Valmet BFB conversions

Joonas Hämäläinen

This is Valmet

Unique offering

- Market's widest offering combining process technologies, services and automation
- Research and development spend EUR 75 million in 2020

Market leadership

- Leading market position in all markets
- Pulp #1–2
- Energy #1–3
- Board #1
- Tissue #1
- Paper #1
- Services #1–2
- Automation #1–3

Strong global presence

- Approx. 100 service centers
- 98 sales offices
- 43 production units
- 16 R&D centers
- 14,000 professionals

EMEA	9,200
China	1,900
North America	1,500
Asia-Pacific	900
South America	500

Leader in sustainability

- Seven consecutive years in Dow Jones Sustainability Index
- Four consecutive years in Ethibel Sustainability Index Europe
- A- rating in CDP climate program 2020

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Leading technology supplier of biomass and multifuel boiler plants globally

Renewables to energy

Biomass to energy

Sorted waste to energy (RDF-refuse derived fuel

Multifuel to energy

Co-firing biomass, waste (RDF, SRF) and fossil fuels (coal, gas)

Industrial boilers

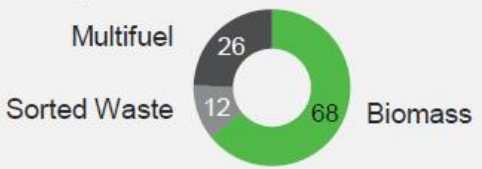
O&G / Process Gas Boiler plants

Heat recovery boiler plants

Air emission control

- Over 200 Bubbling Fluidized Bed boilers (BFB) since 1979 Capacity 10-400 MW_{th}
- Over 100 Circulating Fluidized Bed boilers (CFB) since 1980 Capacity 50 -1000 MW_{th}
- Over 30 Modularized biomass power plants since 1999 Capacity 2-10 MW_e
- 8 Gasification plants for waste and biomass

Since 2007 ~100 new boiler plants
Total capacity ~ 12 000 MW_{th}



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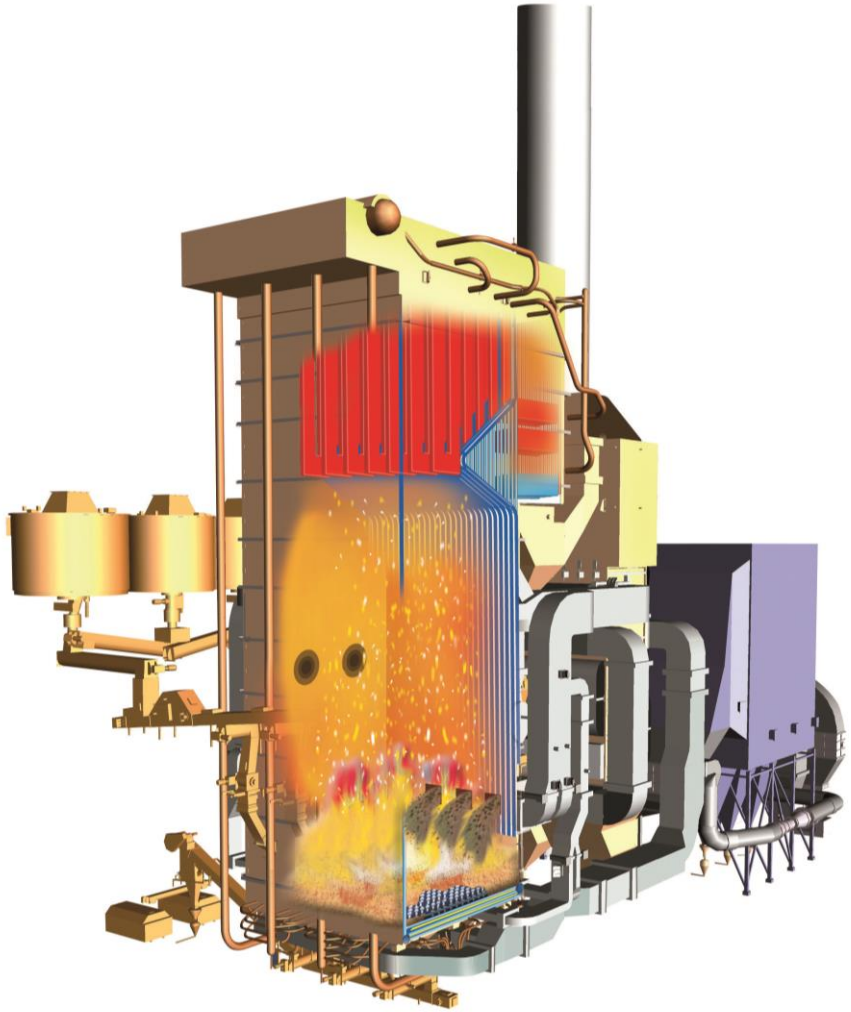
BFB conversion means

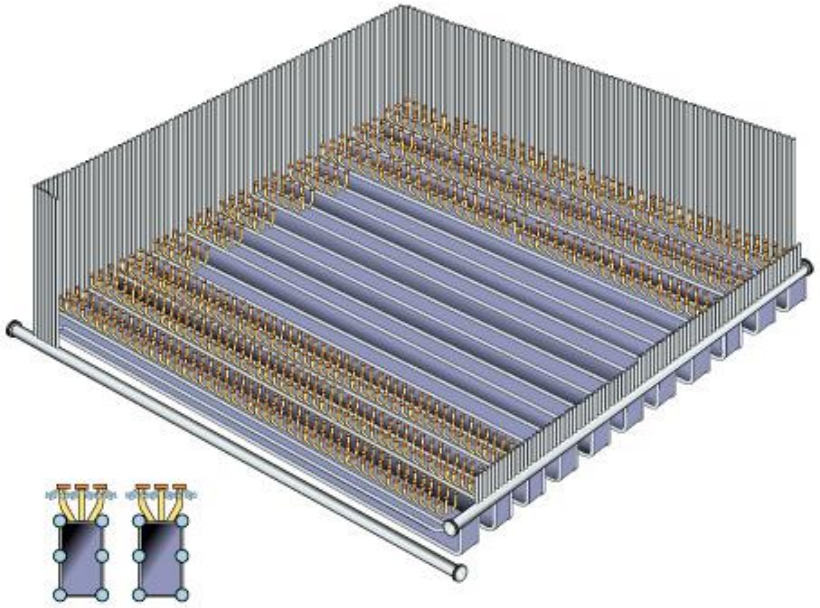
” Modification of an other type of boiler to Bubbling Fluidized Bed combustion”

- Especially existing biomass and coal boilers are suitable for BFB conversion, but also recovery boilers in the pulp mills.

HYBEX boiler

HYBEX = Valmet Bubbling Fluidized Bed Boiler (BFB)



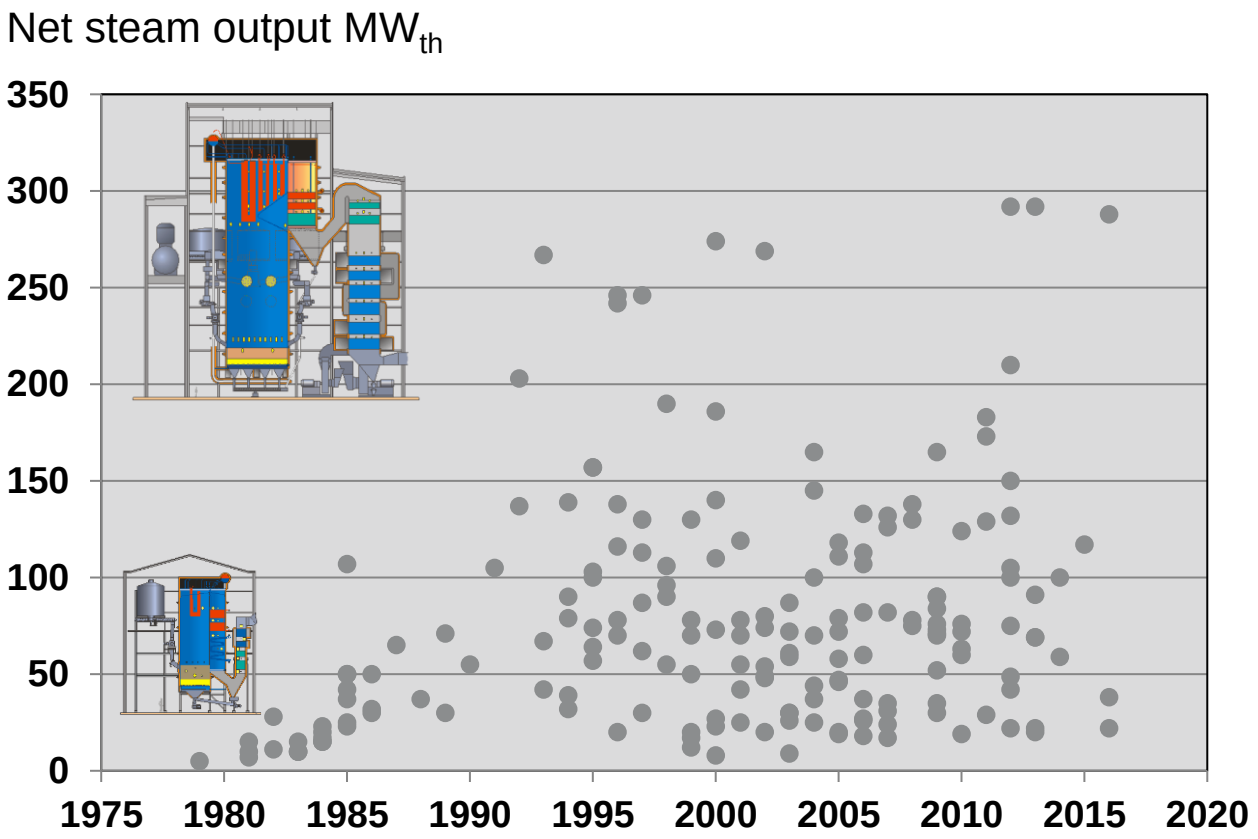


HYBEX® Boilers and Conversions

> 200 delivered boilers, > 60 BFB conversions, > 40 years experience

Conversions:

- Same BFB technology is applied as in new Hybex boilers
- All kind of boilers converted to BFB
  - 10 Pulverized Fired
  - Grate, Recovery, Oil boilers etc.
- Mostly boiler made by other boilermakers, only <10 own
- BFB references In Europe, Asia, North and South America

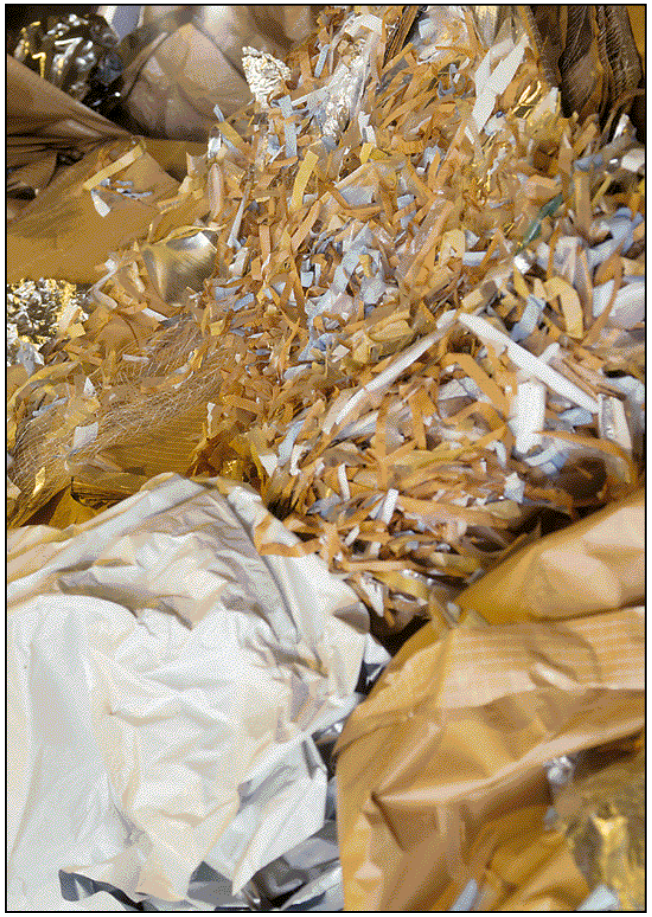


Traditional biomass fuels

Wood chips
Bark
Forest residues
Saw dust
Milled peat
Sod peat
Pulp mill sludges

Demanding fuels

Eucalyptys bark
De-inking sludge
Recycled wood & fiber
Industrial waste (REF)
Recycle Derived Fuel (RDF)
Tire derived fuel (TDF)
Agro wastes



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Fluidized sand bed

- Sand particle size 0.5 - 1.5 mm
- Static bed height 40-60 cm
- Fluidizing velocity 0.8 -1.2 m/s
- Bed temperature 700 – 950 ºC
- Pressure drop 6 – 9 kPa

Conversion to BFB Boiler

Traditional scope of supply

Modify water circulation

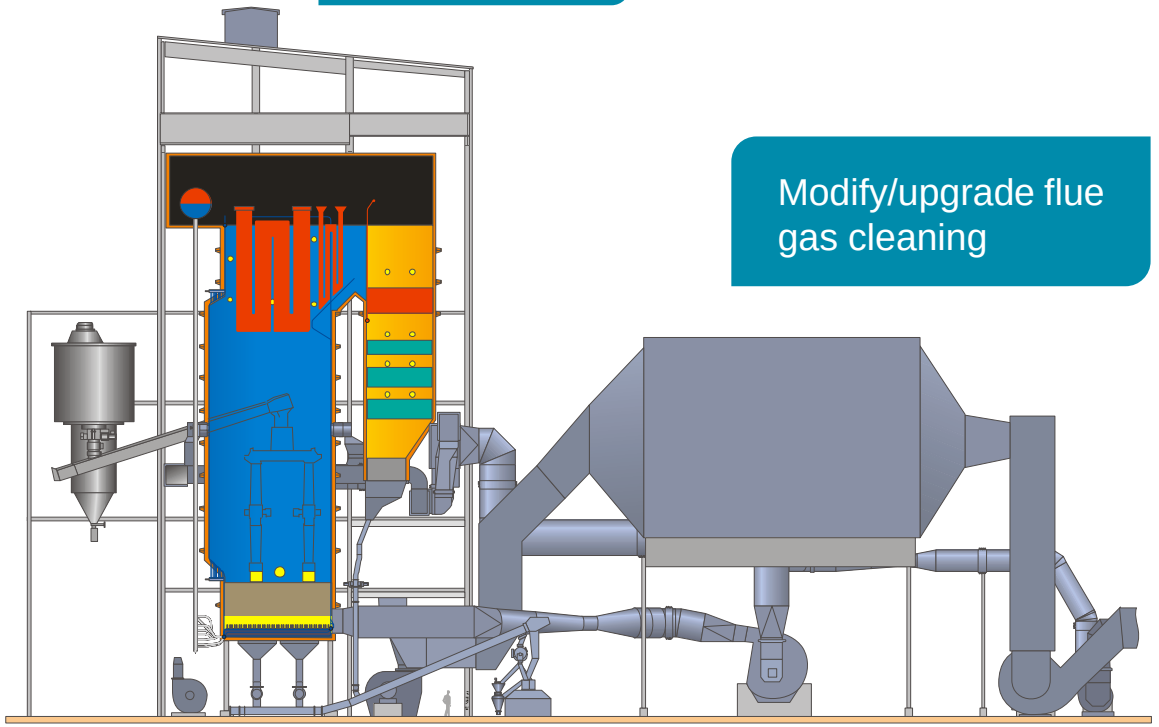
Modify overfire air system

Replace fuel feed system

Add start-up burner(s)

Replace lower furnace with fluidized bed

Add fluidizing fan and ducting



Modify/upgrade flue gas cleaning

Add bottom ash removal

Add flue gas recirculation

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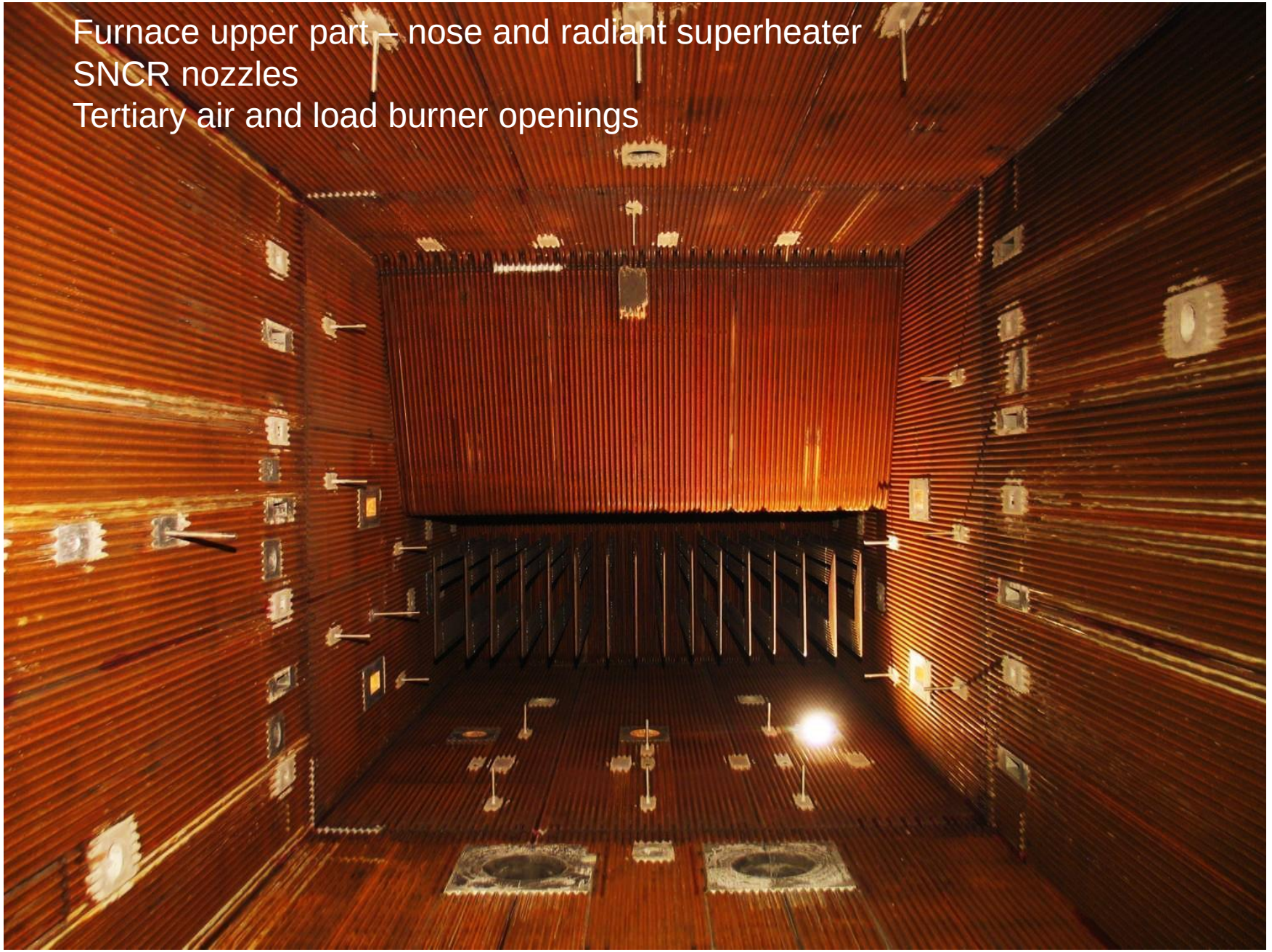
Furnace upper part – nose and radiant superheater
SNCR nozzles
Tertiary air and load burner openings




Furnace lower part – Refractory area
Fuel feeding and start-up burner openings

BFB biomass conversion vs. new boiler

Chances and challenges

CHANCES/BENEFITS

Lower investment cost compared to new plant

- 50 to 70% lower cost
- Possible to utilize large amount of existing equipment

Shorter project schedule

- Typically one year to commissioning

Familiar boiler to operators

- Less training required
- Less operation errors

Simplier permit process

- Less strict environmental requirements
- Faster project start

CHALLENGES

Fuel limitations

- Limitations of the original boiler must be considered – corrosion, fouling, emissions

Capacity

- Capacity gets often lower compared to fossile fuel firing

Efficiency

- Flue gas exit depends on the existing heating surfaces and may be higher than in the new boiler → reduced efficiency

Steam pressure and temperature

- Same as in the original boiler, no possibility to optimize the power plant process

Emission control more difficult

- Limitations in boiler dimensions, layout and space

BFB conversion references

Białystok , Poland

- Pulverized coal boiler to BFB, 2 units

Kuopion Energia

- Pulverized peat boiler to BFB

IP, Kwidzyn, Poland

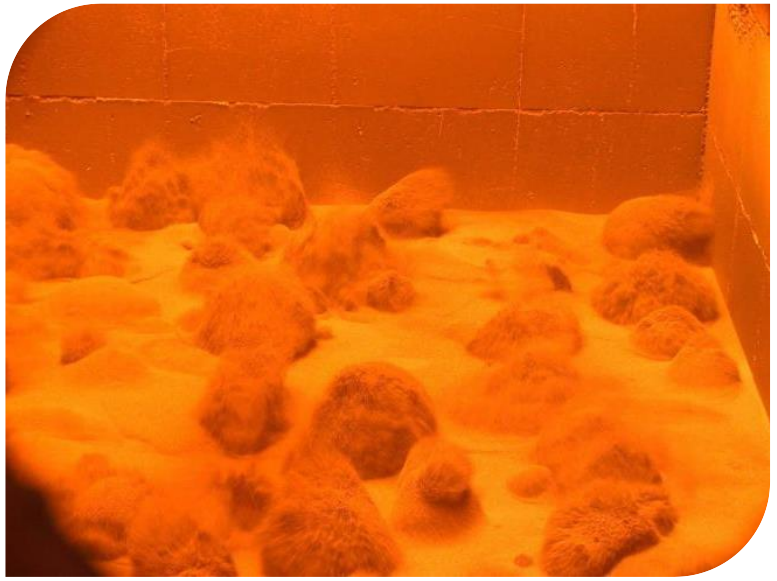
- Traveling grate boiler to BFB

Södra Cell AB, Mörrum, Sweden

- Recovery boiler to BFB

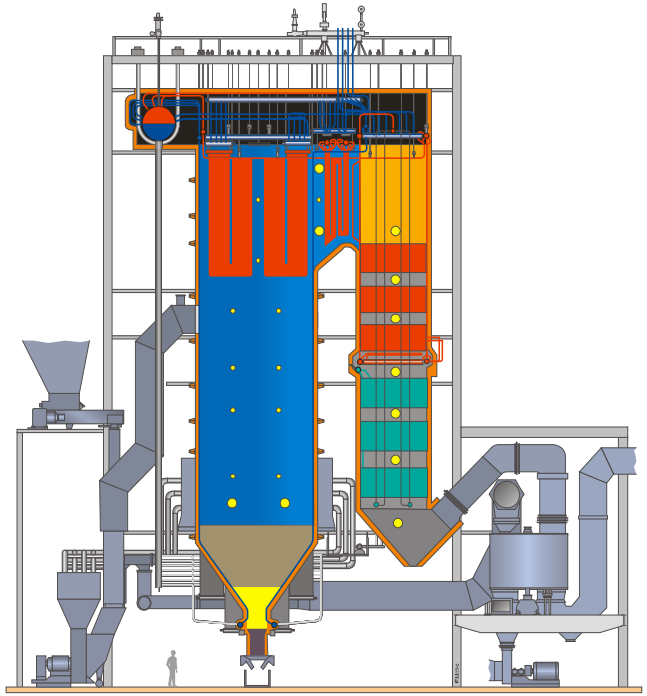
Billerud Gruvön AB

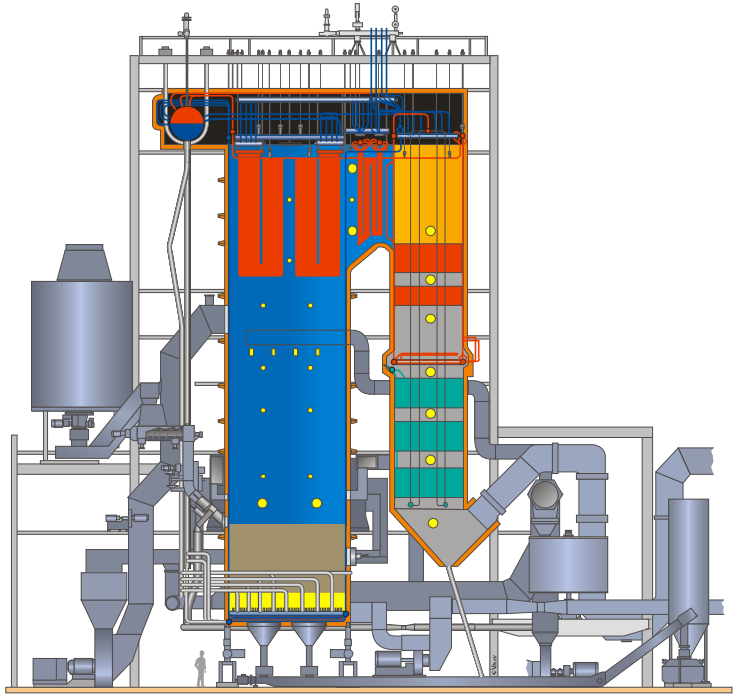
- Inclined grate boiler to BFB



Elektrociepłownia Białystok S.A, Poland
BFB conversion

Original	
Steam	140 t/h 138 bar, 540 °C
Fuels	Coal + oil
Converted	
Steam	115 t/h
Fuels	Wood chips, forest residues, Agro biomass
Start-up	2008





Benefits:
- Coal replaced with biomass, production of green energy
- Lower emissions: SOx, NOx

Fuels and performance

80% wooden biomass:

- forest residues (green and brown), wood chips

20% agro biomass and energy crops:

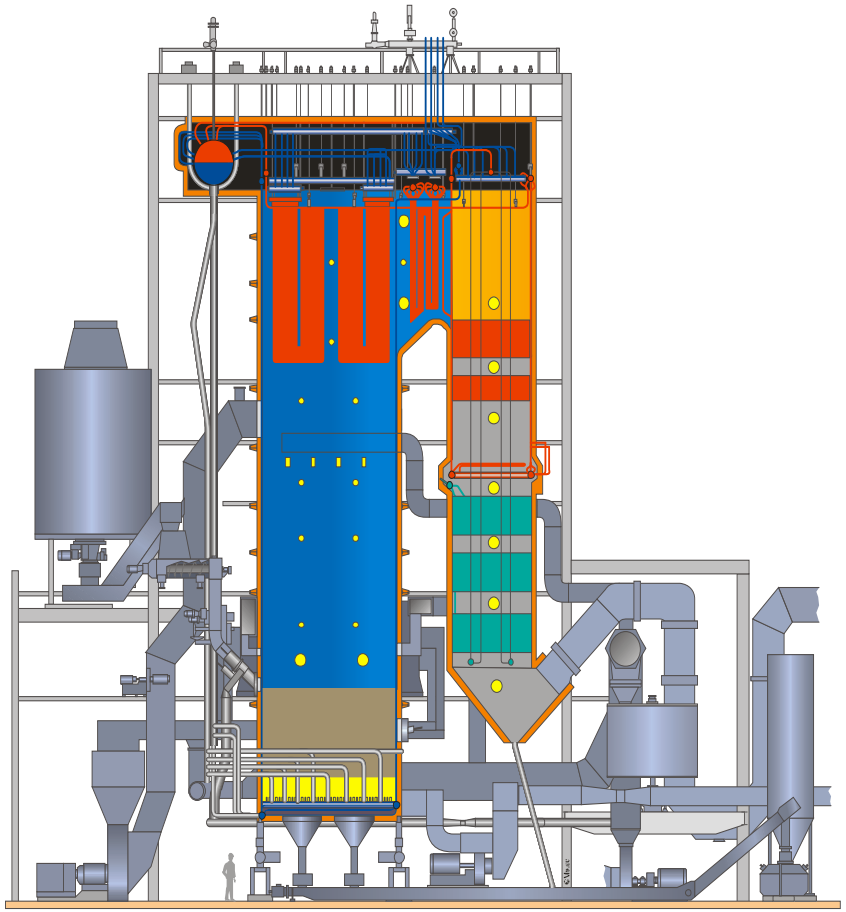
- sunflower pellets, residuel oat grains, straw, willow
- agro fuels 30% of heat input

LHV = 8 – 13 MJ/kg

Steam capacity: 105 t/h (actual 115 t/h)

Efficiency >88%

- NOx < 200 mg/Nm3
- SOx < 200 mg/Nm3



Elektrociepłownia Białystok S.A, Poland

International Paper, Kwidzyn, Poland

Conversion to BFB, from a travelling grate boiler

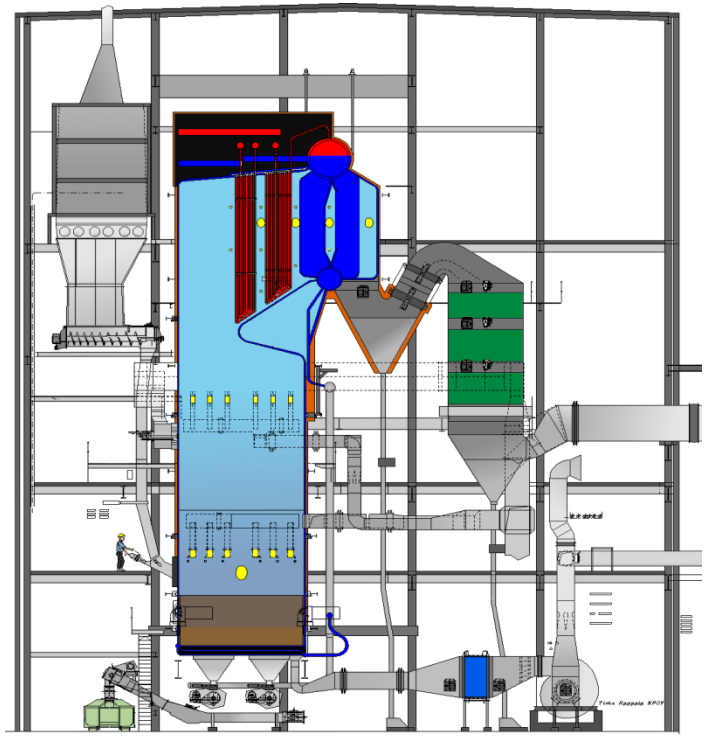
Original design:

- Steam: 22 kg/s, 65 bar, 440 °C
- Fuels: Bark, Coal, Oil

After conversion:

- Steam: 28 kg/s
- Fuels: Bark, Woodwaste, Sludge, Oil

- **Rebuild completed 2000**



Original

Results:

- Increased bark firing capacity (steam 22 kg/s to 28 kg/s)
- Reduced maintenance
- Eliminated support oil firing

Biomasse Energie Alizay SAS, France

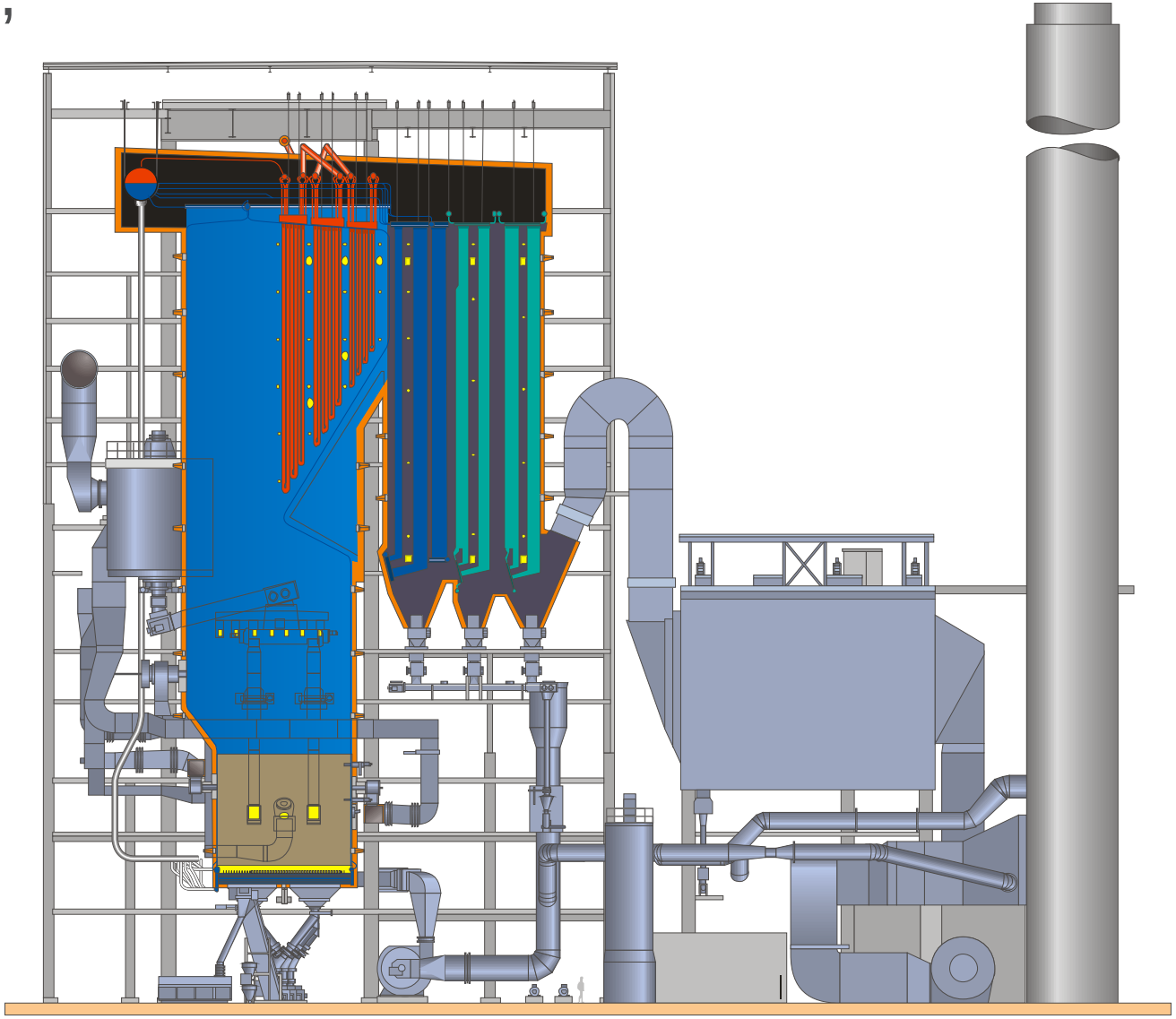
Recovery boiler conversion to BFB firing

Original (Recovery boiler)

Steam	209 t/h 60 bar (g), 450 °C
Fuels	Black liquor, natural gas
Start-up	1991

Converted (BFB boiler)

Steam	163 MW_{th} 209 t/h 62 bar (g), 460 °C
Feedwater	120 °C
Fuels	Wood chips, bark, clean recycled wood, natural gas
Start-up	2020

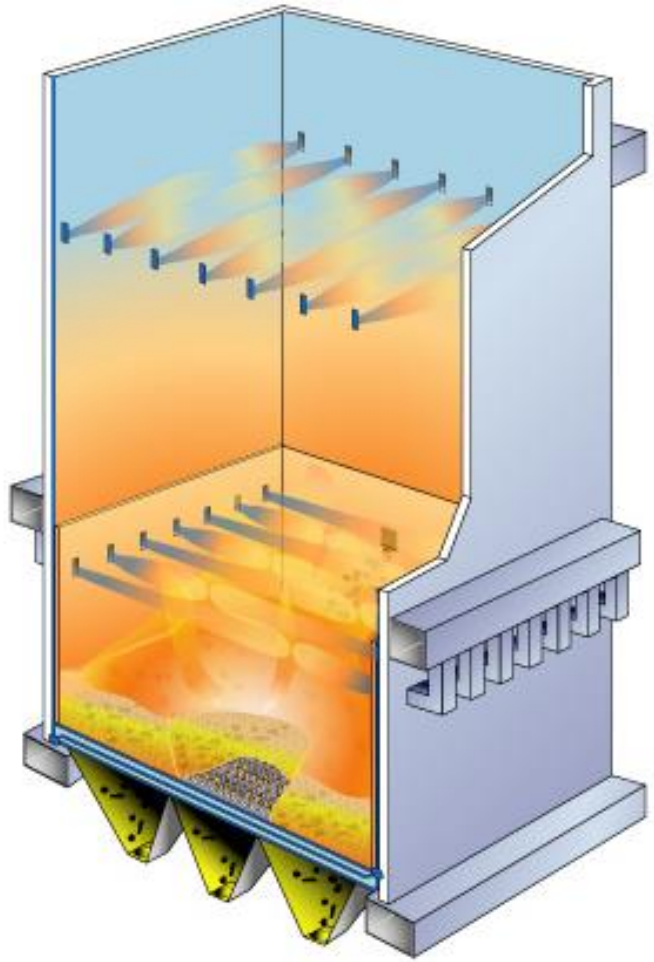


Newest References

DELIVERY YEAR	CUSTOMER	COUNTRY	STEAM DATA					TYPE OF PROJECT		FUELS
			BFB CAPACIT kg/	TOTAL CAPACIT kg/	PRESSURE bar(	TEMP °C	CAPACITY MW			
2021	Zespół Elektrowni Pątnów-Adamów-Konin SA	Poland	61,1		97	540	157	PC boiler conversion to BFB boiler	BFBc	Wood chips, willow chips, light fuel oil
2020	Biomass Energie Alizay, Alizay	France	58,0		62	460	163	Recovery boiler (RB) conversion to BFB boiler	BFBc	Wood chips, bark, recycled wood
2013	Kuopion Energia Oy, Kuopio	Finland	88,0		114	535	220	Pulverized peat fired boiler conversion to BFB	BFBc	Wood residues, peat, oil
2012	OJSC Mondi, Syktyvkar	Russia	35,0		40	440	80	RB conversion to BFB	BFBc	Bark, wood, residues, sludge, oil
2012	CMPC Celulosa S.A., Laja	Chile	42,0	49,0	46	440	114	RB conversion to BFB	BFBc	Eucalyptus and pine bark, wood residues, fuel oil
2012	Elektrociepłownia Tychy S.A., Tychy	Poland	38,0		100	540	105	Coal fired CFB boiler conversion to BFB firing	BFBc	Wood chips, non-forest biomass
2012	Elektrociepłownia Białystok S.A, Białystok	Poland	29,0		138	540	75	PC boiler conversion to BFB firing	BFBc	Wood chips, forest residue, willow, grain waste, coal
2011	Howe Sound Pulp and Paper Ltd Port Mellon, BC	Canada	67,0		85	480	173	Hydrograte Stoker conversion to BFB	BFBc	Wood residues, sludge, natural gas
2011	Dalkia Łódź S.A., Łódź	Poland	50,0		130	540	129	PC boiler conversion to BFB	BFBc	Wood chips, non-forest biomass
2010	Kogeneracja S.A., Wroclaw	Poland	28,0		80	500	76	PC boiler conversion to BFB	BFBc	Wood chips, non-forest biomass
2010	Martinská Teplárenská a.s., Martin	Slovakia	21,0		57	450	60	PC boiler conversion to BFB	BFBc	Wood chips
2009	Portucel Cacia, Cacia	Portugal	25,0	35,0	63	425	67	Travelling grate conversion to BFB	BFBc	Eucalyptus bark, wood residues, oil, gas
2008	Elektrociepłowni Białystok S.A., Białystok	Poland	29,0		138	540	75	PC boiler conversion to BFB	BFBc	Wood chips, forest residue, willow, grain waste, coal

BFB conversions - Current trends

- Emission limits going tighter
- Clean wood based biomass not easily available
- Peat will be replaced with wood and other fuels
- Fuels getting more challenging – recycled wood, REF, SRF, agro wastes
- → BFB conversions projects are larger in scope of supply and technologically more challenging
  - Achievable capacity becomes lower
  - Corrosion issues and fouling need more attention
  - Flue gas cleaning requires bigger modifications (SNCR, Baghouse filter to replace ESP, scrubber etc.)



Biomass combustion in Ukraine

- Ukraine has confirmed commitment to develop green energy (plan to be carbon neutral by 2060)
- Currently, woody biomass used effectively but agro fuels again is scarcely used.
- Future potential in agro fuels and energy crops (miscanthus, sunflower husk, straw, willow, poplar)
- Willow and some poplars can be considered good fuel for BFBs
- Miscanthus, sunflower husk and straw are considered as agro fuel that can be burned in limited quantities (mixed with quality fuels)

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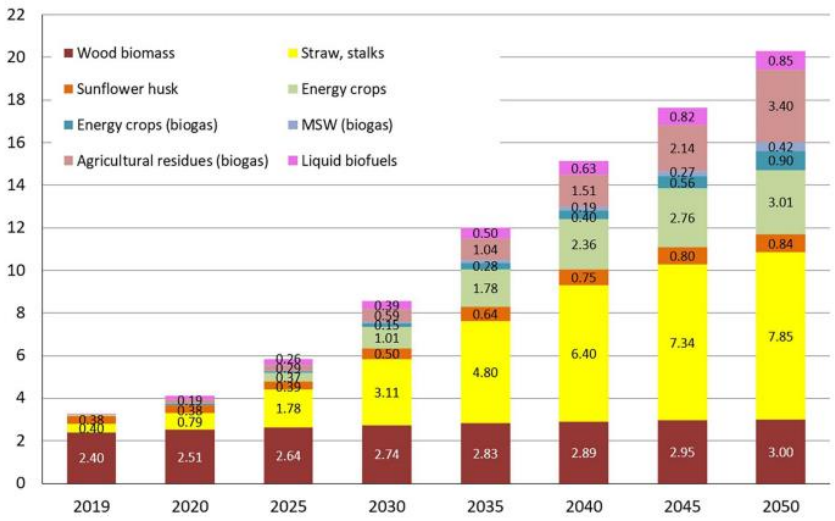

Figure 5. Suggested structure of biofuels consumption in Ukraine until 2050, by biomass type, Mtoe


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FORWARD