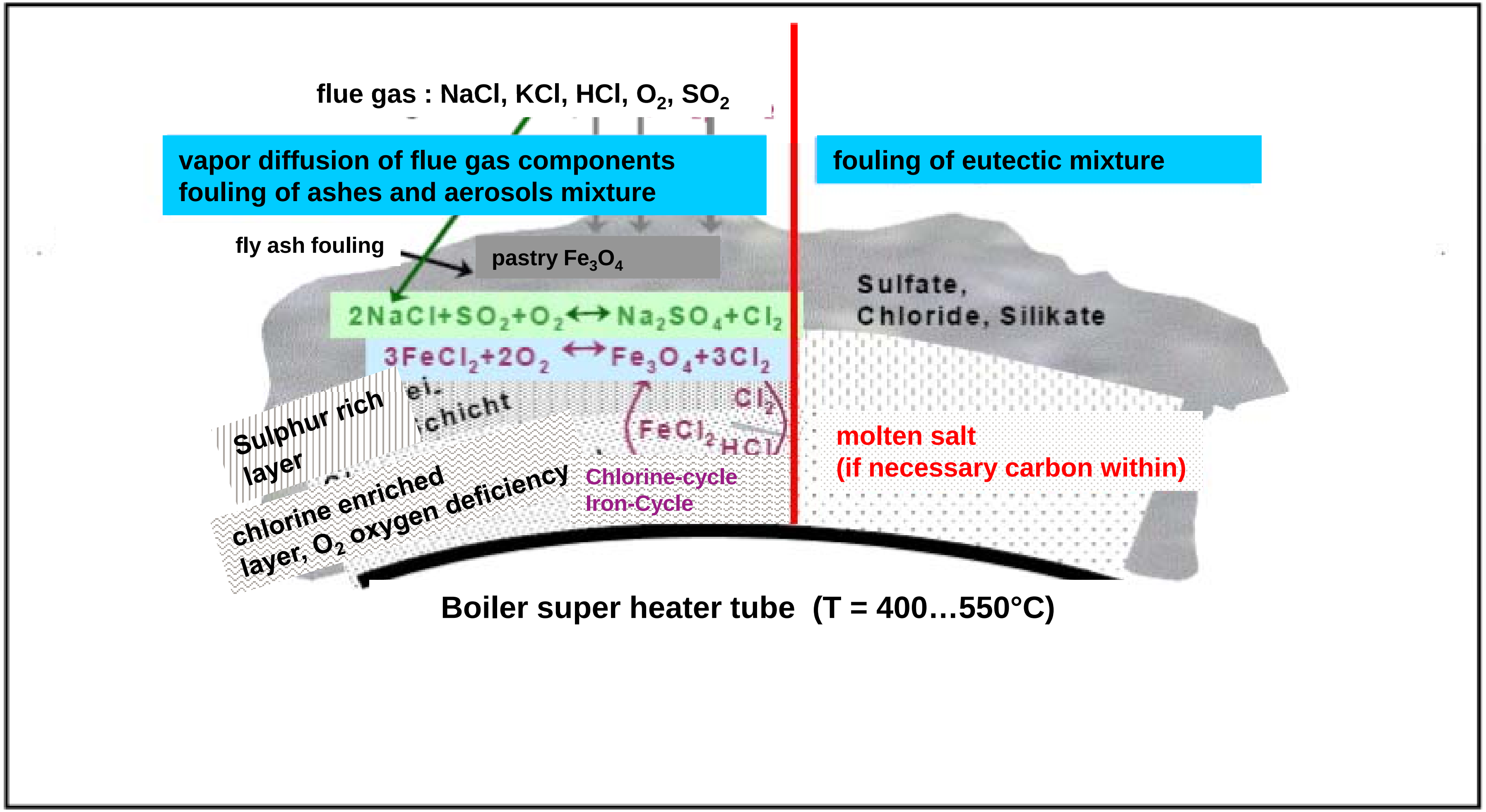
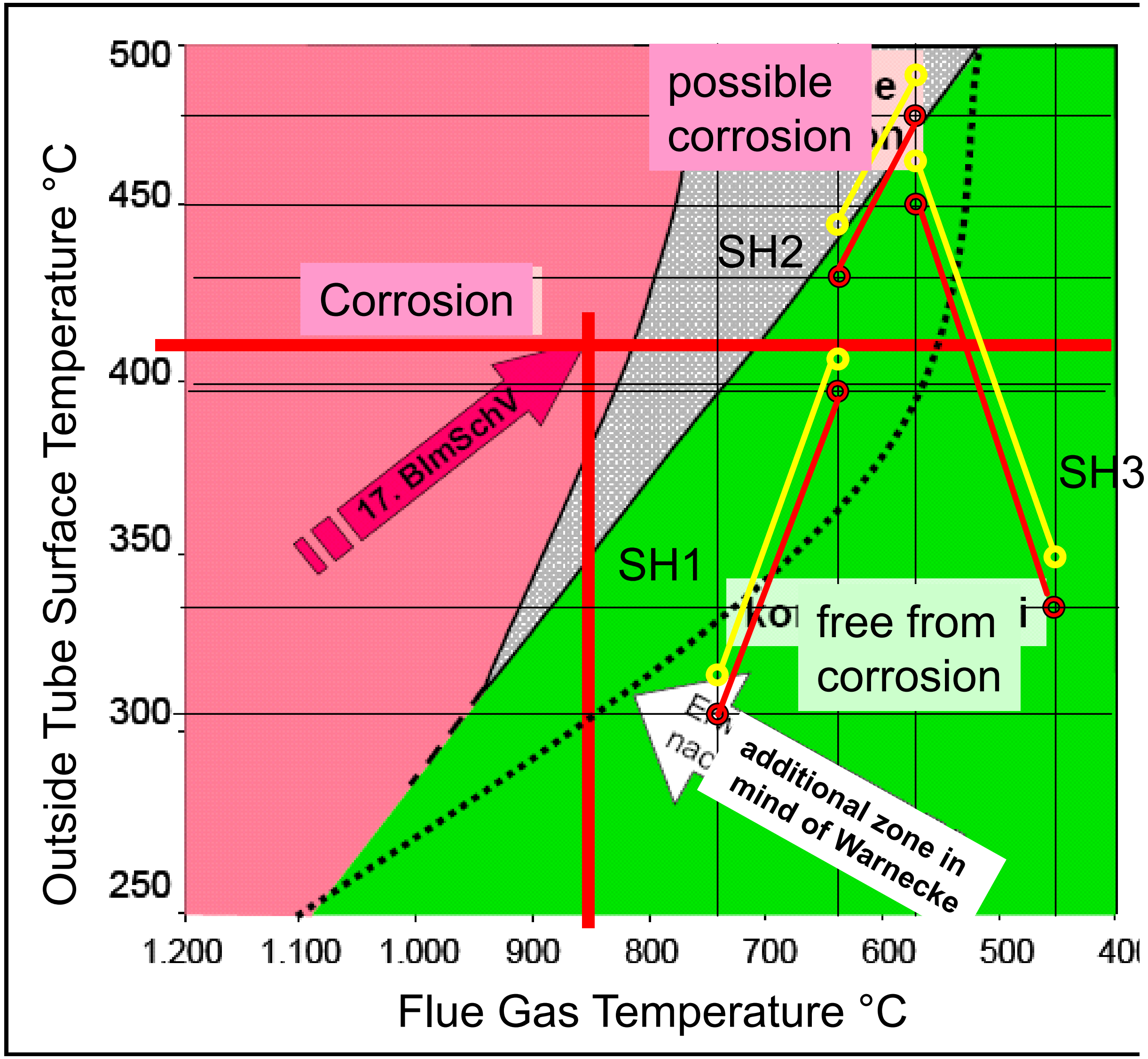


Modell der Korrosionsvorgänge unter Belägen [Born, 2004]

Corrosion Diagram Waste to Energy Plant



Fuel composition and fouling structure on boiler tube

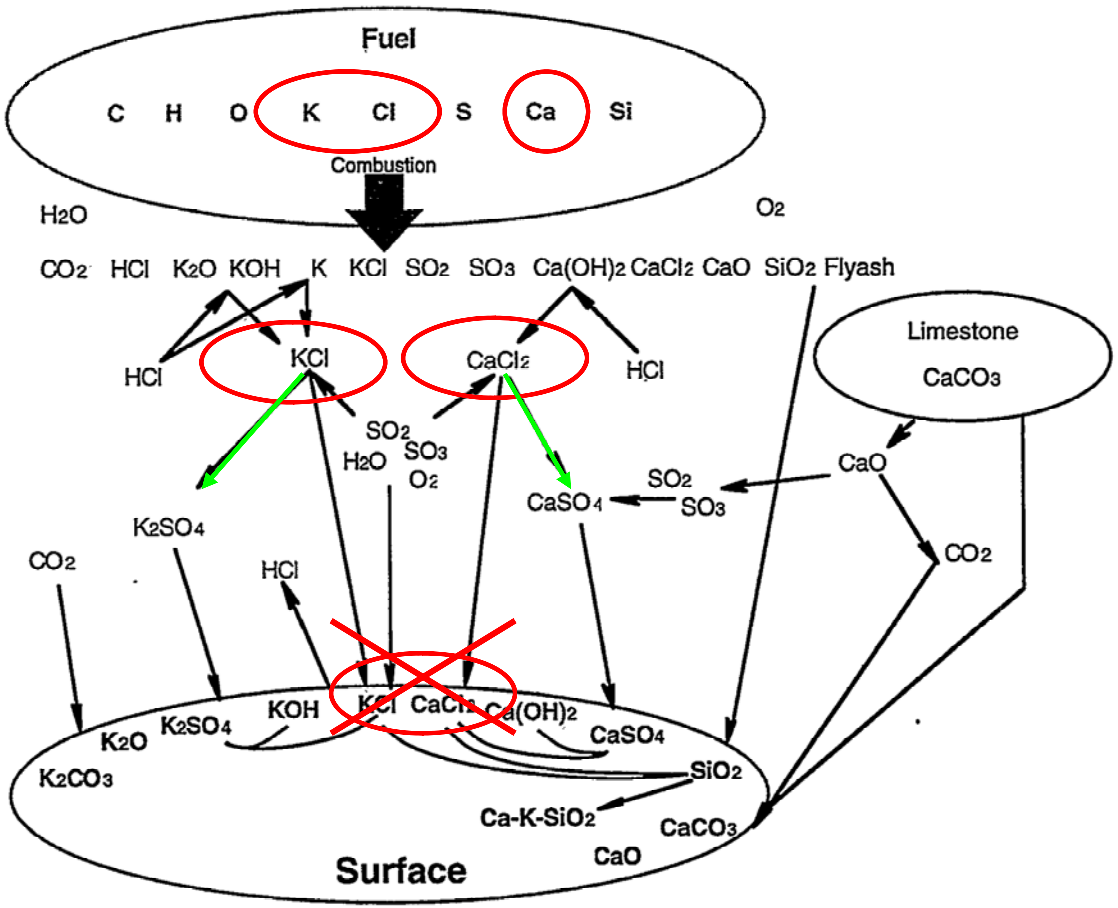
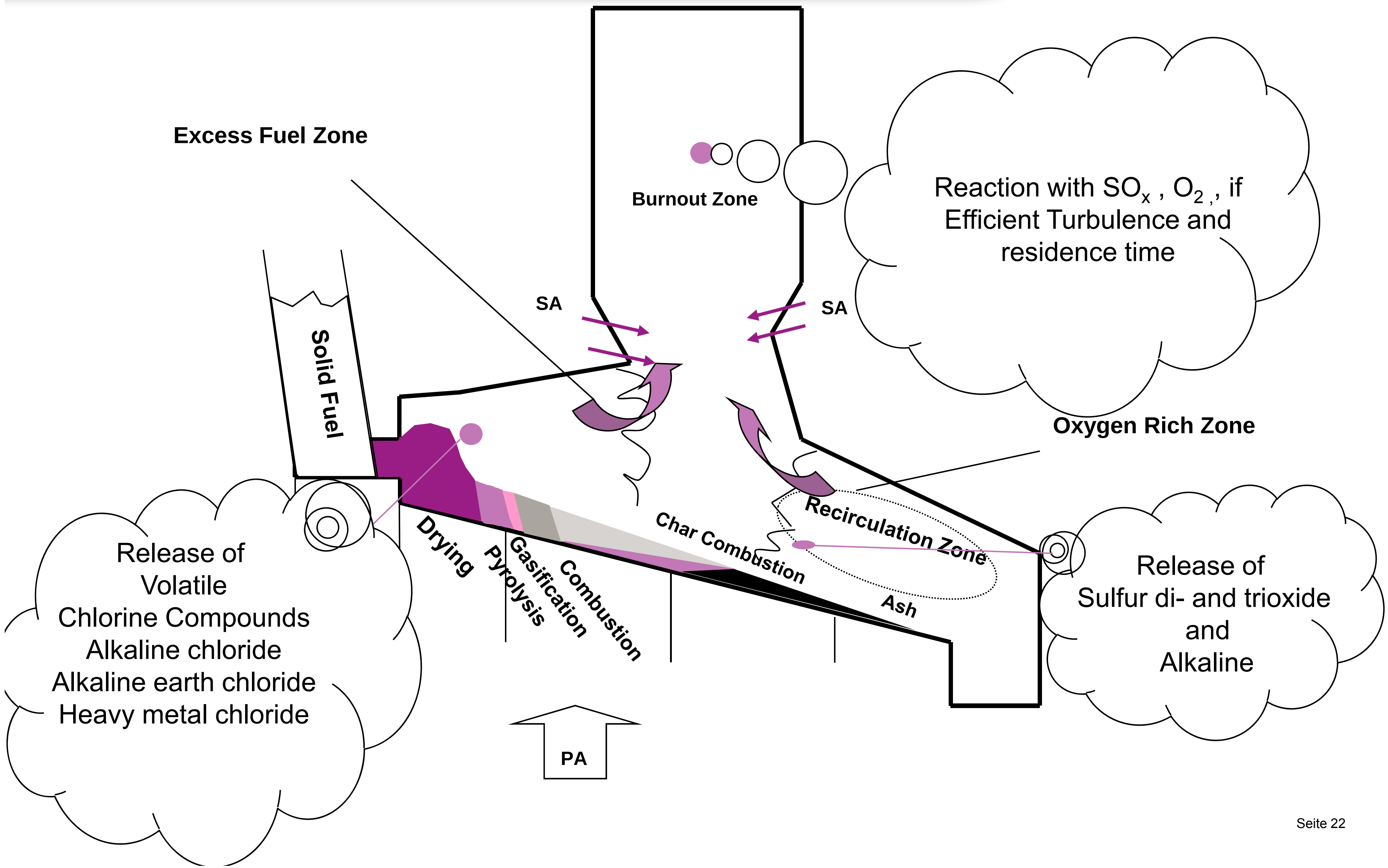
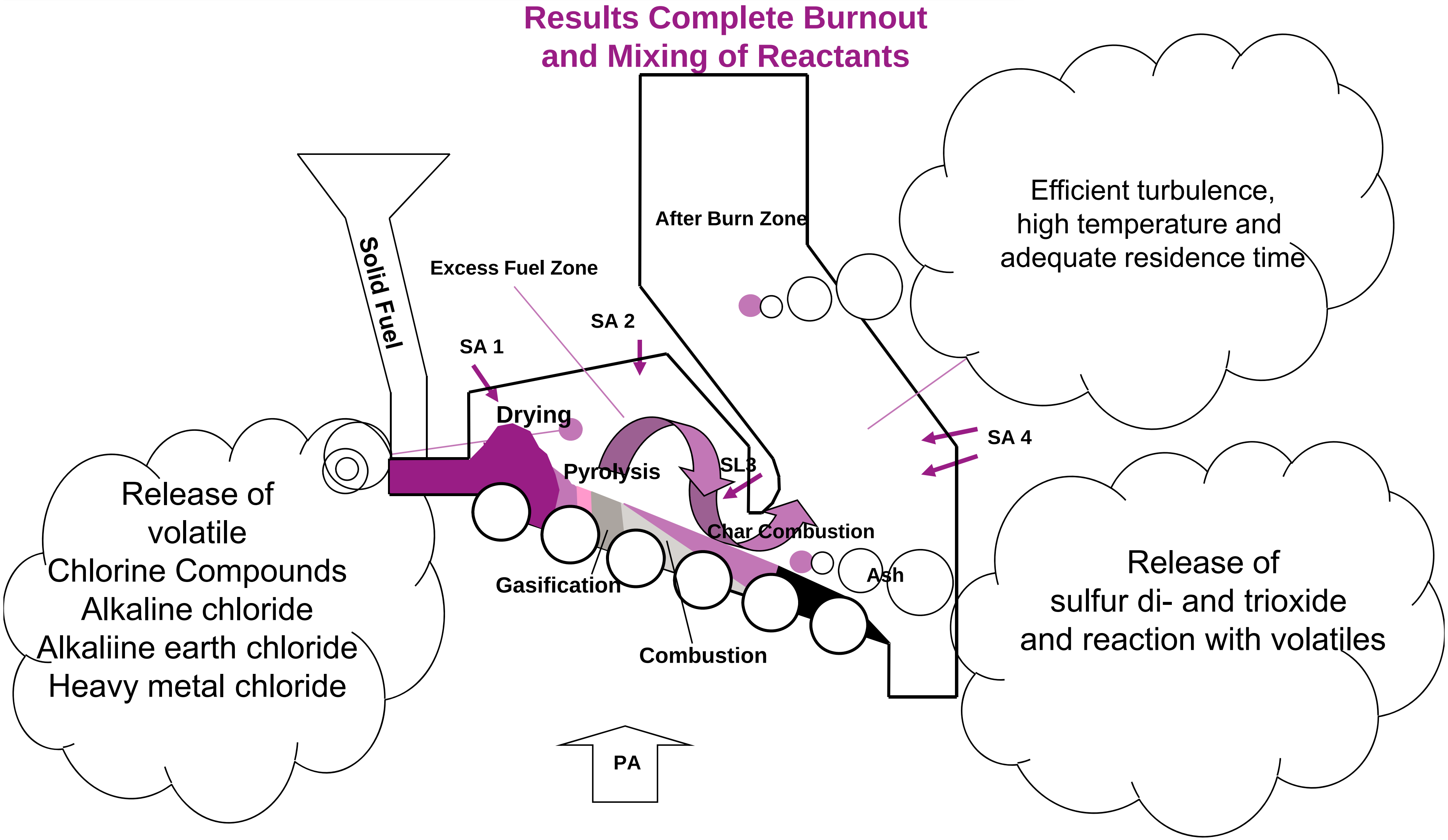


Figure 121 Simplified conceptual interactions among selected fouling elements in biomass.

Combustion Model
Centre Flow Combustion



Combustion Model
Parallel Flow Combustion



Alkali potential on fuel

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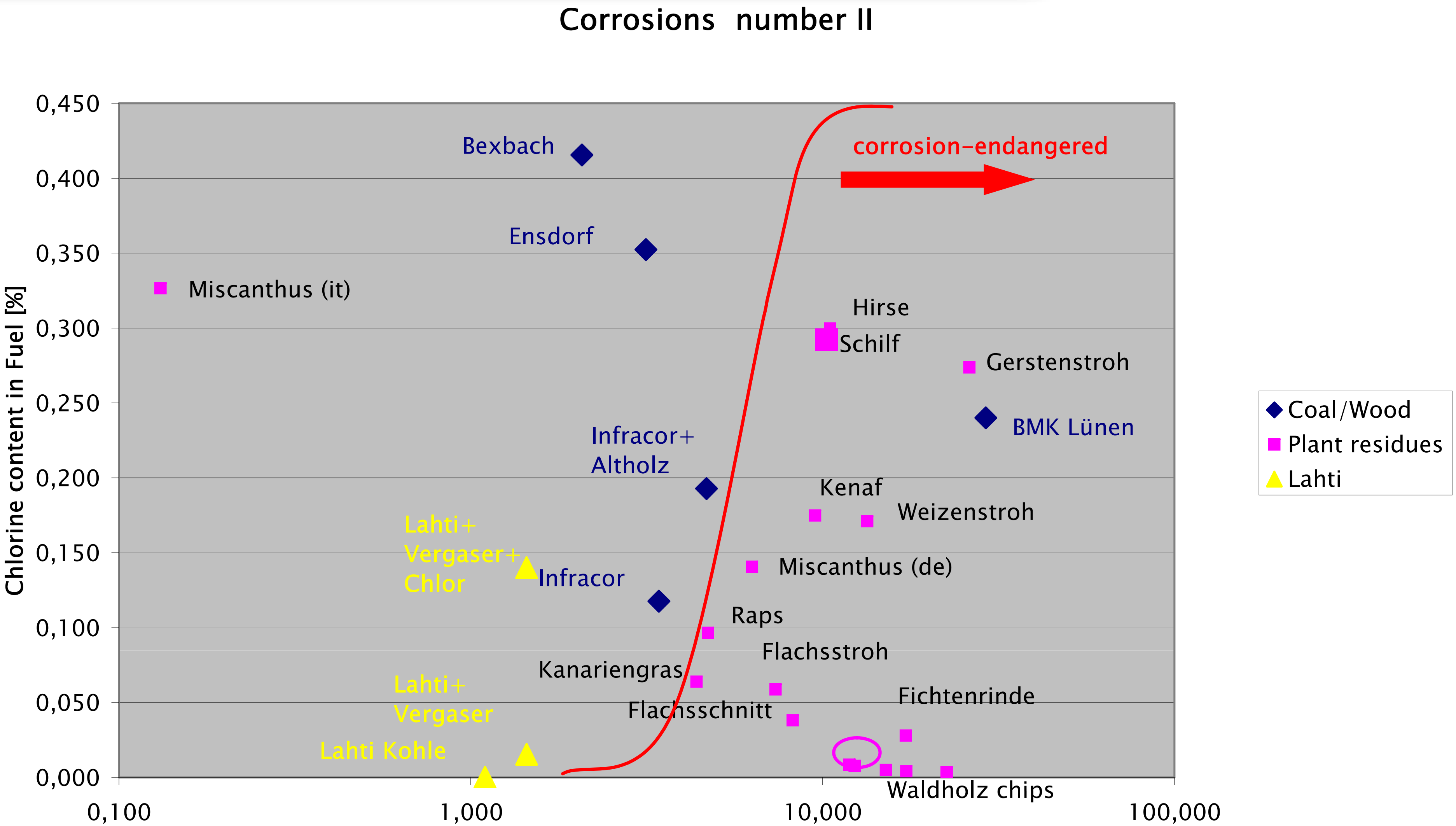

$$K_{CK} = \frac{2 \cdot [NaCl_{(g)} + KCl_{(g)}]}{SO_2}$$ [mol/mol]

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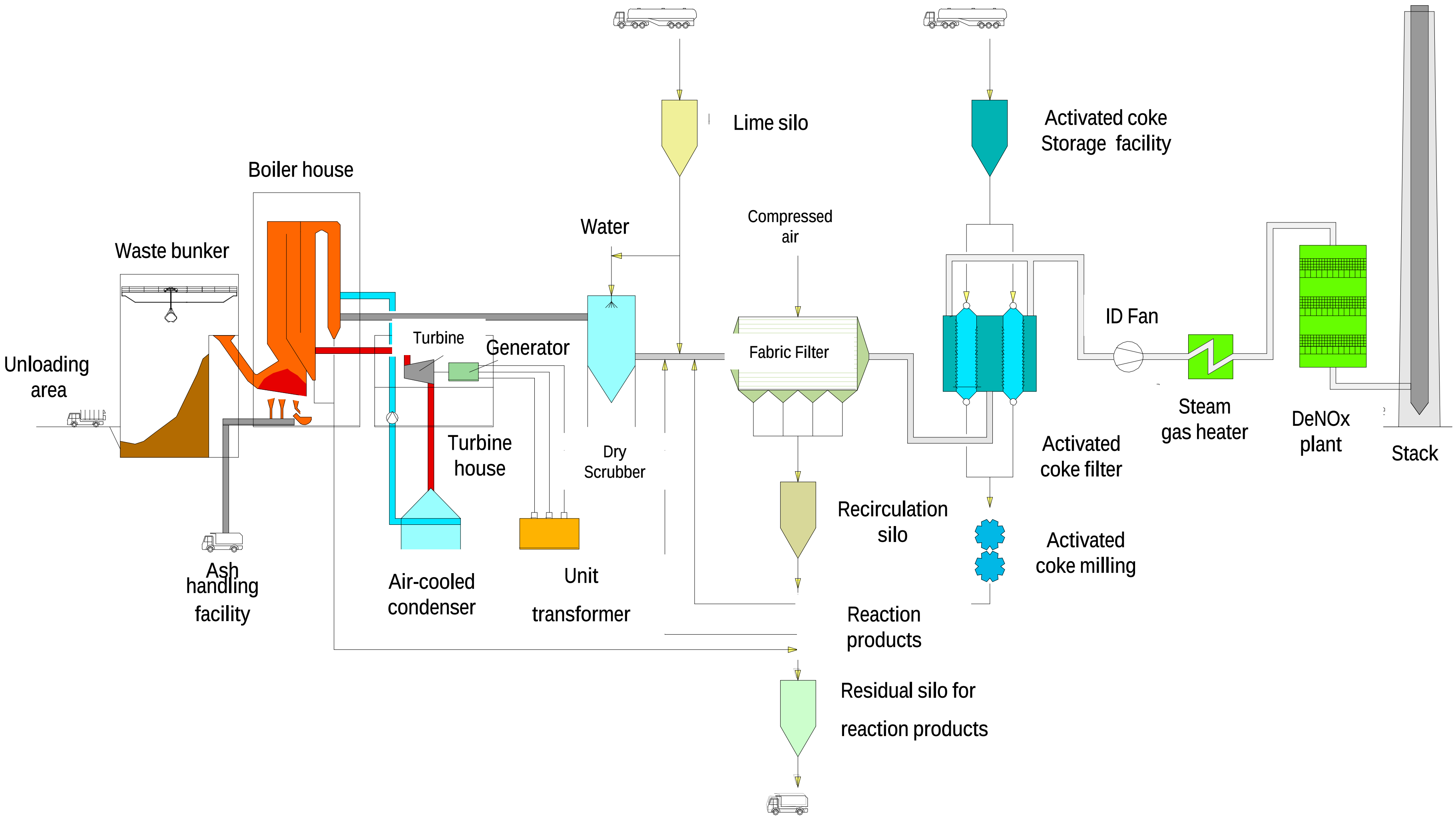
Waste to Energy

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 consuption	MW_{el}	ca. 4
Waste bunker capacity	m³	ca. 11.000

Waste to Energy

T. A. Lauta Flow Diagram



Thermal Waste to Energy Plant Lauta

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Current Projects

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- 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

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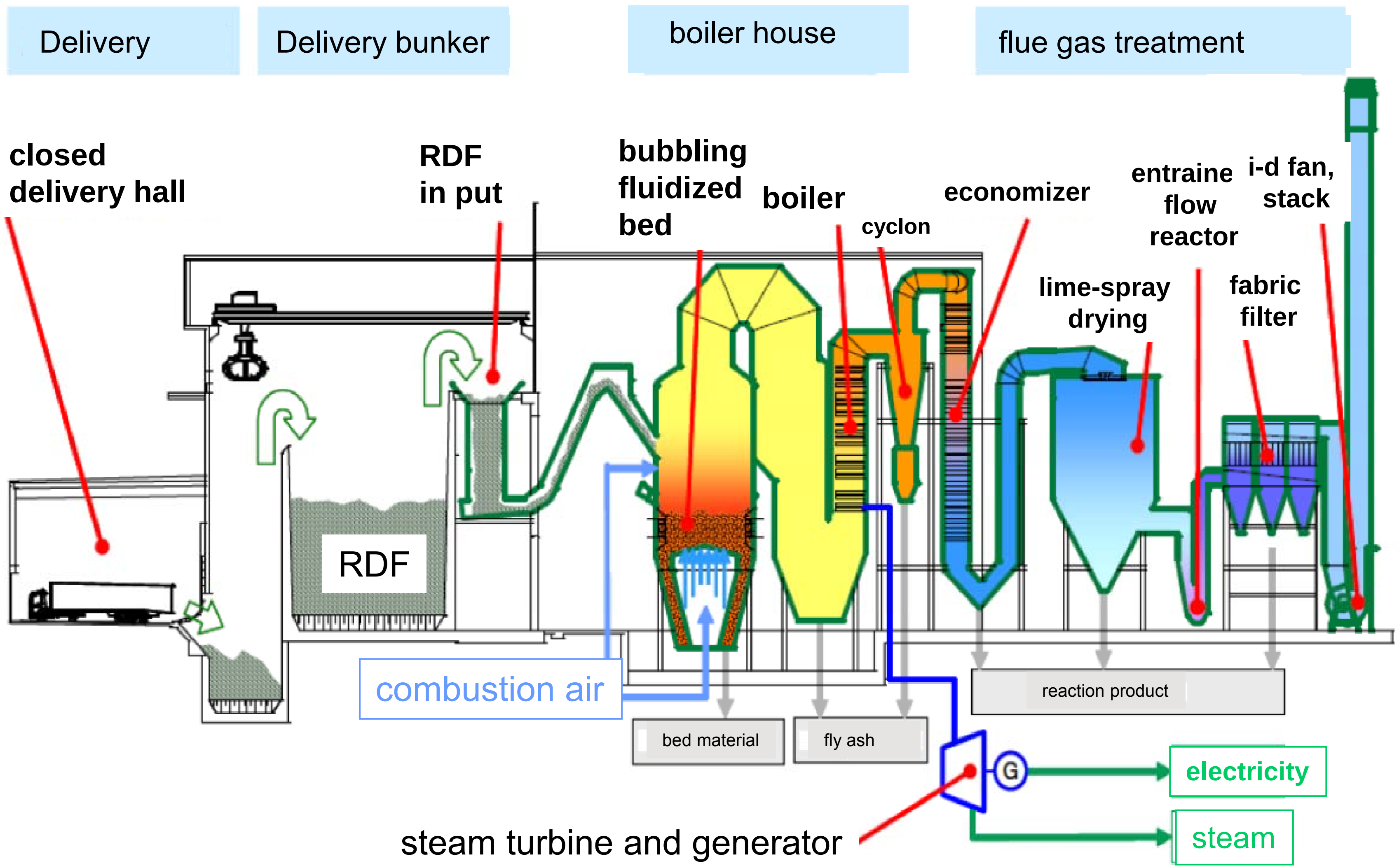

ICFB Combustion of Refuse derived fuel; Infraserv Frankfurt

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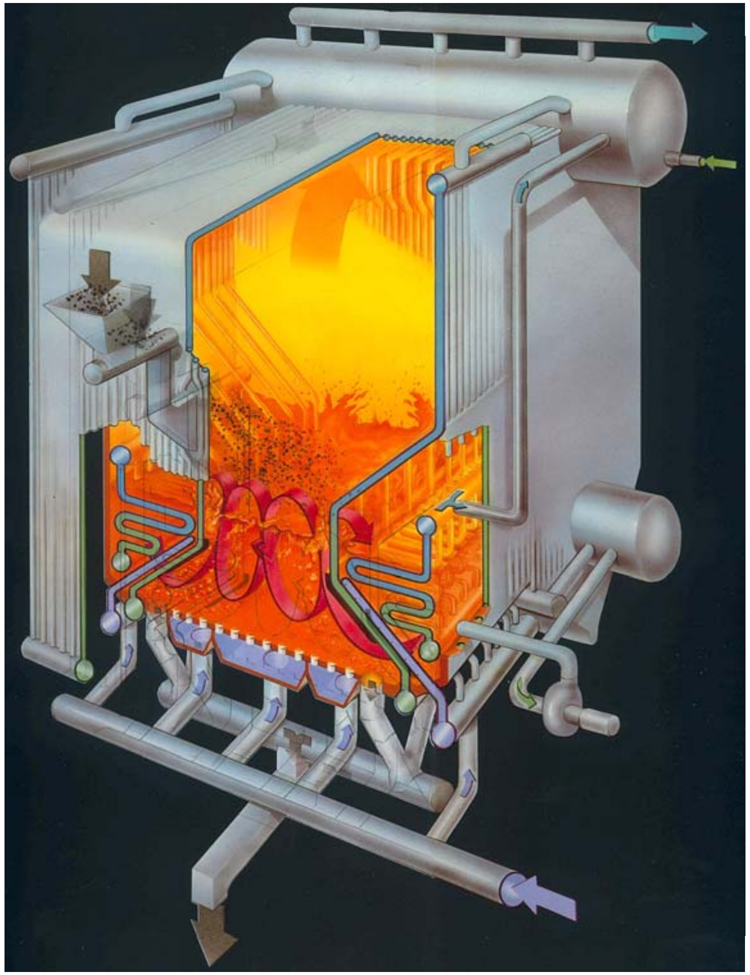
- Internal Circulating Fluidised Bed Combustion with Combustion insite the Boiler
- Stable Technology – without moving parts inside the Furnace
- wide range in respect of calourific value of fuel and waste
- Efficient in-bed heat-transfer
- Recycling of metalls like iron, steal and non-ferrous metals



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Current Projects

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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**

Brennstoffcharakterisierung Altholz
Fuel Quality Waste Wood

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- **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

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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 / Commisioning
- Plant Operation
- Plant Optimization

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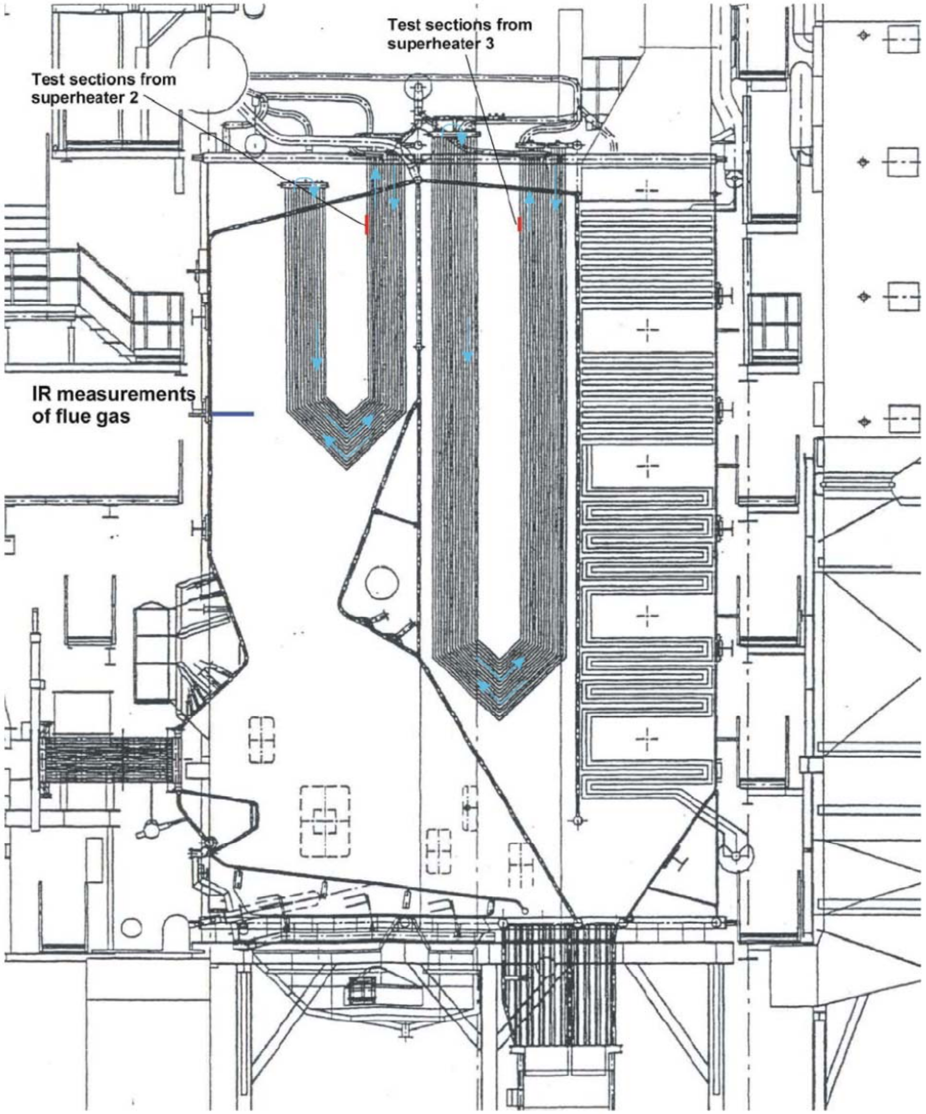
Specific Boiler Design
Super Heater at high Flue Gas Zone



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.

Corrosion Investigations at Maribo Sakskøbing
Combined Heat and Power Plant Part IV
Melanie Montgomery et.al. ; April 2007

RDF and Biomass to Energy Plants

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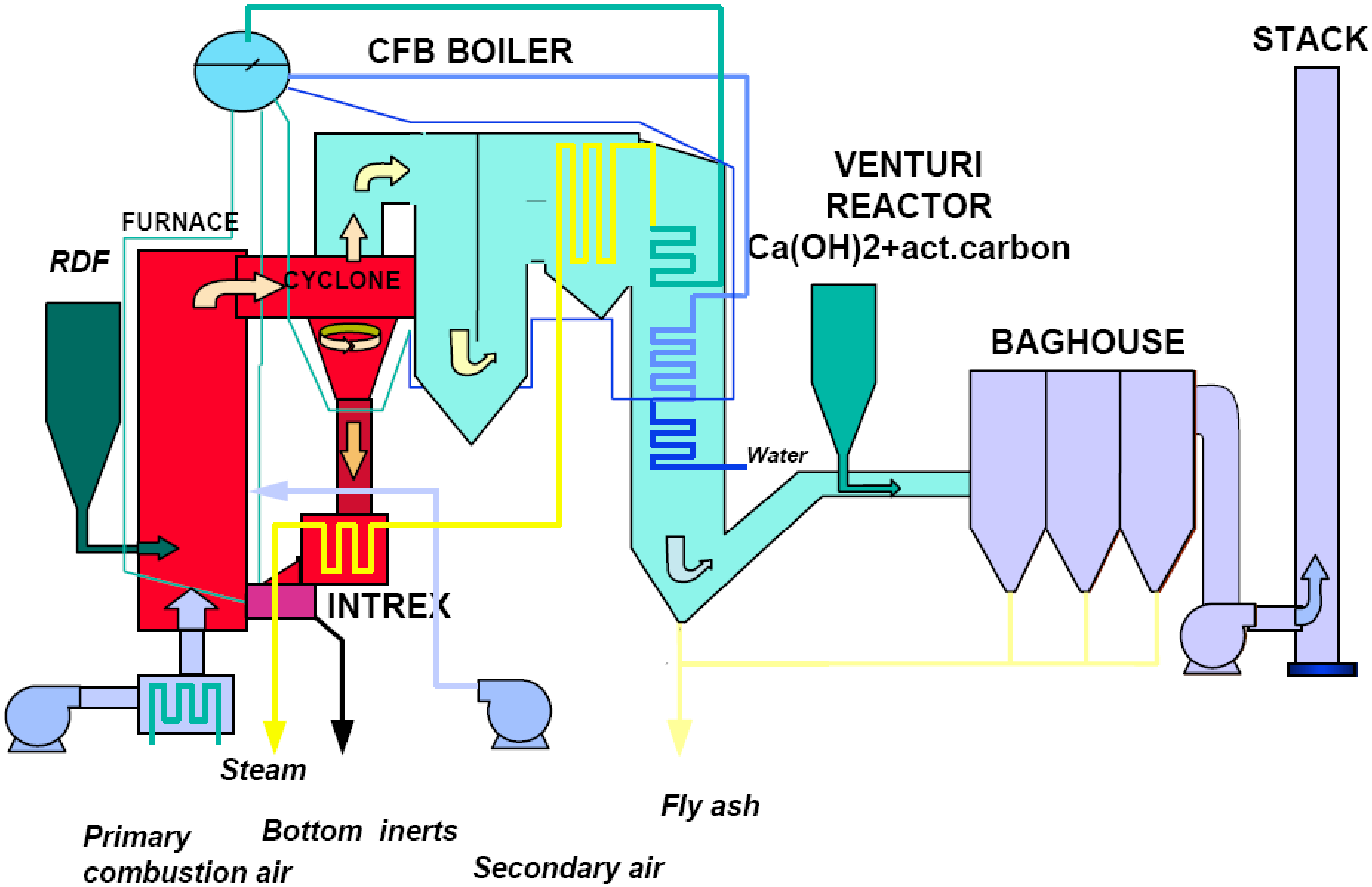
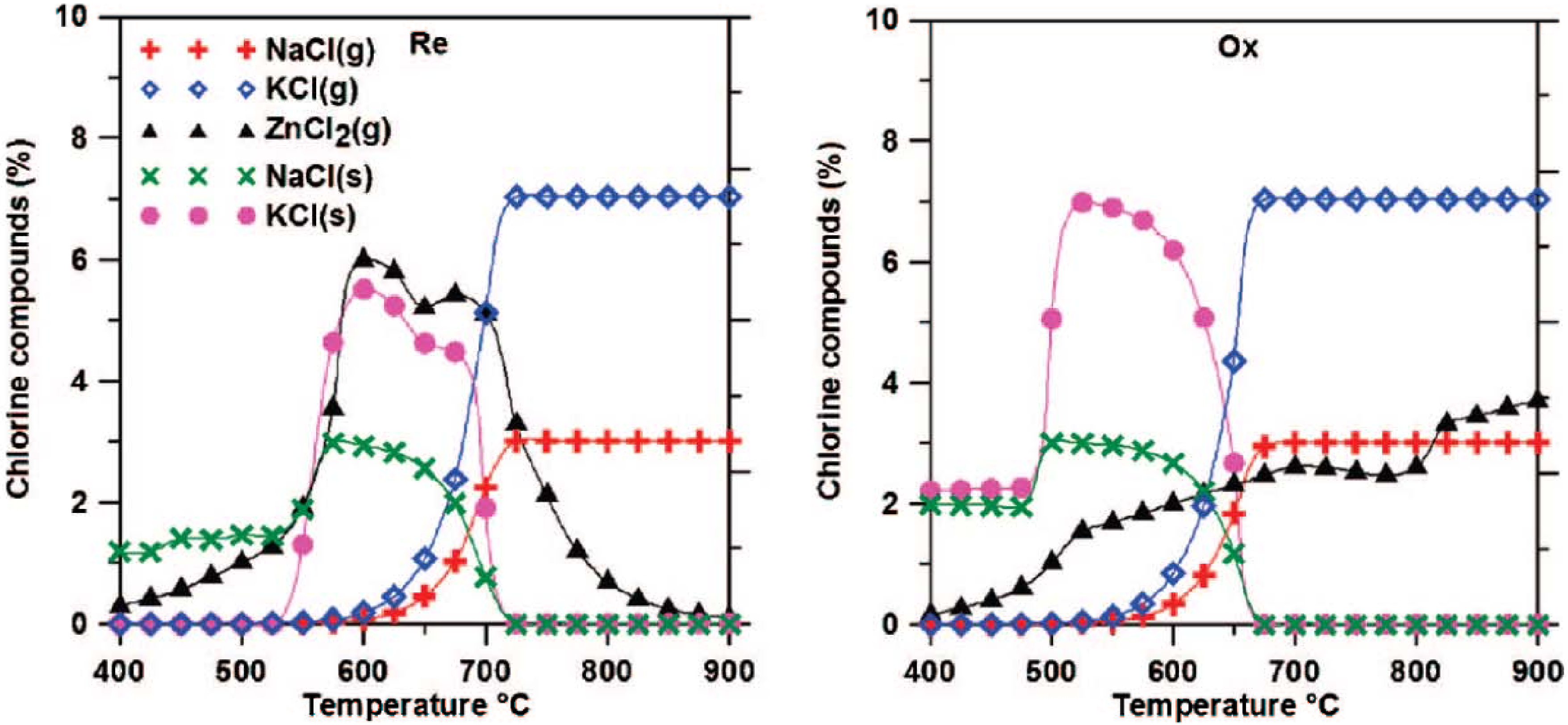


Chemistry of Potassium, Sodium, Zinc and Chlorine

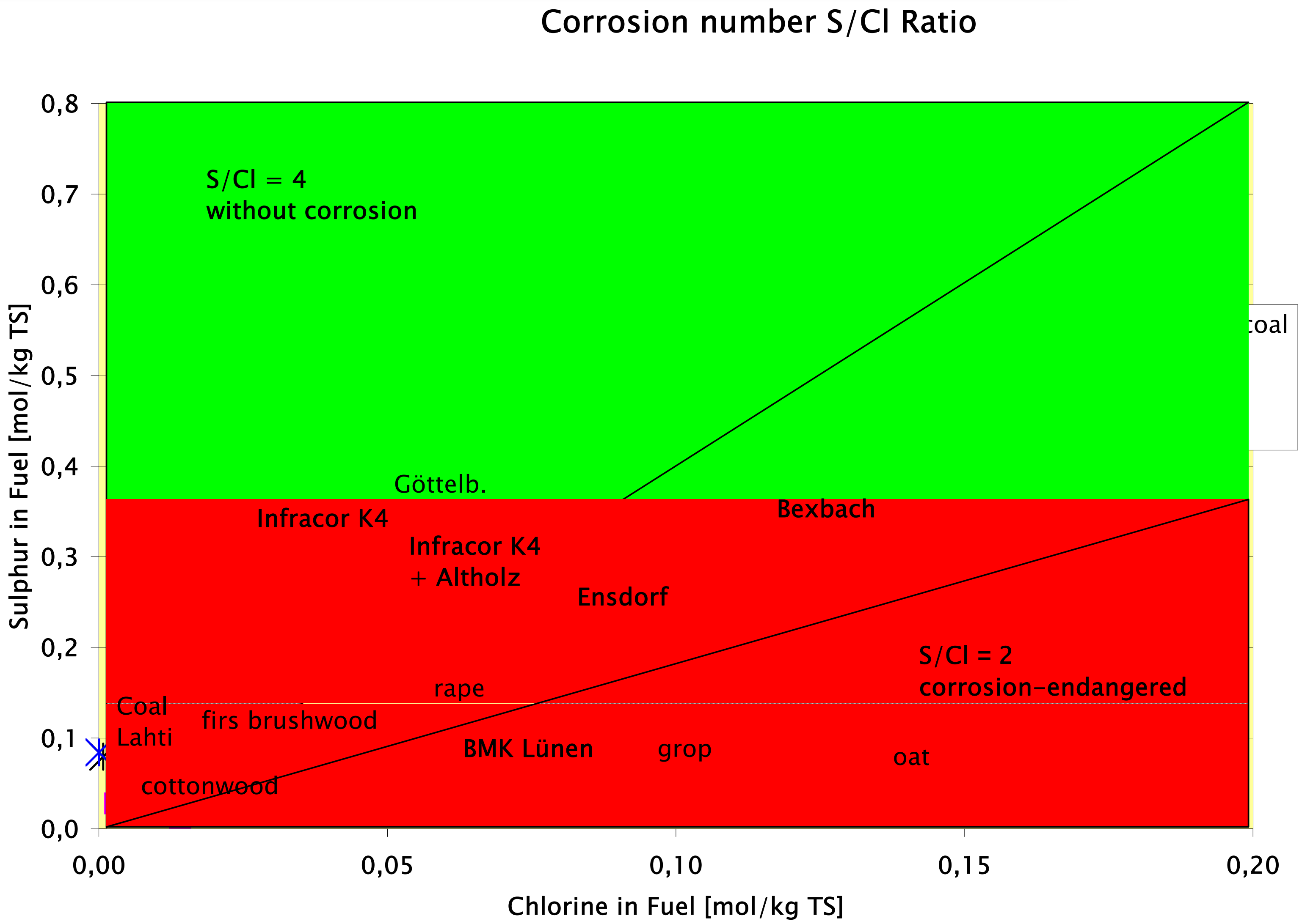


Chlorine compounds at reducing and oxidizing conditions for the case Cl/Zn = 11. Remaining chlorine (80%–90%) was found in the flue gas mainly as hydrogen chloride.

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.

Anna-Lena Elled, Lars-Erik Åmand, David Eskilsson
Energy & Fuels 2008, 22, 1519–1526

Sulfur / Chlorine ratio



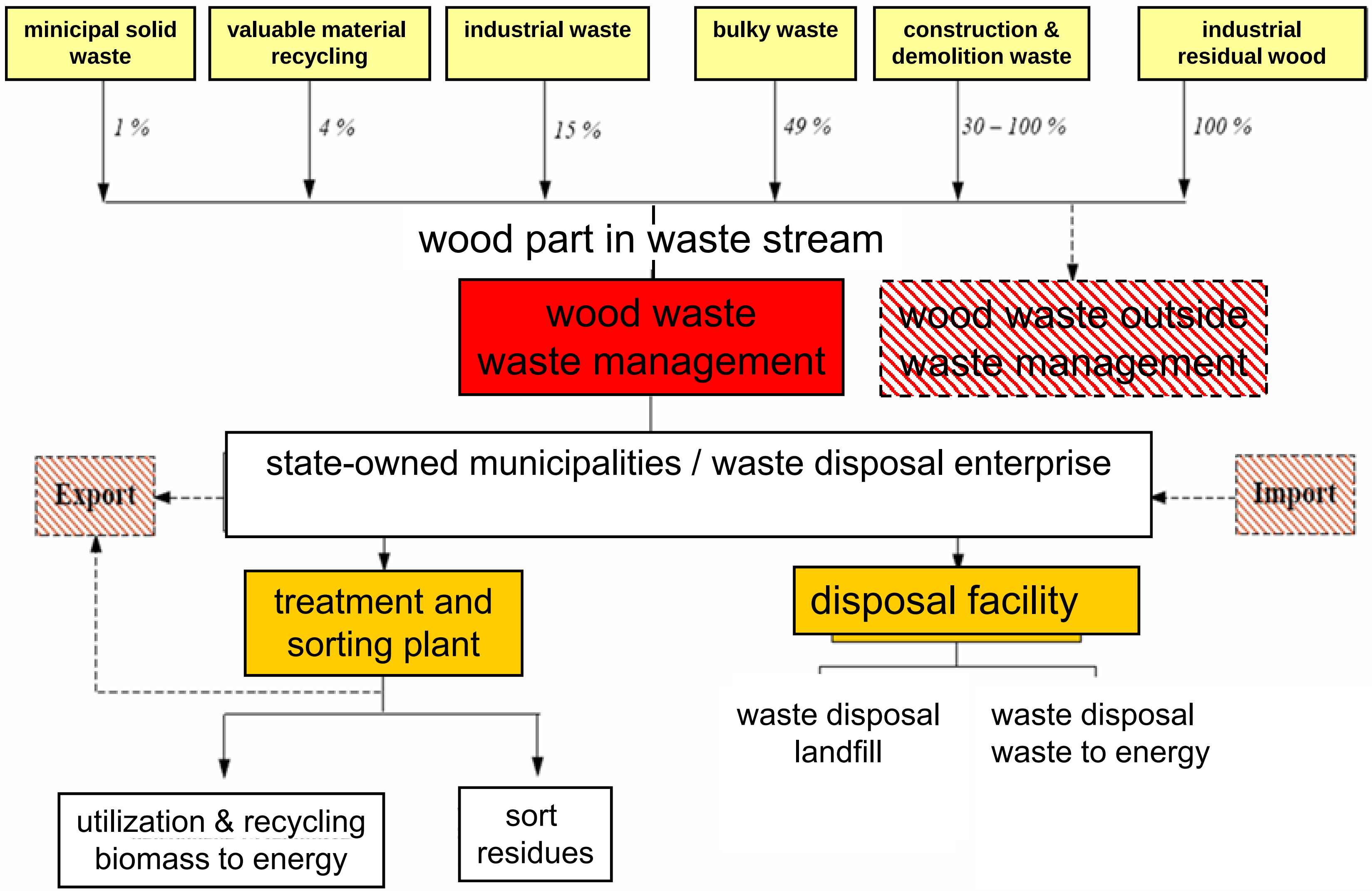
Waste to Energy

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



Monitoring zur Wirkung der Biomasseverordnung auf Basis des Erneuerbare-Energien-Gesetzes (EEG),
Forschungs- und Entwicklungsvorhaben 201 41 132, Institut für Energetik & Umwelt gGmbH (IE), Leipzig, 17. Dez. 2003