Higher Efficiency with External Superheating in Waste-to-Energy Plants

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Overview - not one measure stands alone -

1. Reduction of waste heat losses by adjusting the surplus air λ

Reduction surplus air λ < 1,25 by:

- Substoichiometric atmosphere on the grate
- Multi stage surplus air injection (secondary-, tertiary-, quartery-air)
- Exhaust gas homogenization
- Optimisation of combustion control system

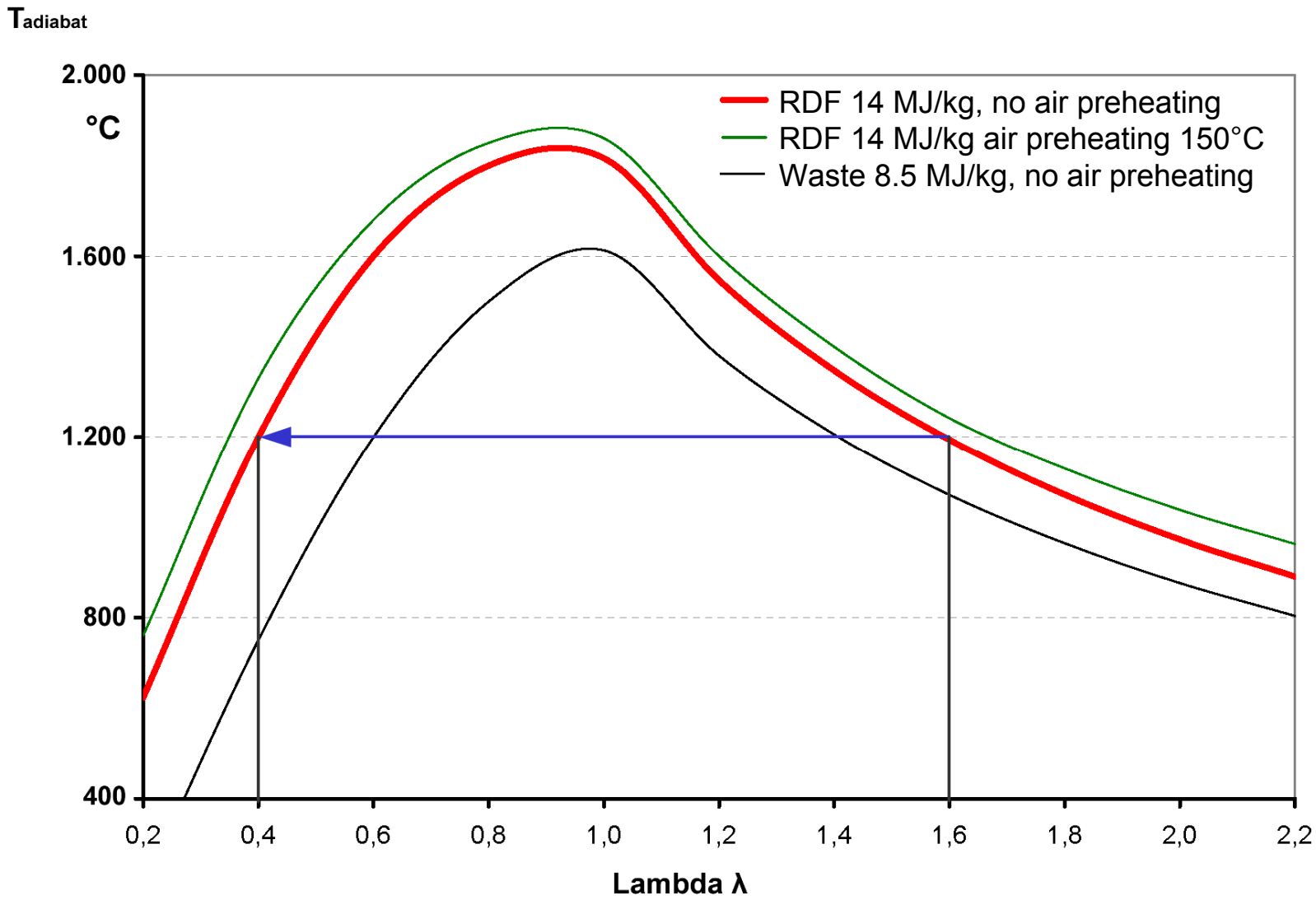
2. Reduction on energy losses by using residual heat of exhaust gas

- Pre heating of fresh air
- Preheating of condensate
- Preheating runback of district heating
- Local heat

3. Increase of electric efficiency by

- Higher steam parameters by external superheating

1. Reduction of waste heat losses by adjusting the surplus air λ - Sub-stoichiometric Combustion on the Grate



Adiabatic combustion temperature against surplus air

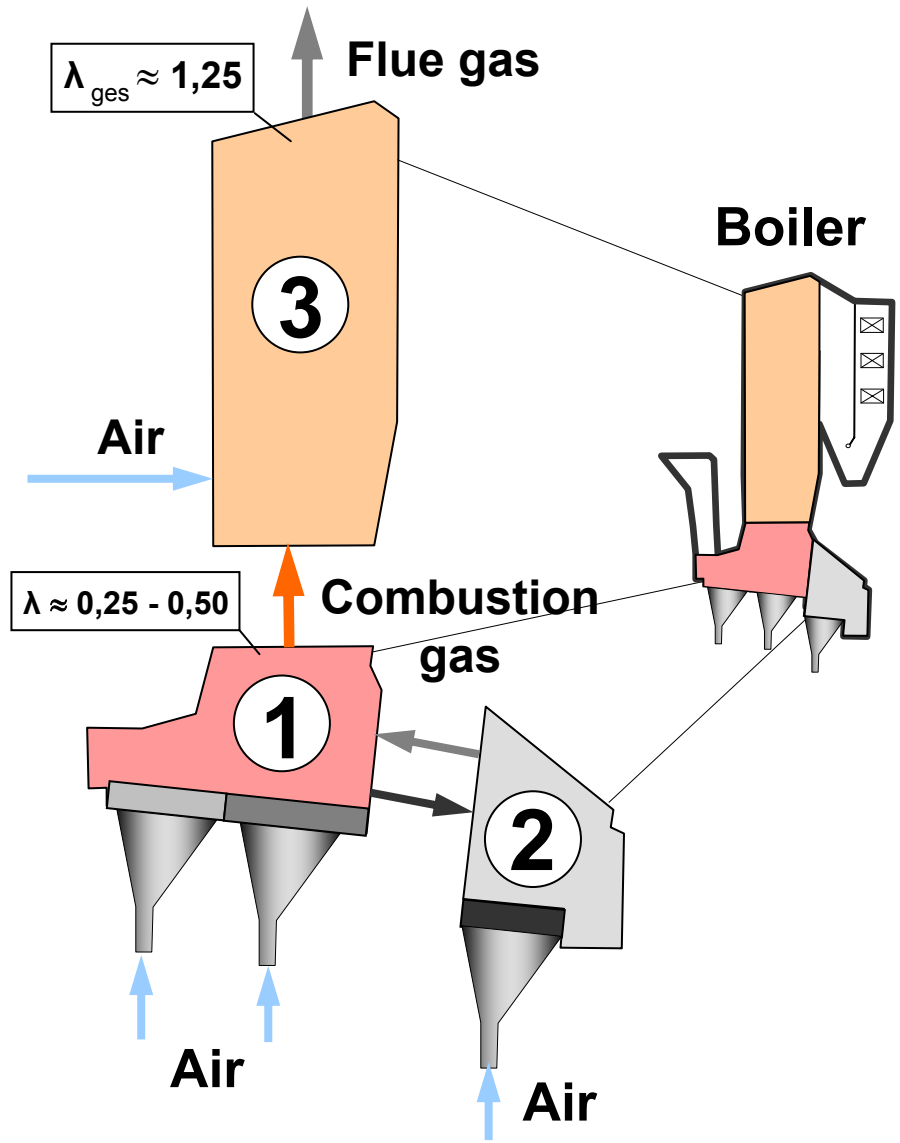
Sub-stoichiometric Combustion on the Grate

Separation of process steps:

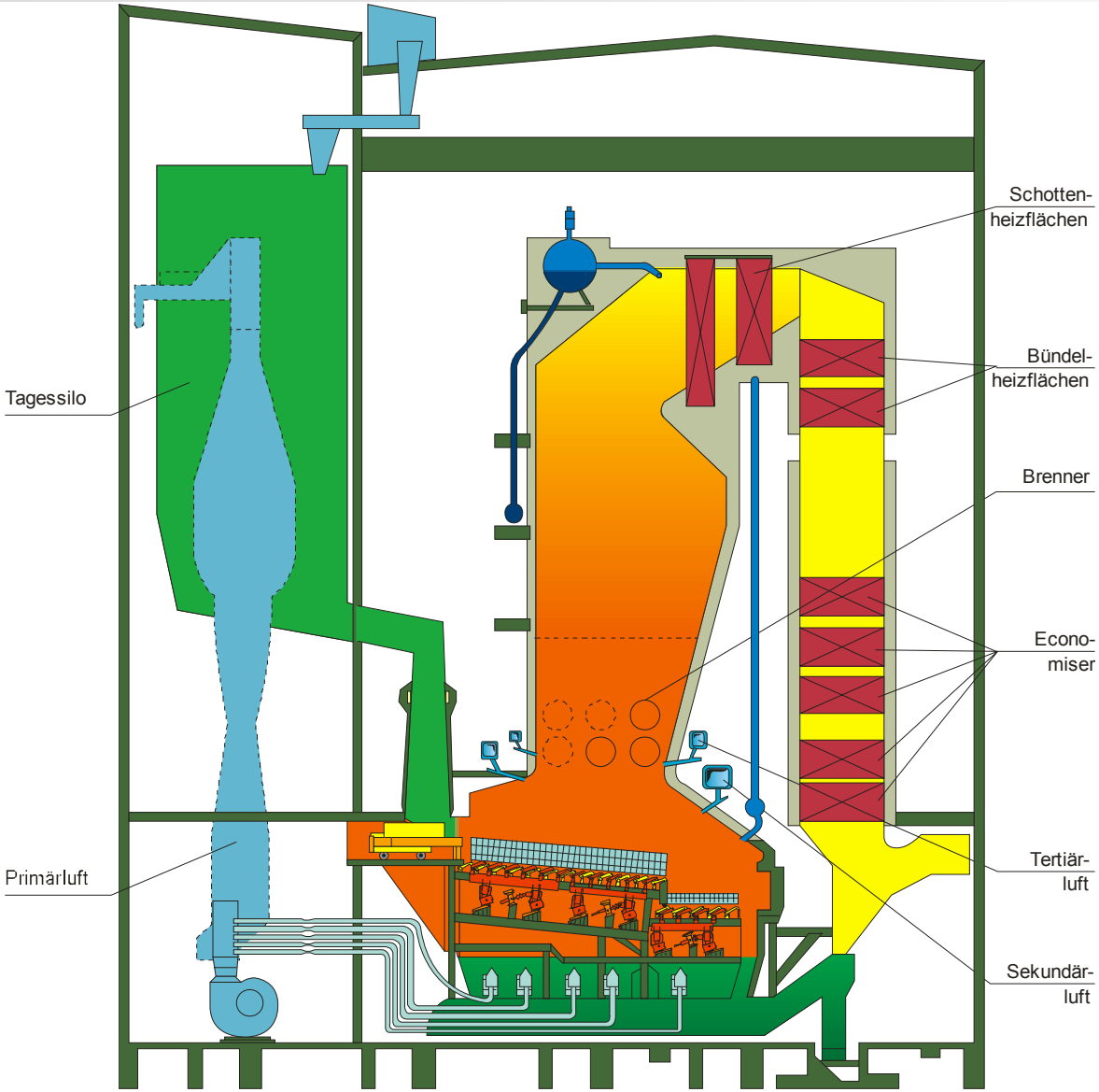
1. Drying/Pyrolysis
2. End zone
3. Afterburner chamber

Goals:

- ✓ **Better combustion**
- ✓ **Reduction of total lambda value**
- ✓ **Reduction of grate temperature**
- ✓ **No water cooling?**



CHP Igelsta, Södertälje, Schweden



Conversion 1997

From coal to RDF

Noell KRC Energie- und Umwelttechnik GmbH

- Today Fisia Babcock –

<u>Technical Data:</u>

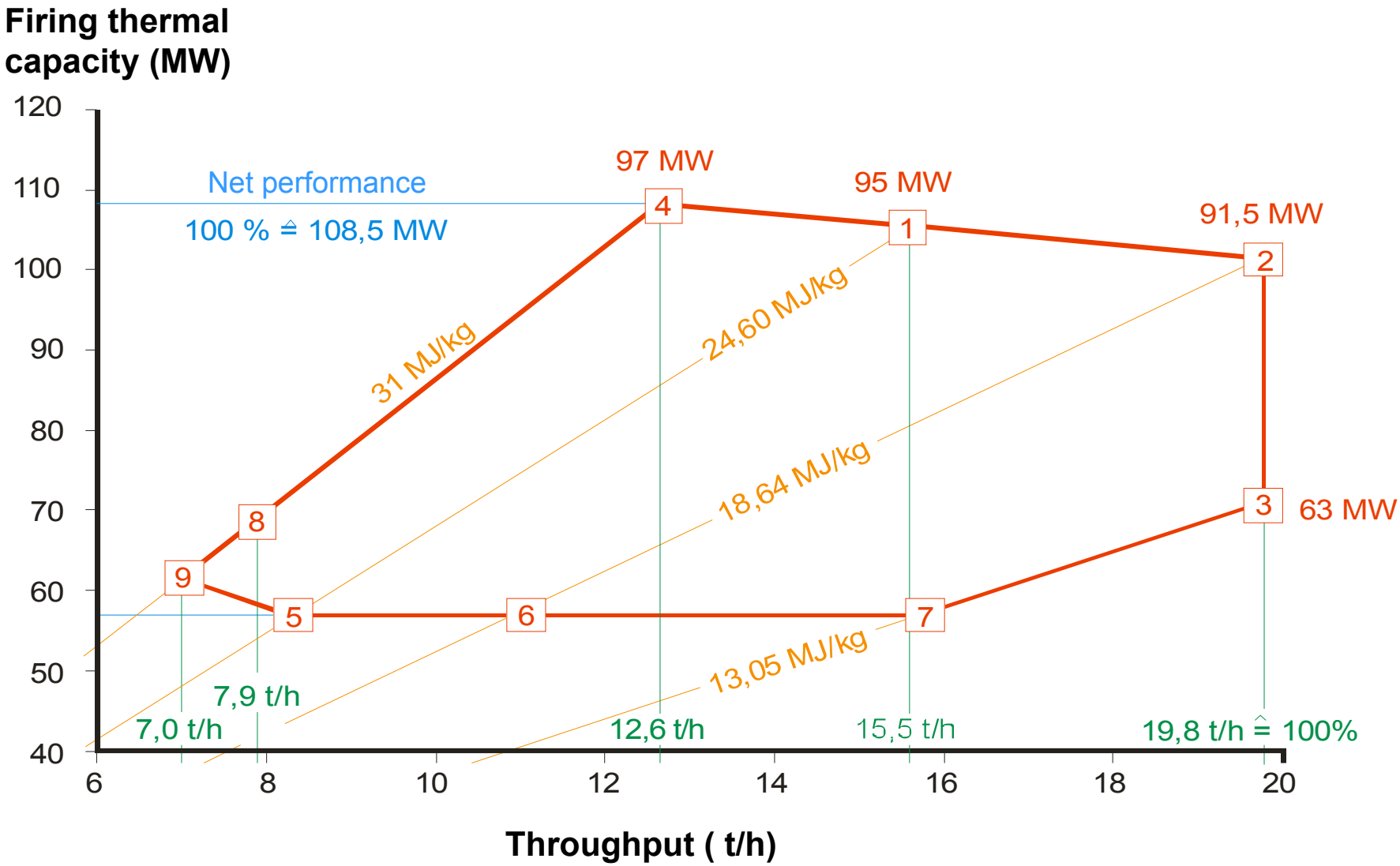
Lambda Grate = 0,25 – 0,5

100 MW Firing thermal capacity

Heating value RDF:

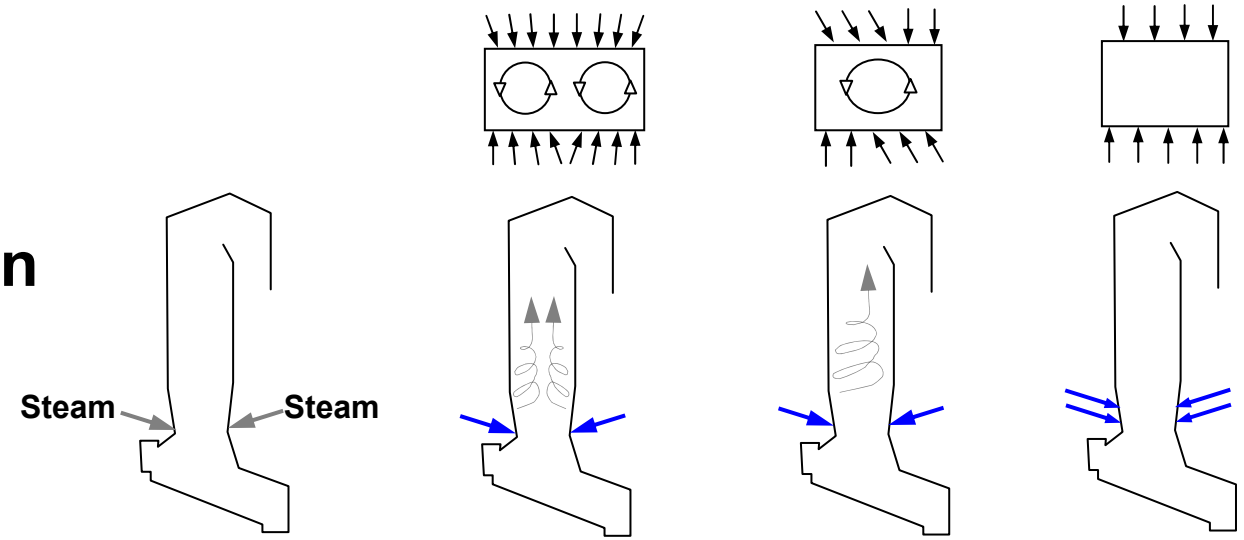
13 – 31 MJ/kg

Combustion Performance Diagram, CHP Igelsta, Södertälje, Schweden



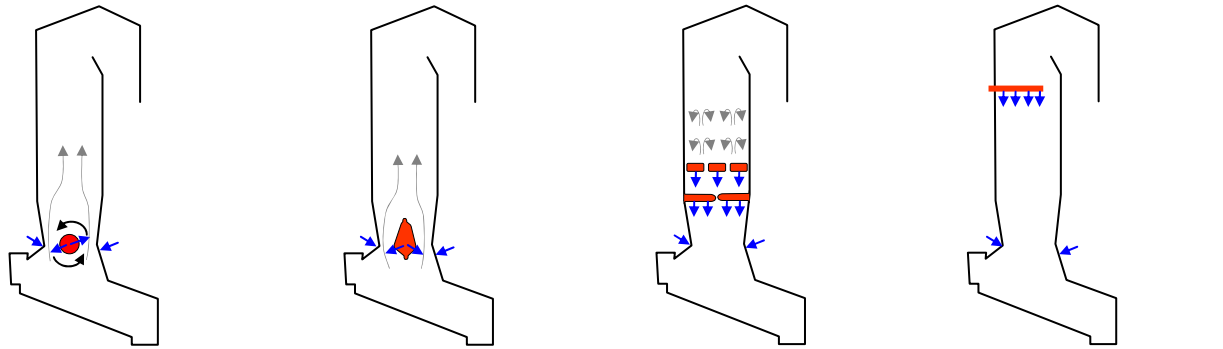
Flue gas Homogenization and Combustion Air Distribution

Air injection systems



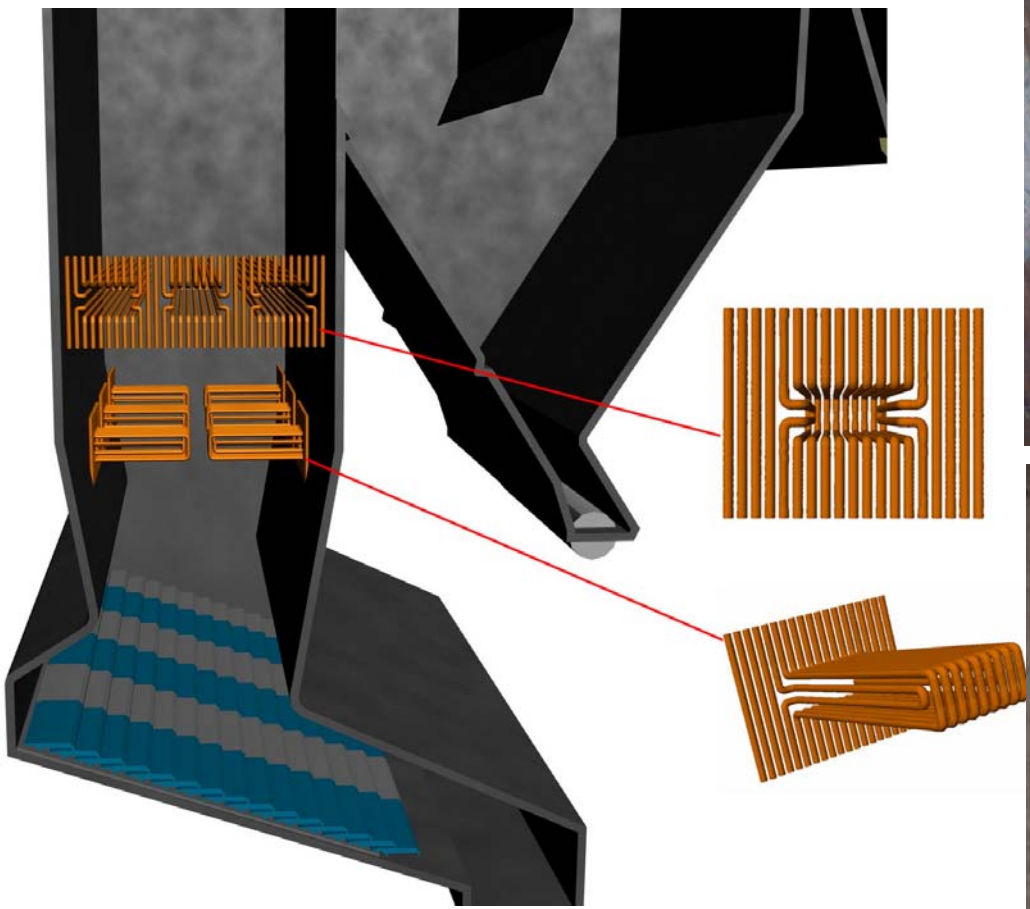
Schwandorf | Babcock | von Roll | Alstom

Fixtures for air injection

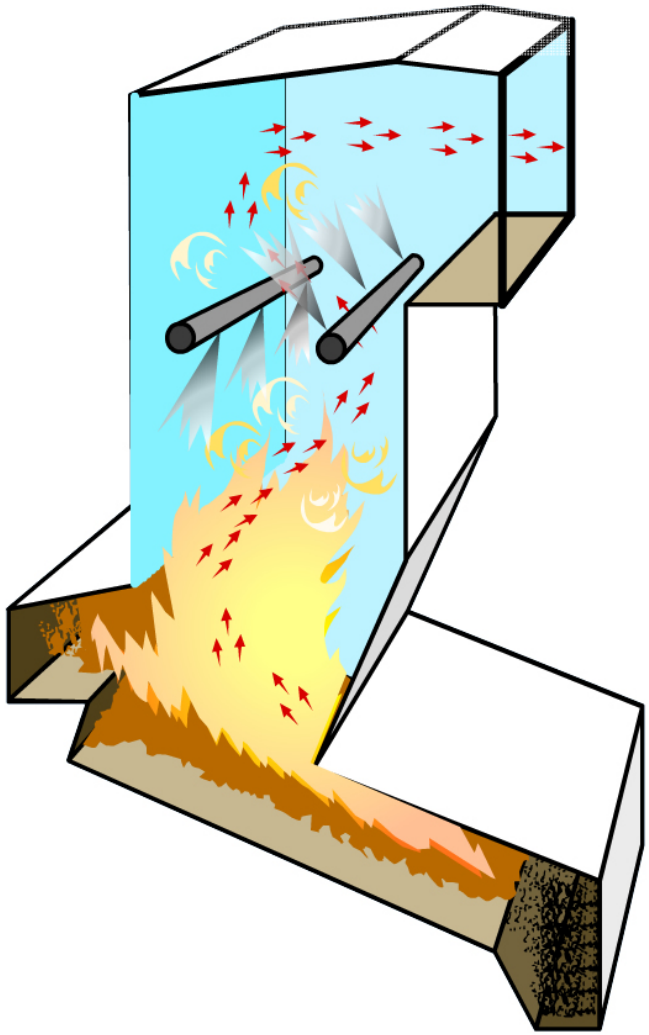


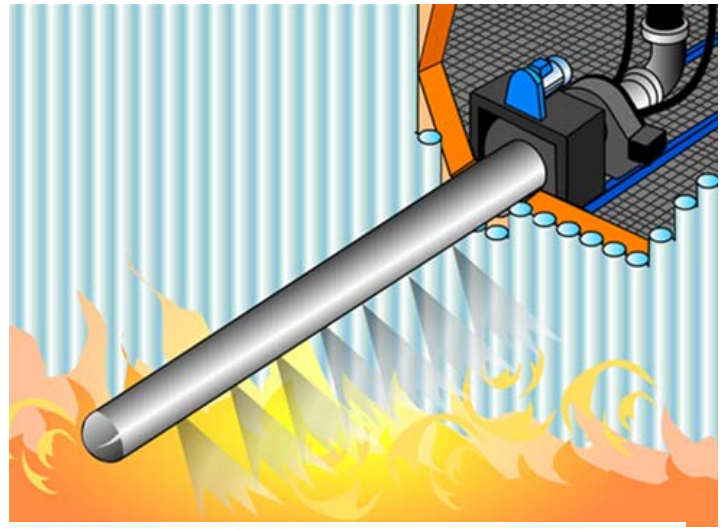
Temelli-Beam | - KS-Prisma - FCC | Tetratubes® | ECOTUBE®

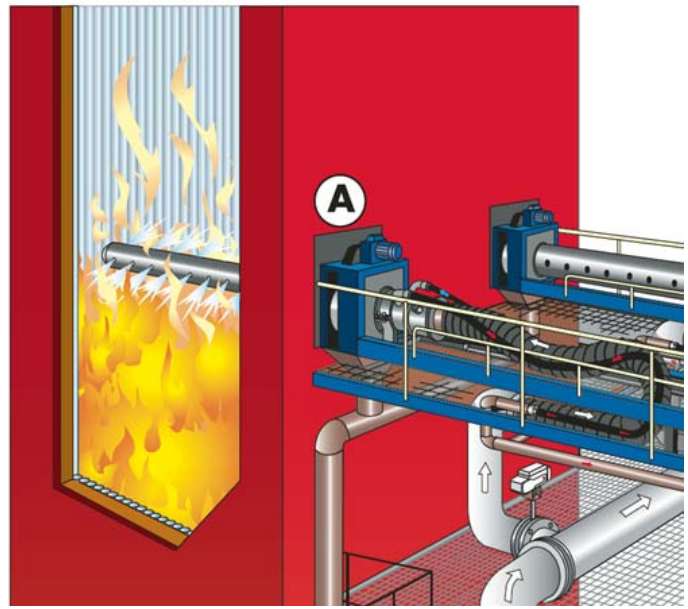
Implementation of Tetratubes, NEM Energy Services



System EcoTubes, ECOMB AB, Södertälje



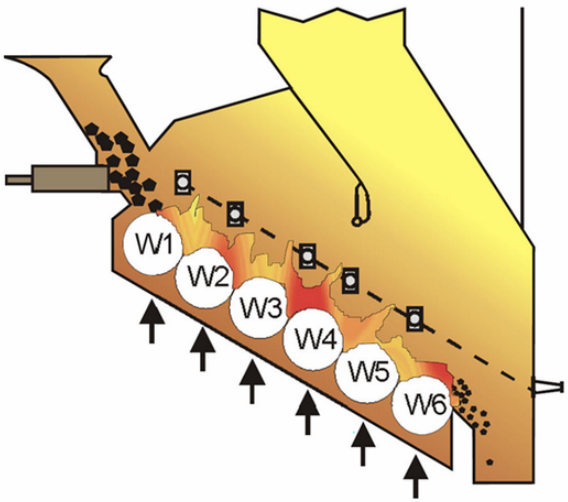


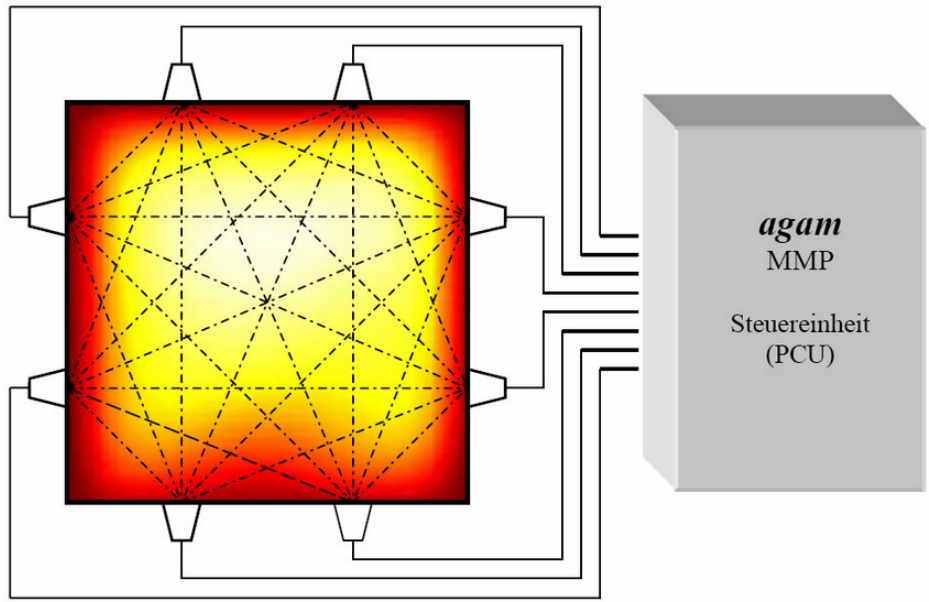


Combustion control

Measurement for combustion control (temperature, position)

- Thermocouples
- Acoustic gas temperature measuring
- Temperature measuring by infrared
- Online-Heat flow measuring



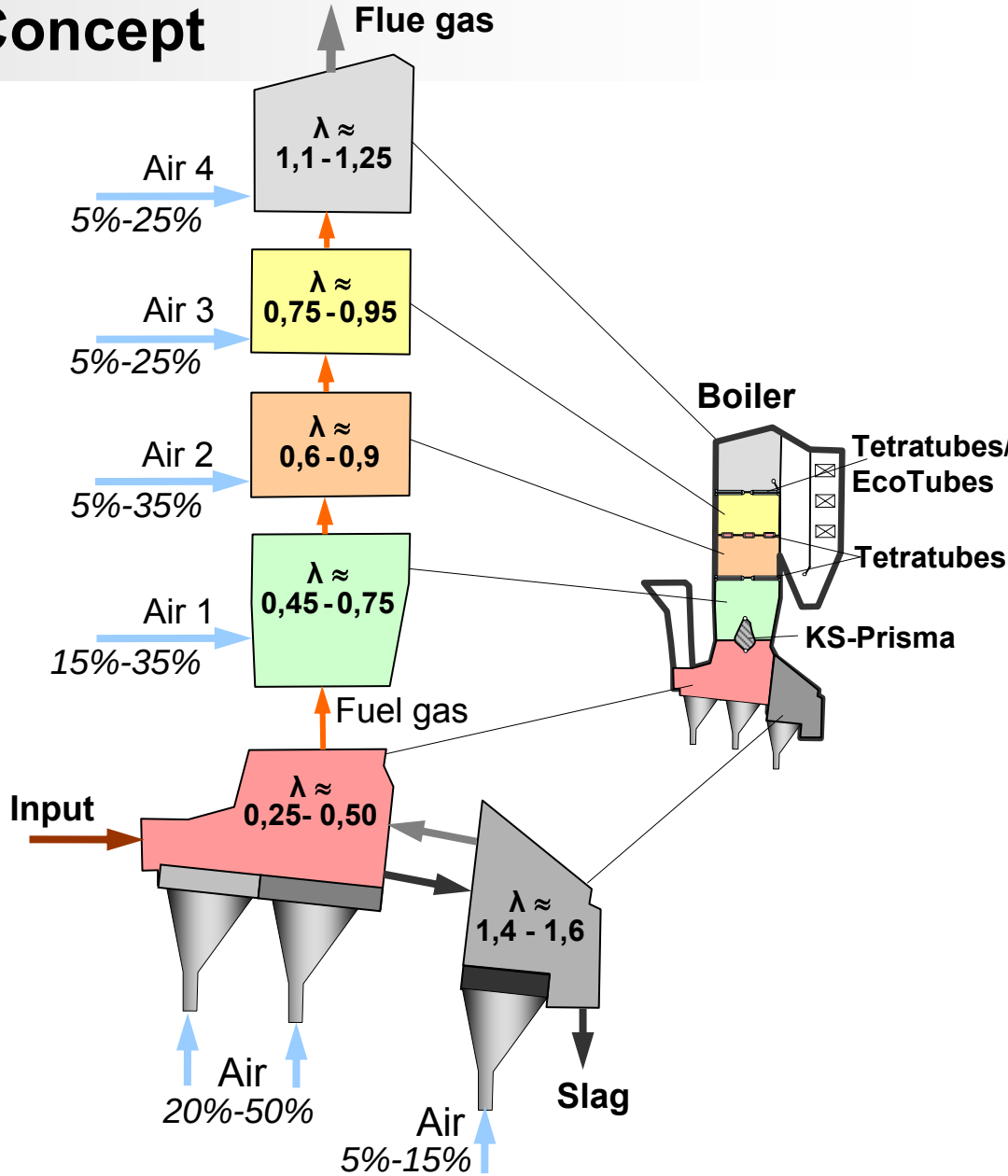


System agam

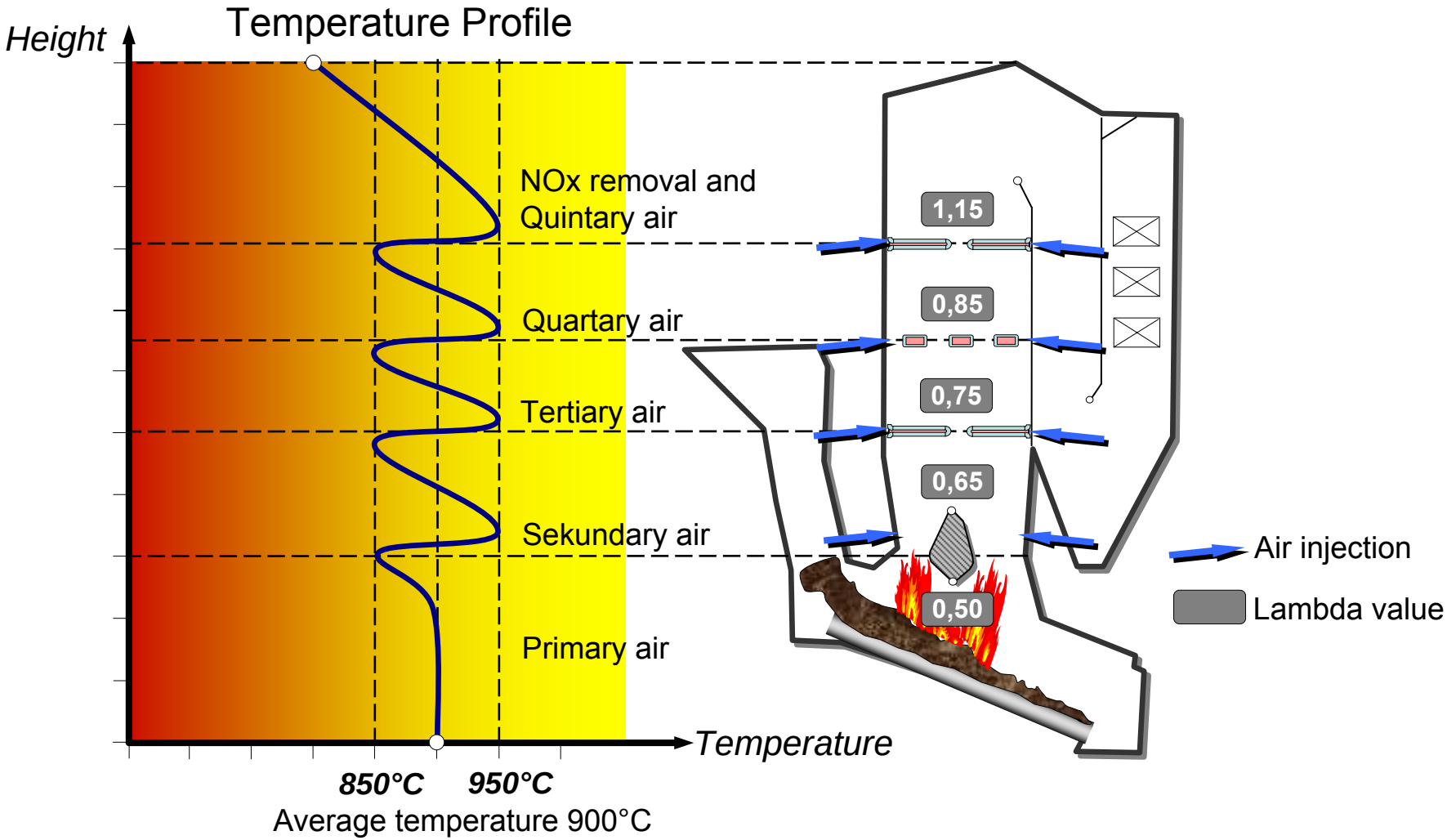
Optimized Combustion Concept

Ideal multi step afterburning

1. Lambda < 1,25
2. Low temperature in combustion chamber
3. Reduction of corrosion and slagging
4. Wide range of heating value
5. Reduction of fly ash



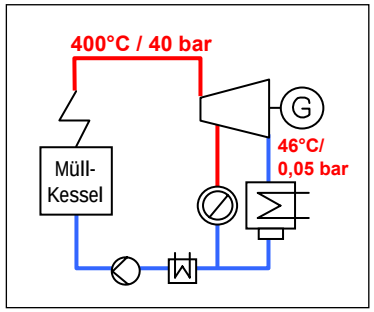
Optimized Combustion Concept



Idealized temperature profile with optimized firing concept

Evaluation of different superheating concepts

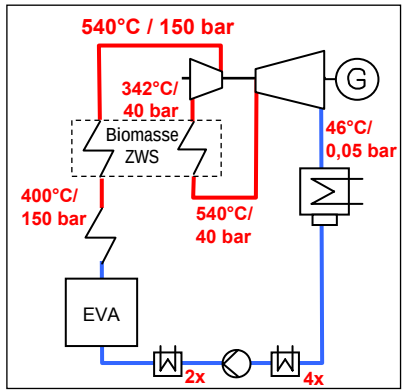
Standard MVA/EBS



ηel. net = 26%

no intermediate superheating

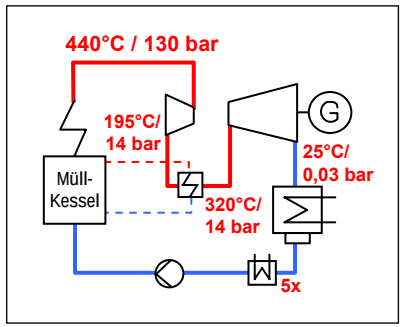
BiFuelCycle®



ηel. net = 37%

external superheating with biomass/coal

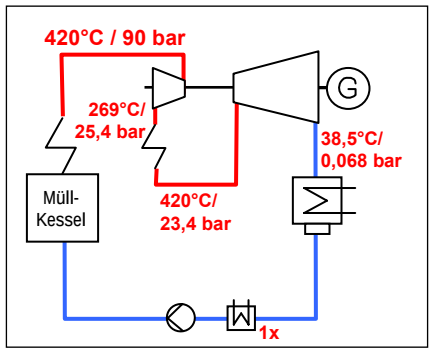
AVI-Amsterdam



ηel. net > 30%

Internal superheating with steam

EBS Rüdersdorf

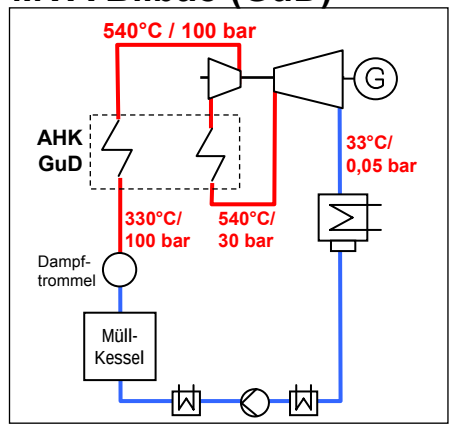


ηel.netto > 29%

Internal superheating with waste

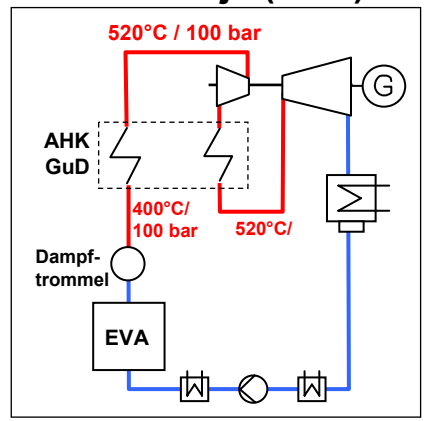
Intermediate superheating in combination with Gas and steam turbine Power Plant

MVA Bilbao (GuD)



ηel. net = 20% reg. waste

AZN Moerdijk (GuD)

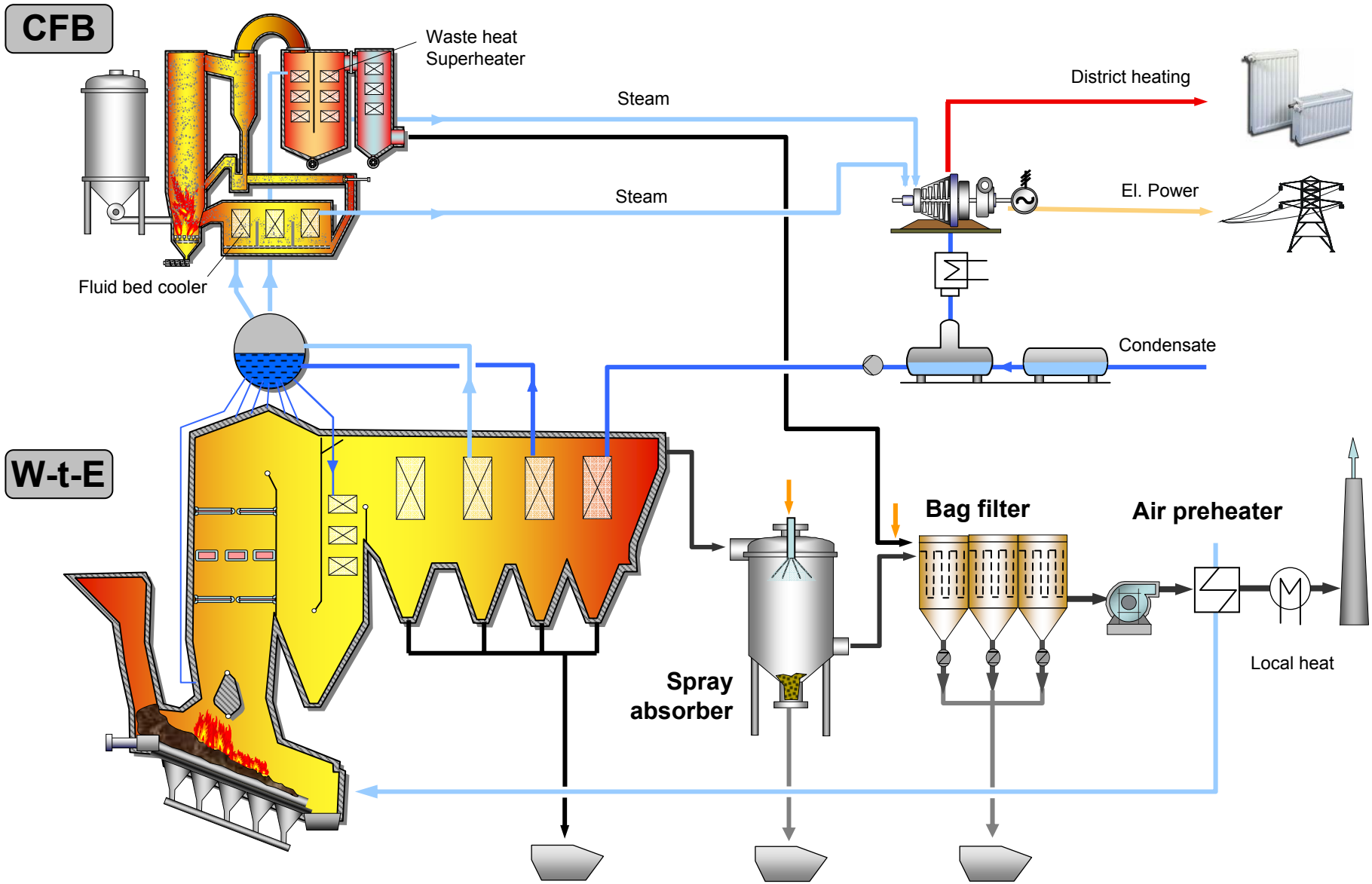


ηel. net = 15% reg. waste

Popular fallacy: increasing el. efficiency of WtE with Gasturbine

	Bilbao	MHKW Mainz	AZN Moerdijk
Gasturbine Type	LM6000 PD General Electric	SGT5-4000F Siemens	V64.3 Siemens
Firing Performance Gasturbine	112 MW	ca. 671 MW	ca. 491 MW
η el. gross Gasturbine	ca. 41 %	ca. 39 %	ca. 36 %
El. performance Gasturbine	46 MW	269 MW	3 x 59 MW
Exhaust Temperature	ca. 450 °C	ca. 585 °C	ca. 535 °C
Additional firing	40 MW	-	-
Firing performance total	152 MW	671 MW	491 MW
Firing performance waste	71 MW	88 MW	231 MW
El. Performance steam turbine	54 MW	160 MW (140 MW + ca. 20 MW)	145 MW
∑ electic gross	100 MW	429 MW	322 MW
∑ electric net.	93,66 MW	409 MW	(304 MW)
η el. electric gross total	45%	57%	45%
η el. net total	42%	53,9 %	(42%)
η el. net benchmark GuD	**52,5%**	**58,4%**	**55%**
el. Performance natural Gas benchmark GuD	79,8 MW	392 MW	270 MW
Residual el. performance Waste	13,86 MW	17 MW	34 MW
η el. net waste	**ca. 20%**	**ca. 20%**	**ca. 15%**

BiFuelCycle®



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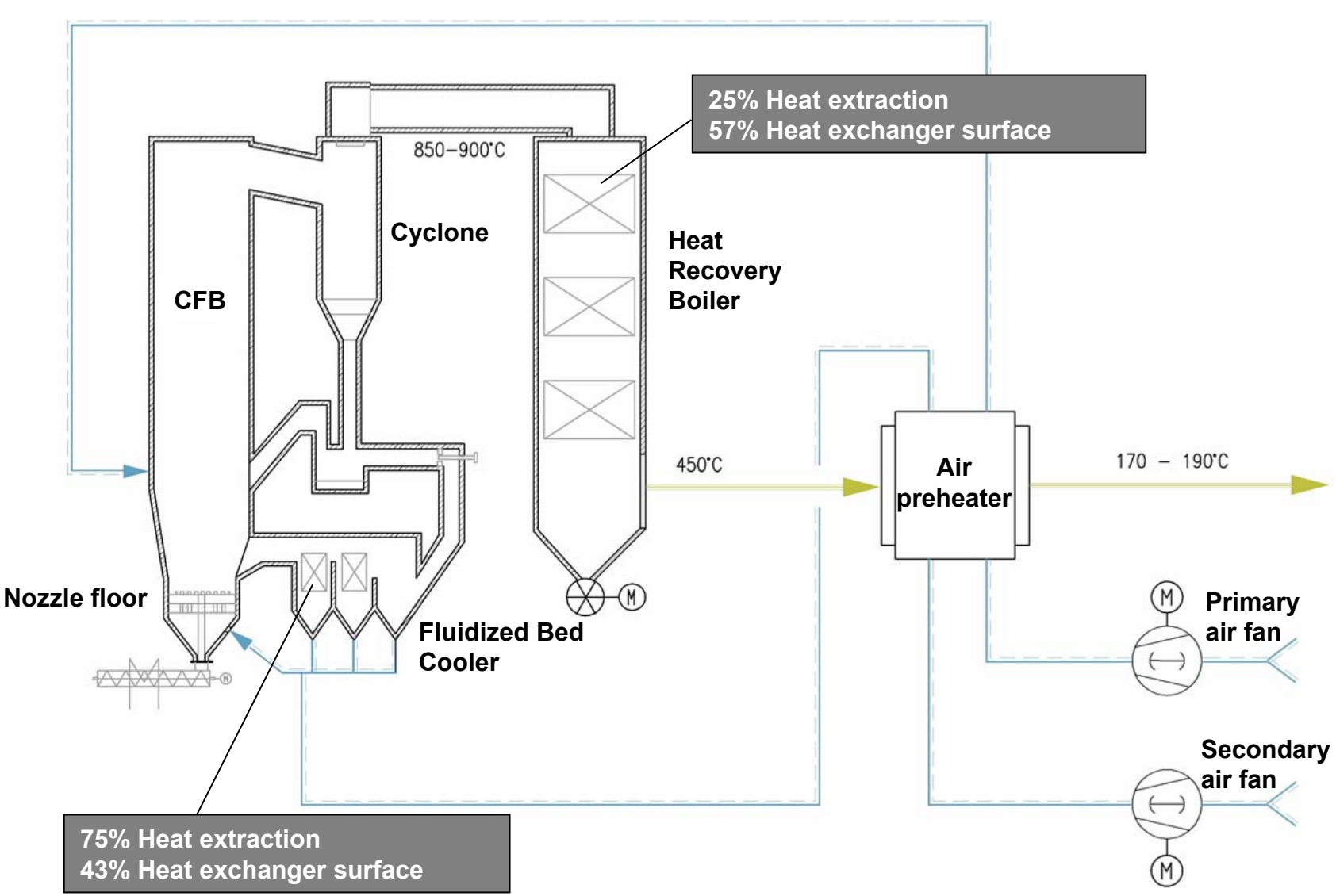
External Superheater - BiFuelCycle®



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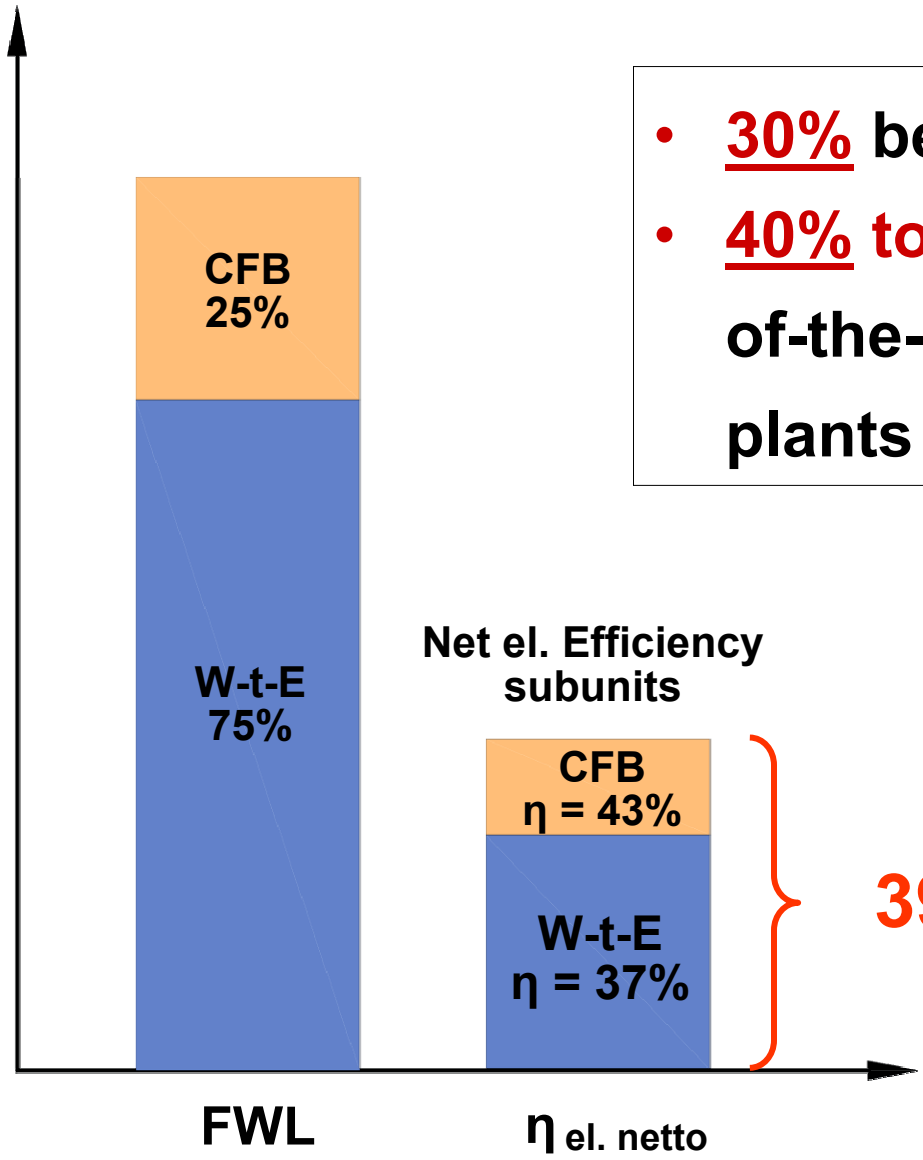
BiFuelCycle – Weight of effectiveness of BiFuelCycle®



- 30% better than AVI-Amsterdam
- 40% to 100% better than state-of-the-art Waste-to-Energy plants

39% Total net el. efficiency

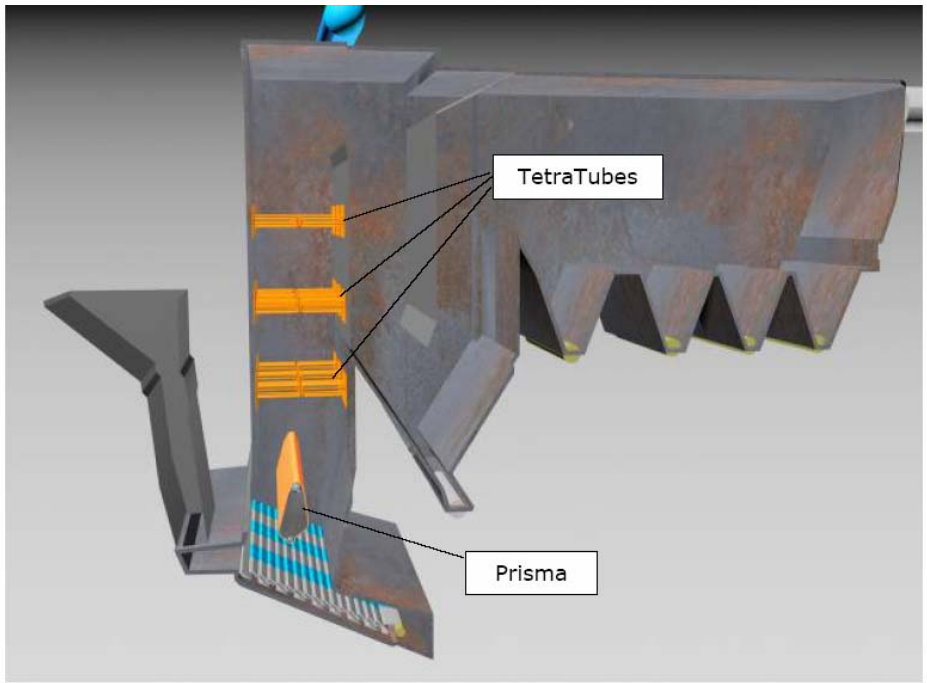
Genehmigungsfähigkeit optimiertes Feuerungskonzept

17. BImSchV, § 4 Feuerung, Absatz 2:

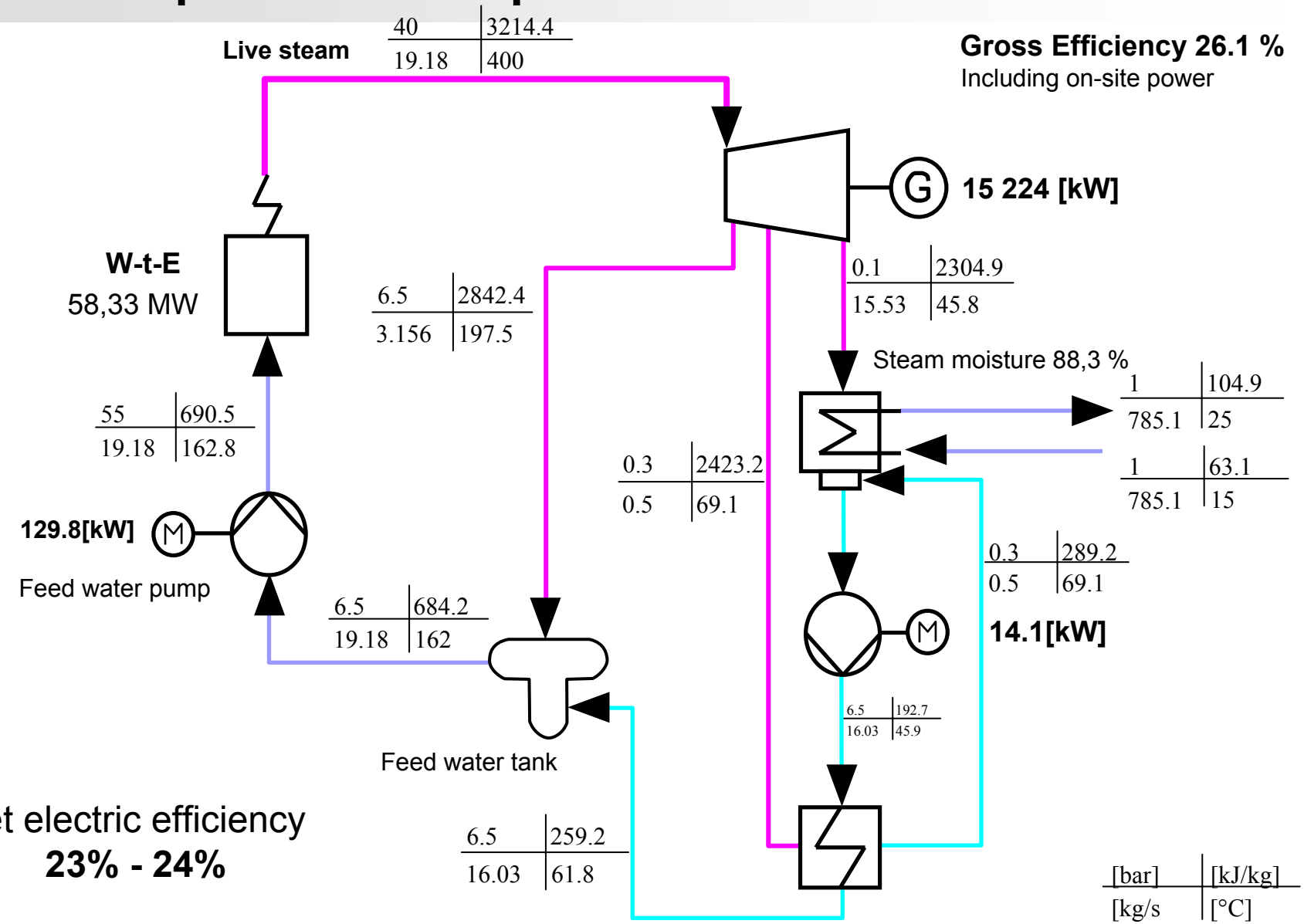
„Einhaltung einer Verweilzeit nach der letzten Luftzugabe von mindestens 2 Sekunden bei 850°C“

Alternativ nach Abs. 3:

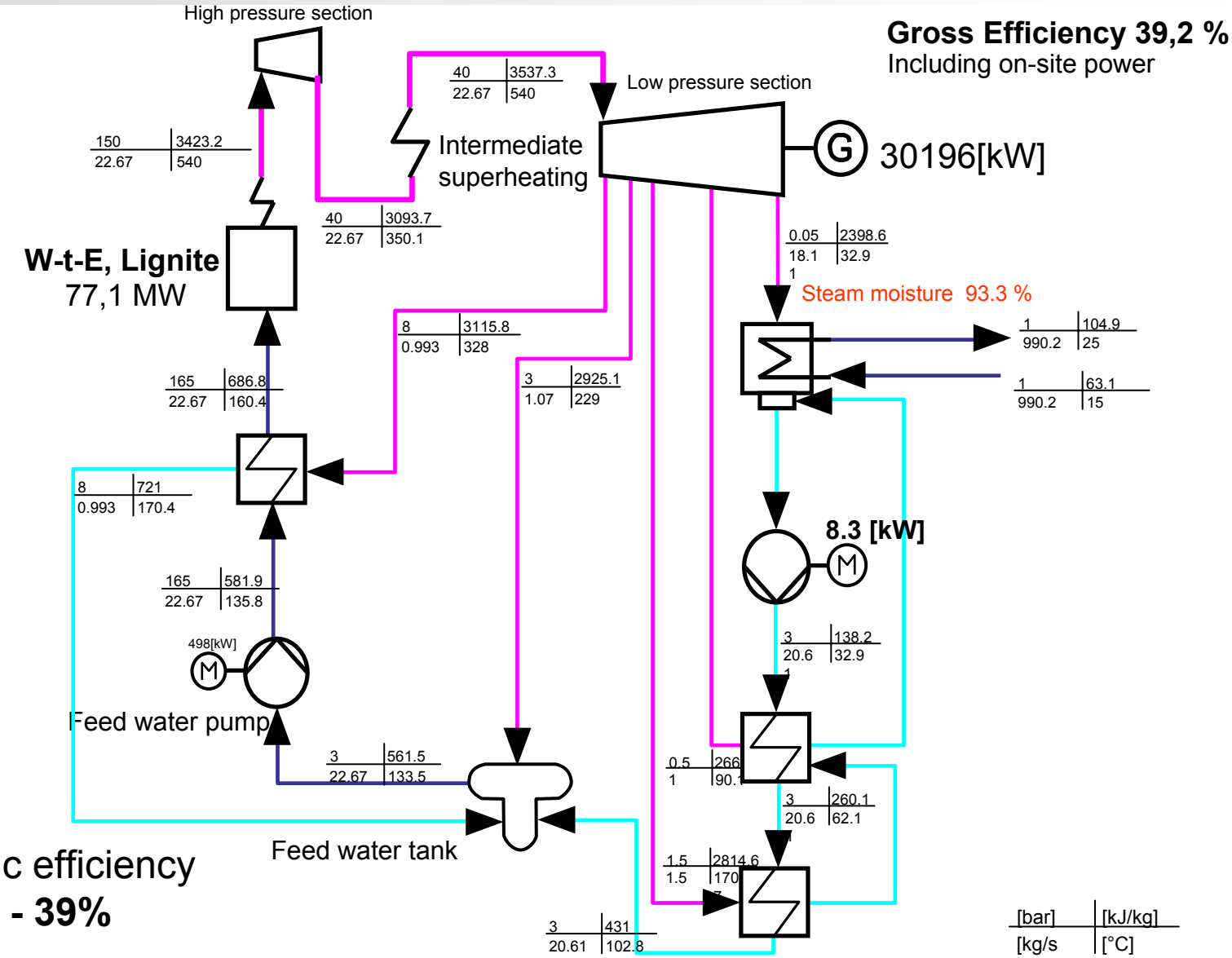
Einholung eines Gutachtens über die Gleichwertigkeit der Emissionen oder messtechnische Überprüfung bei der Inbetriebnahme



Standard plant – Steam parameters 40 bar/400°C



BiFuelCycle plant – Steam parameters 150 bar/540°C



Gross Efficiency 39,2 %
Including on-site power

Net electric efficiency
37% - 39%

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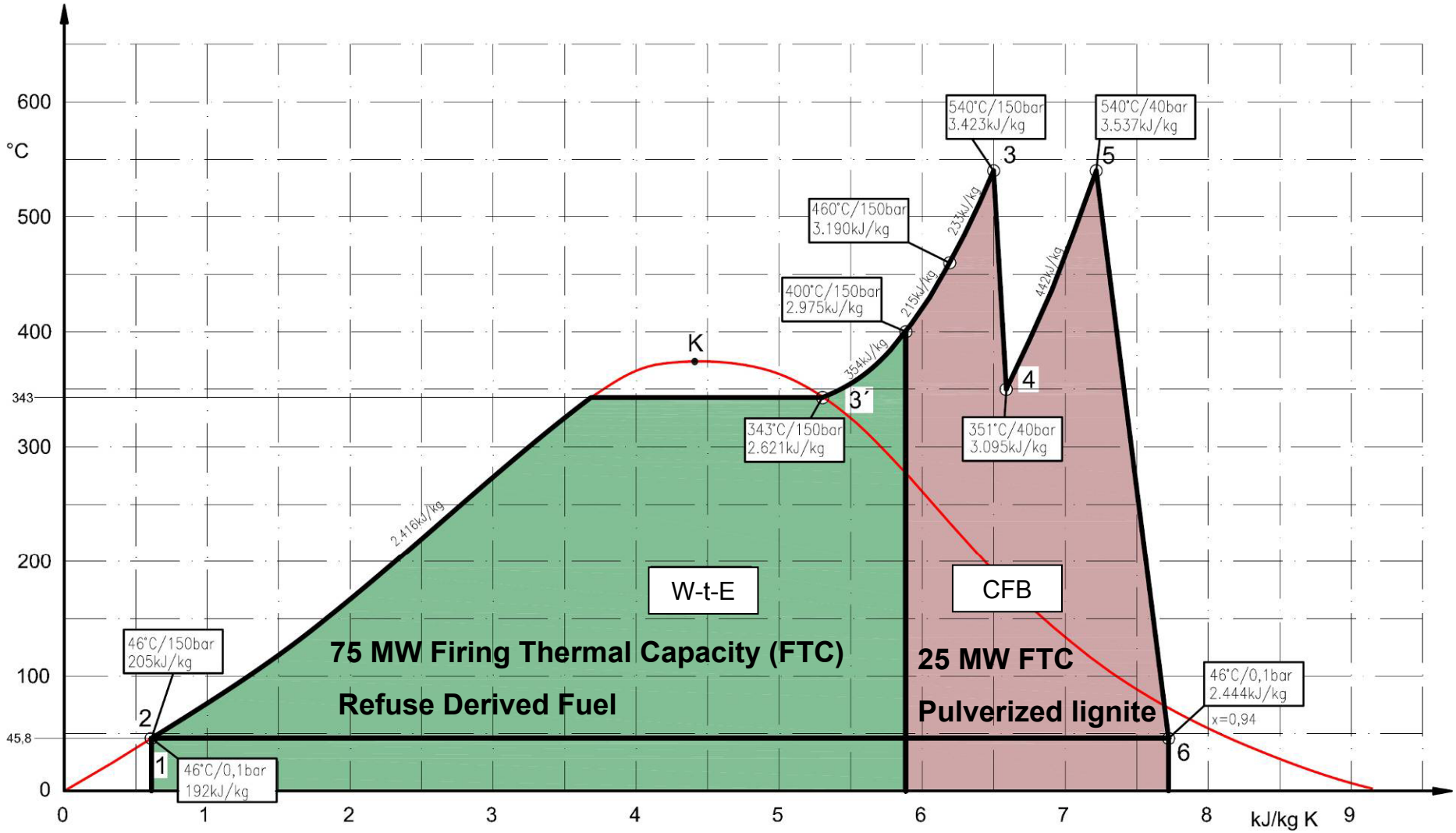
BiFuelCycle – TS-Diagram



BiFuelCycle – Animation