



Valmet solutions for residue streams

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Valmet solutions for residue streams

Content of the presentation:

1. **Valmet in brief**
2. Fuel research in Valmet and process technologies available
3. Solutions for plastics recycling
4. Valmet WtE solutions
 - Fuel options
 - References
5. Summary



Valmet is a technology provider with global presence

33 countries, over 120 service centers, 87 sales offices, 36 production units, 16 R&D centers

Valmet numbers 2019:

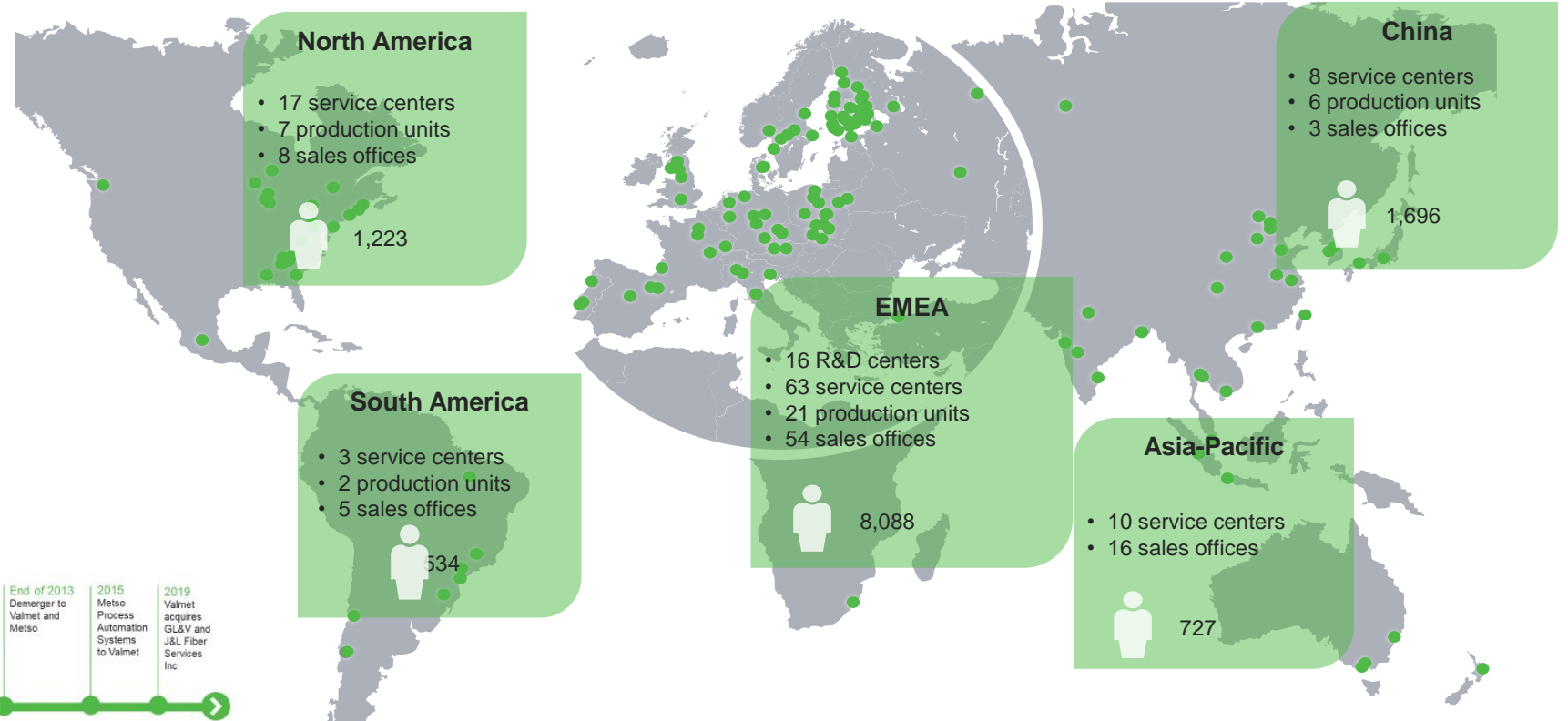
Orders received
EUR 3,986 million

Net sales
EUR 3,547 million

Comparable EBITA
EUR 316 million

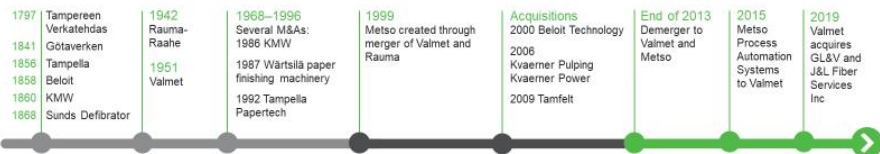
Comparable EBITA margin
8.9 %

Employees (on Dec 31, 2019)
13,598



Progress built on 220 years of industrial history

From cloth making to high-tech processes



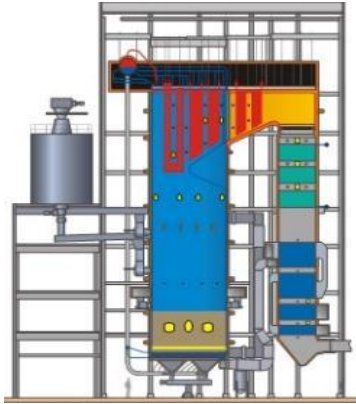
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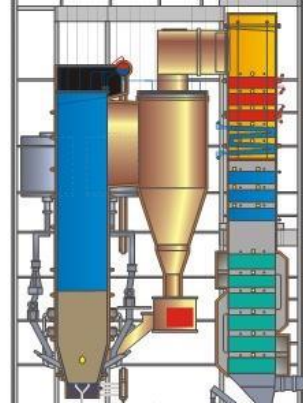


Valmet's products in energy



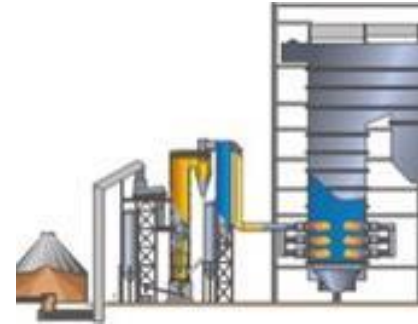
Valmet BFB Boiler

- Biomass and waste
- BioPower modular power plant



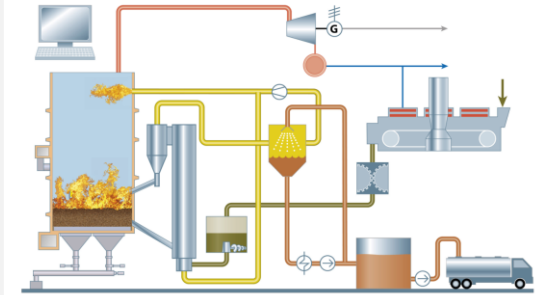
Valmet CFB Boiler

- Biomass, waste and multifuel
- RecycPower modular power plant



Valmet Gasifier

- Biomass and waste
- Power plant, co-gasification and lime kiln



Valmet Pyrolysis

- Biomass to bio-oil
- Integrated process

Rebuilds and conversions

Air pollution control

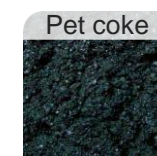
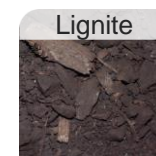
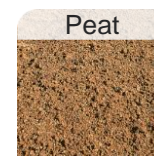
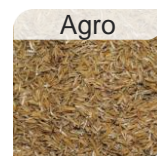
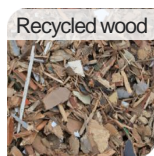
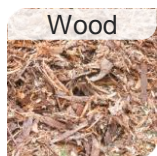
Automation

Valmet has extensive experience with demanding fuels

Over 300 fluidized bed references and own R&D center

Fuel testing since 1990:

- 4 MW_{th} CFB
- 2 MW_{th} BFB
- Pyrolysis reactor
- 10–100 kW tube reactors
- Cold models
- Fuel library with 9,000 samples



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What to do with plastic

- Global plastic demand (=production) is exceeding 200 Mt/a this year
- In EU one third of plastic is recycled and in the US less than one tenth

- Possible utilization routes to recycled plastic

1. Mechanical recycling: plastic to plastic

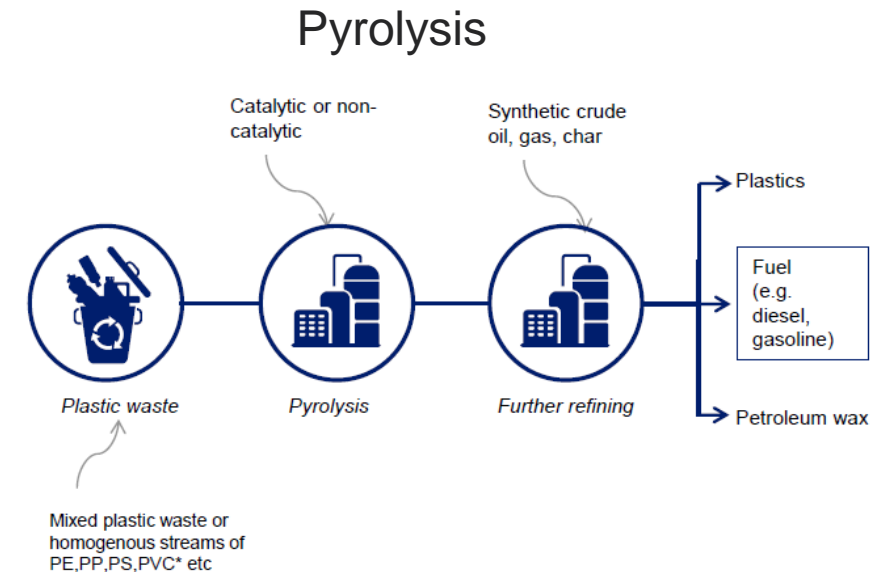
- Requires presorting => some qualities are not accepted
- Color challenge (=>grey)
- Valmet is not in this business

2. Chemical recycling: plastic to chemical and plastic to fuel

- No commercial scale solution available
- Pyrolysis, cracking and HTL (hydrothermal liquefaction) possible technologies for mixed plastics
- Valmet is studying those technologies – technical evaluation is going on

3. Combustion: plastic to power

- CFB technology is capable to fire 100% plastic – chemical composition is not limiting combustion
- Only fuel feeding and flue gas cleaning designs require special attention



Valmet solutions for residue streams

Content of the presentation:

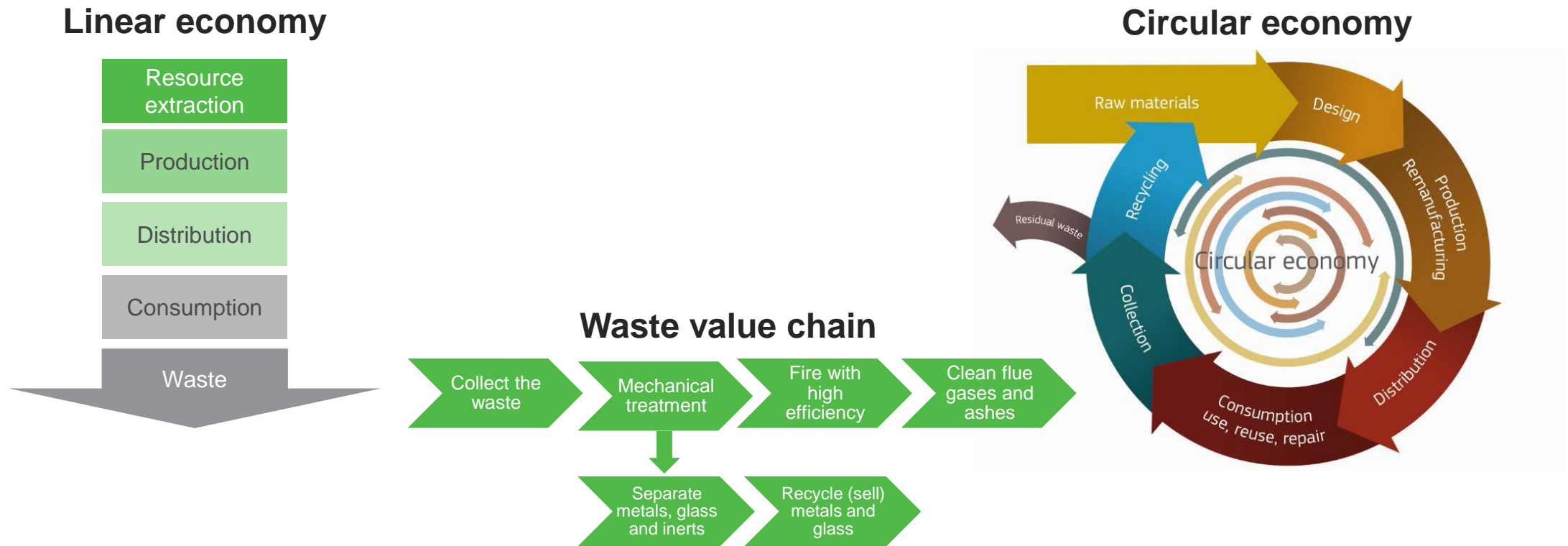
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Valmet follows resource efficiency principle

Resource efficiency is important part of circular economy

- A circular economy aims to keep products, components and materials in a continuing cycle instead of disposal => Waste is minimized => Resource efficiency



From municipal solid waste (MSW) to refuse derived fuel (RDF)

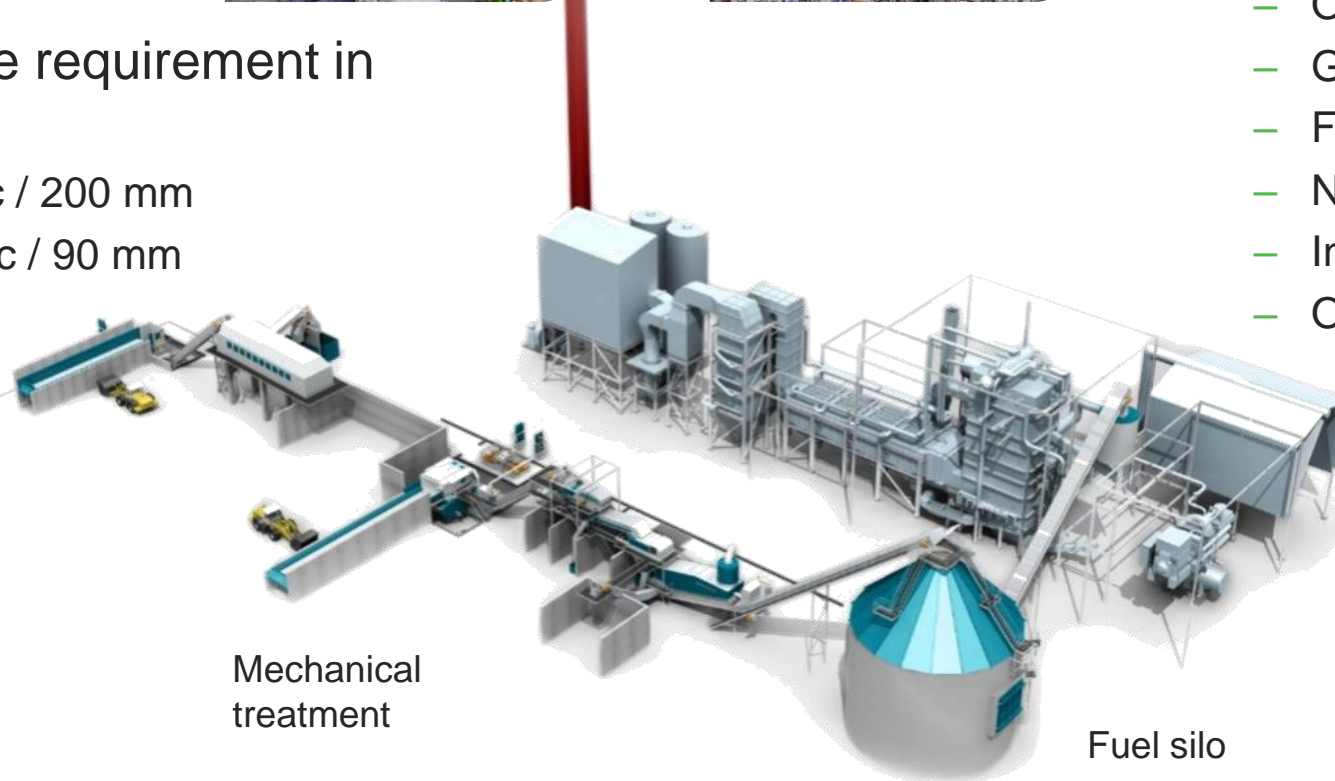
- MSW → RDF
 - 90% combustables
 - 10% recycleable+inerts



- RDF fuel size requirement in CFB boilers
 - 100% < 8 inc / 200 mm
 - 90% < 3.5 inc / 90 mm

- Single stage shredder
- Separation of:
 - Oversized material
 - Glass
 - Ferrous metal
 - Non-ferrous metals
 - Inert material
 - Organic material (if applicable)

Organic separation if applicable



Mechanical treatment

Fuel silo

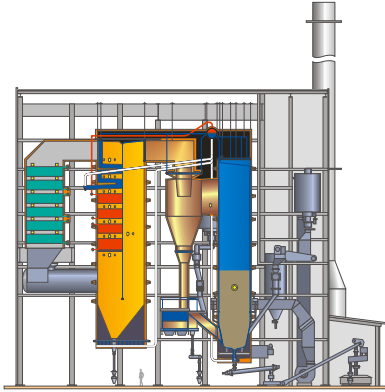
- This approach supports very well resource efficient targets

Valmet solutions for WtE, 40 references



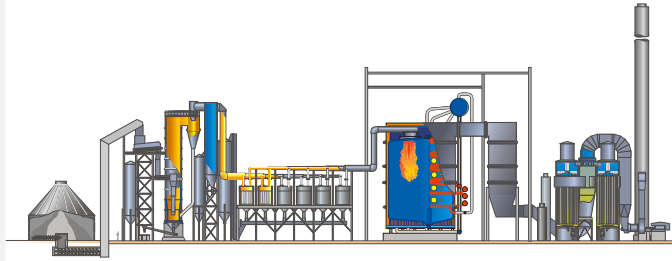
Valmet RecycPower

- Abt 100 000 t/a RDF
- Modular power plant



Valmet CFB Boiler

- Up to 650 000 t/a RDF
- RDF, recycled wood, TDF, multi-fuel



Valmet Gasifier

- Up to 400 000 t/a RDF
- No limit for steam values

Air emission control

Automation

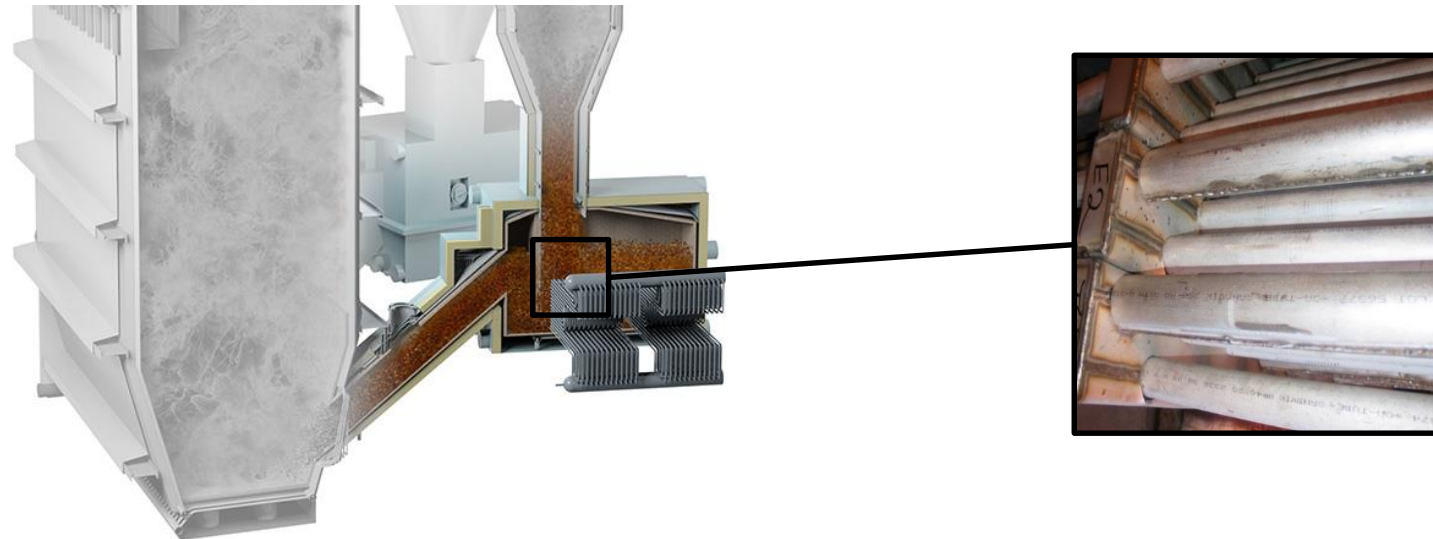
Services

Valmet WtE references – 40 references since 80's

Start Up	Customer	Country	Fuels	Steam Flow, lb/h	Steam Pressure, psi	Steam Temperature, °F	Steam capacity, MMBtu/h
2022	Braunschweiger Co. KG BS ENERGY, Braunschweig	Germany	Recycled wood	215 683	1088	977	268
2021	Shanying International Holdings Co.,Ltd., Ma' anshan	China	Reject (plastics), Sludge	285 463	1363	1004	314
2020	Beijing Environment Sanitation Engineering Group, Beijing	China	RDF, Sludge	364 758	783	842	419
2020	Chongqing Lee & Man Paper Mfg. Ltd., Chongqing	China	Sludge, Paper	301 322	1363	1004	341
2020	Beijing Environment Sanitation Engineering Group, Beijing	China	RDF, Sludge	364 758	783	842	419
2020	Aituo Eco-Energy (Zhejiang) Co., Ltd., Jiaying	China	Sludge, Paper	444 053	1363	1004	484
2019	Shanying Huazhong Paper Industry Co., Ltd., Jingzhou	China	Reject (plastics), Sludge	222 026	1363	1004	242
2019	Shanying Huazhong Paper Industry Co., Ltd., Jingzhou	China	Coal, Reject, Sludge	222 026	1363	1004	242
2018	Zibo Green Energy New Energy Co.,Ltd., Zibo	China	RDF	293 392	1160	968	368
2016	Nybro Värmecentral AB, Nybro	Sweden	RDF	55 507	943	770	75
2014	Mälarenergi AB, Västerås	Sweden	RDF, Recycled wood	444 053	1073	878	529
2013	Eneco Bio Golden Raand CV, Delfzijl	Netherlands	Recycled wood	396 476	1305	968	433
2013	Tullis Russel Papermakers	UK	Recycled wood	483 700	1305	968	529
2013	Västervik Miljö & Energi AB, Västervik	Sweden	RDF	55 507	870	770	68
2012	Lahti Energia, Lahti	Finland	RDF	396 476	1740	968	477
2011	S.A. Industrias Celulosa Aragonesa (SAICA), El Burgo De Ebro	Spain	Reject (plastics), Sludge	404 405	1088	968	477
2010	Stora Enso Langerbrugge N.V., Langerbrugge	Belgium	RDF	356 828	870	887	426
2010	Vattenfall AB, Haninge	Sweden	Demolition wood	198 238	1160	878	215
2007	Falu Energi & Vatten AB, Falun	Sweden	Recycled wood	87 225	1015	932	106
2005	Borås Energi AB, Borås	Sweden	RDF, recycled wood	55 507	609	761	68
2005	Borås Energi AB, Borås	Sweden	RDF, recycled wood	55 507	609	761	68
2004	Termomeccanica S.P.A., La spezia	Italy	RDF	79 295	609	761	102
2004	Termomeccanica S.P.A., La spezia	Italy	RDF	79 295	609	761	102
2004	Nynäshamn Värme AB, Nynäshamn	Sweden	Recycled wood	71 366	638	662	85
2003	Norrköping Miljö och Energi, Norrköping	Sweden	RDF, Sewage sludge	214 097	943	878	256
2003	A2A Ambiente S.p.A, Cortelona (pv)	Italy	RDF	79 295	580	756	102
2002	Lidköping Energi AB, Lidköping	Sweden	Demolition wood, RDF	71 366	435	32	68
2000	Sogama S.A., Meirama	Spain	RDF	214 097	624	842	256
2000	Sogama S.A., Meirama	Spain	RDF	214 097	624	842	256
1999	MVV Environment Baldovie Limited, Dundee	UK	RDF	55 507	580	752	58
1999	MVV Environment Baldovie Limited, Dundee	UK	RDF	55 507	580	752	58
1999	T.E.V. S.P.A. Termo Energia Versilia, Pietrasanta (lu)	Italy	RDF	31 718	580	752	41
1999	T.E.V. S.P.A. Termo Energia Versilia, Pietrasanta (lu)	Italy	RDF	31 718	580	752	41
1997	Carolina Energy, Wilson	USA	RDF	87 225	624	754	102
1996	Vattenfall AB, Motala	Sweden	RDF		232	32	68
1985	Västervik Miljö & Energi AB, Västervik	Sweden	RDF		232	32	34
1984	Sundsvall Energiverk	Sweden	RDF	63 436	464	518	68
1984	Lidköping Energi AB, Lidköping	Sweden	RDF		290	410	51
1984	Lidköping Energi AB, Lidköping	Sweden	RDF		232	32	51
1983	Västervik Miljö & Energi AB, Västervik	Sweden	RDF		232	32	34

Valmet CFB Boiler for WtE – More electric power from same amount of waste

- In Valmet CFB Boiler the steam values can be as high as **520°C/968°F** and **90 bar/1305 psi** => higher power output
- Difference to "standard" steam data (824°F, 870 psi) cycle efficiency can be 3-5% points
- Final (tertiary) superheater is located inside bed material => surface is not in contact with corrosive gases
- Final superheater has a special double tube design
 - Despite high steam parameter the lifetime of final superheater is 3-5 years



Valmet CFB Boiler for WtE – High annual operation hours

Long-time reliable operation in Langerbrugge

Stora Enso Langerbrugge nv
Gent, Belgium

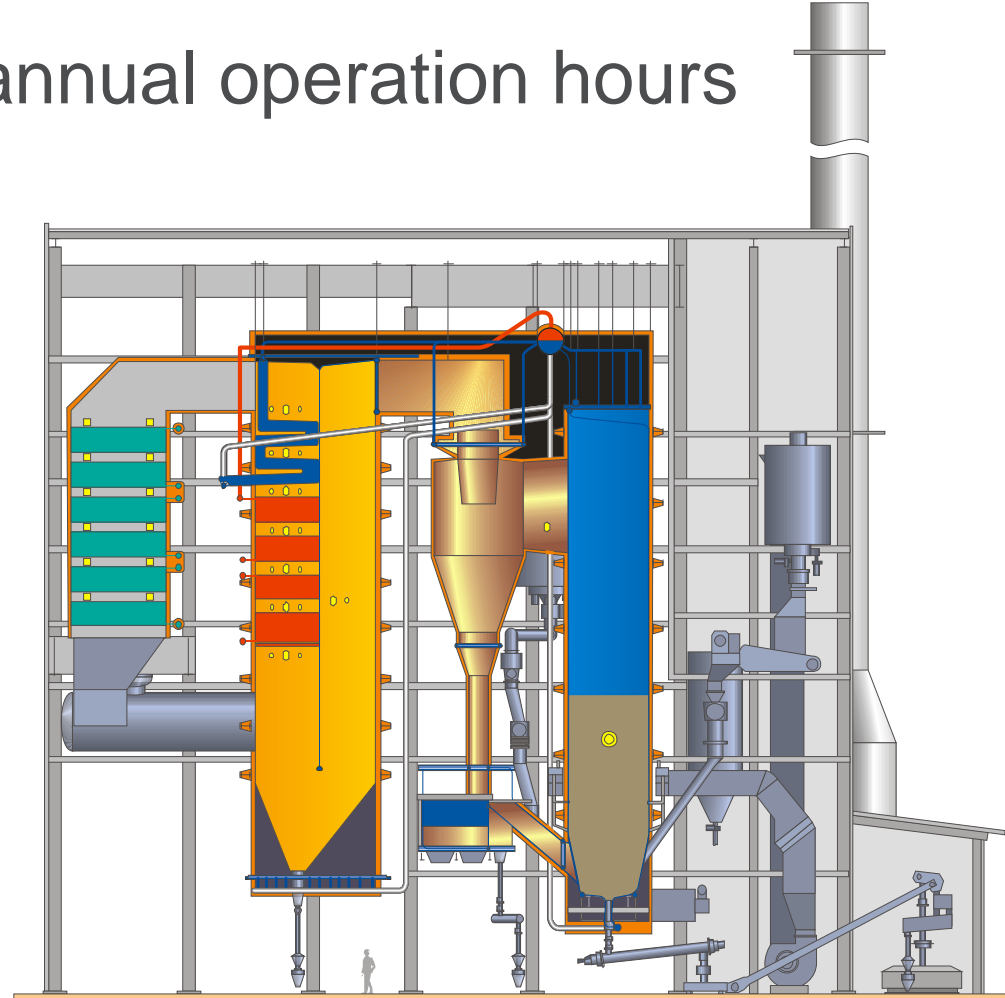
Steam 45 kg/s, 60 bar, 475 °C
 357 000 lb/h, 870 psi, 887°F

Fuels RDF 320 kt/a

Start-up 2010

2011-2018 average:

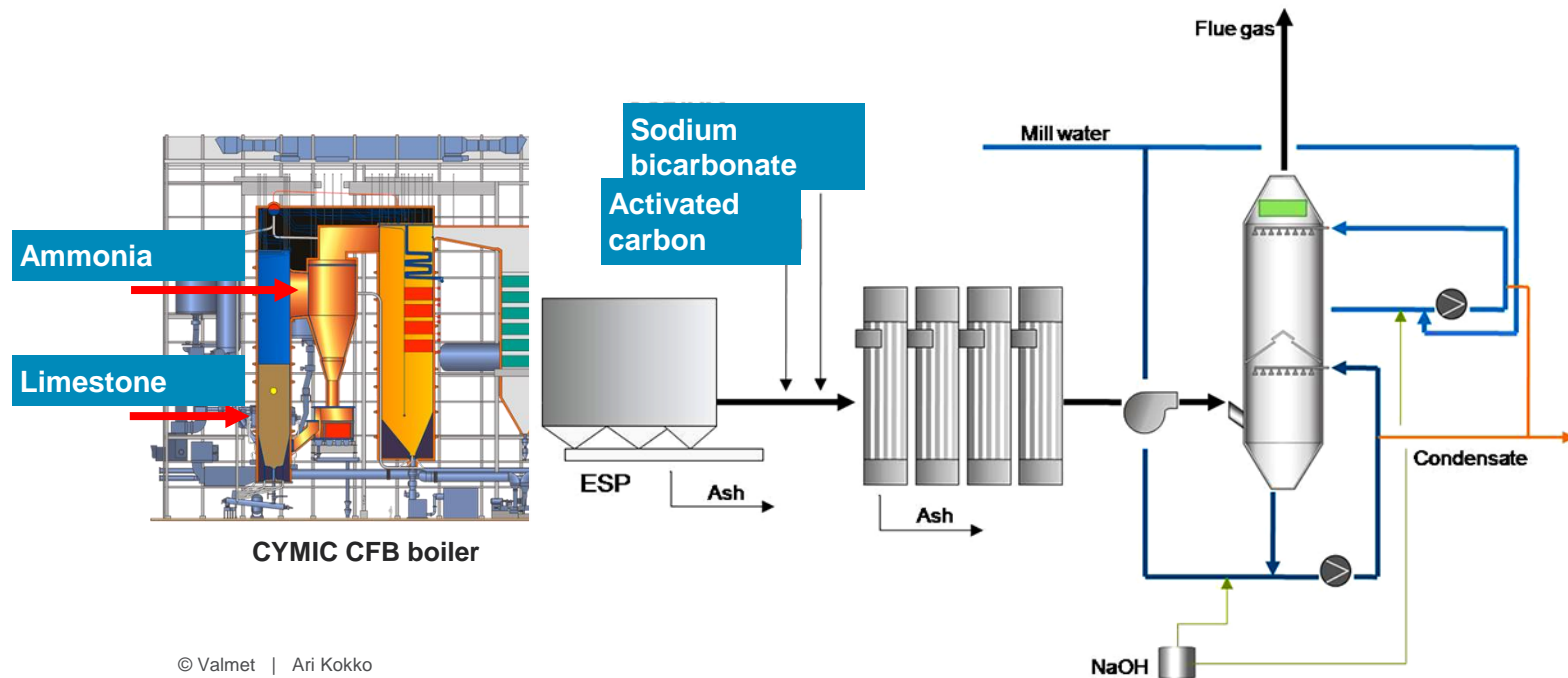
- Operation hours 8272 h/a
- Reliability 99.1%



		2011	2012	2013	2014	2015	2016	2017	2018
Boiler in operation	h	8323	8213	8341	8331	8171	8332	8145	8323
Boiler unavailability	h	88	11	70	67	109	68	159	53
Boiler reliability	%	99.0	99.9	99.2	99.2	98.7	99.2	98.1	99.4

Valmet CFB Boiler for WtE – Excellent emission performance

Component	Unit	Langerbrugge (320 kt/a RDF)		Mälär Energi (400 kt/a RDF)	
		Guaranteed	Measured	Guaranteed	Measured
NO as NO ₂	mg/Nm ³ / lb/MMBTU	125 / 0.09	40 / 0.03	120 / 0.09	33 / 0.025
CO	mg/Nm ³ / lb/MMBTU	50 / 0.03	0	50 / 0.03	1 / 0.0006
Particulates	mg/Nm ³ / lb/MMBTU	10 / 0.007	0.1 / 0.00007	5 / 0.0035	0.24 / 0.0002
SO ₂	mg/Nm ³ / lb/MMBTU	50 / 0.03	n.d.	40 / 0.03	n.d.
PCDD/F	ng/Nm ³ / lb/MMBTU	0.1	<0.1	0.1	0.008



Valmet CFB Boiler for WtE – Fuel flexibility

Co-firing option

- CFB's big benefit is fuel flexibility which mitigates future fuel risk
- Acceptable waste fuel properties for CFB:
 - Calorific value 2900 – 14 000 Btu/lb / 6 – 32 MJ/kg
 - Moisture content up to 60%
 - No support fuel needed
- Possible to co-fire RDF with other fuels or to have following fuels as back-up fuel:
 - Biomass
 - Coal
 - Petroleum coke
 - Recycled wood
 - Tire derived fuel (TDF)
 - Paper mill rejects
 - Any mixture of fuels



Wood biomass



Coal



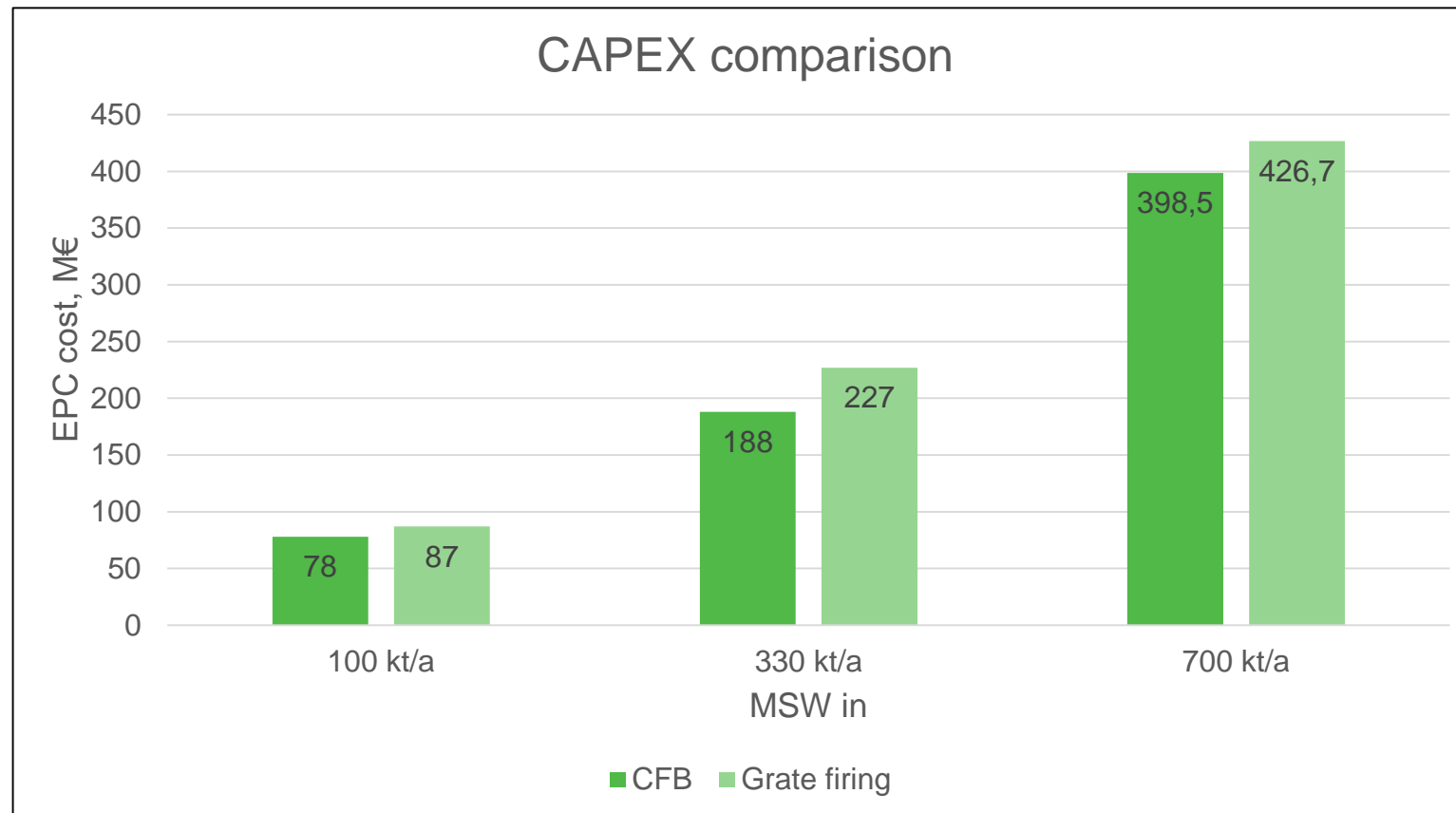
Recycled wood



TDF

Valmet CFB Boiler for WtE - Lower CAPEX

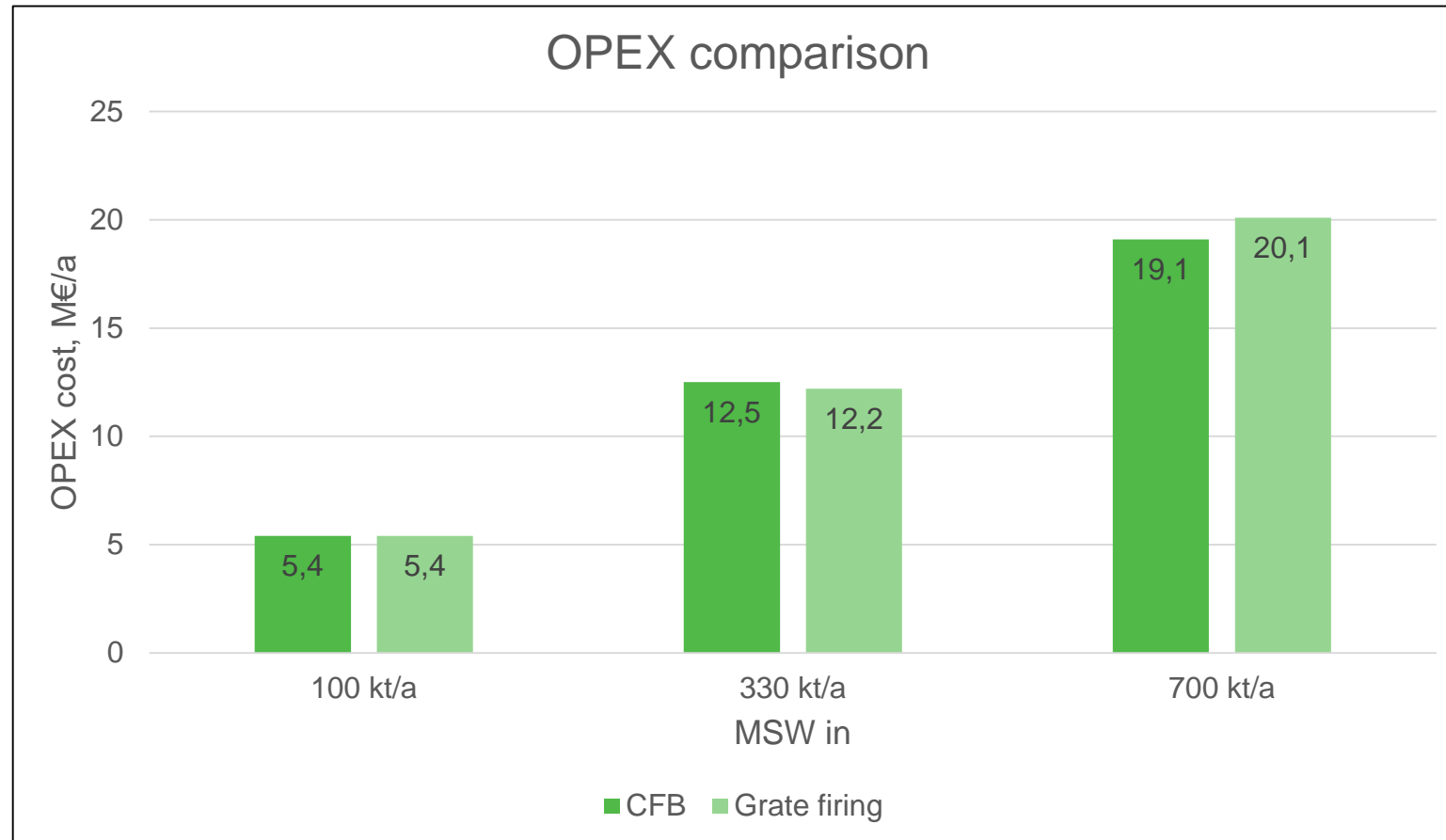
- CFB total EPC price is lower compared to grate firing
 - Plant as erected and including civil works
 - Includes fuel preparation system and flue gas cleaning



- 700 kt/a MSW:
- Grate two units
 - CFB single unit

Valmet CFB Boiler for WtE – Equal OPEX

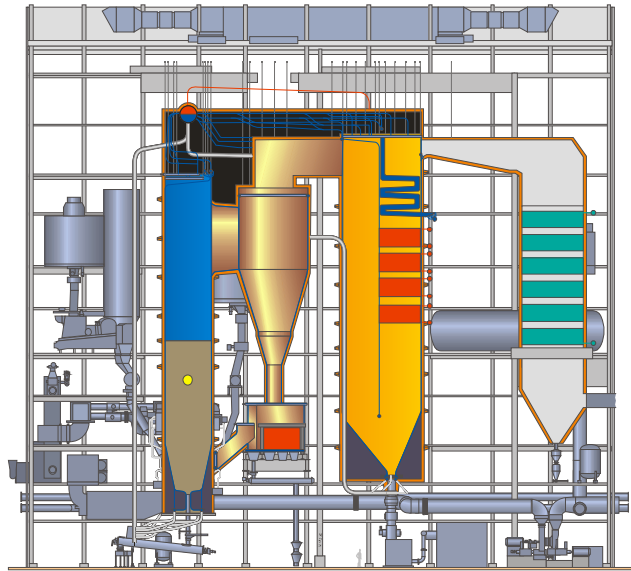
- CFB operation and maintenance cost is equal compared to grate firing
 - Includes fuel preparation system and flue gas cleaning



700 kt/a MSW:

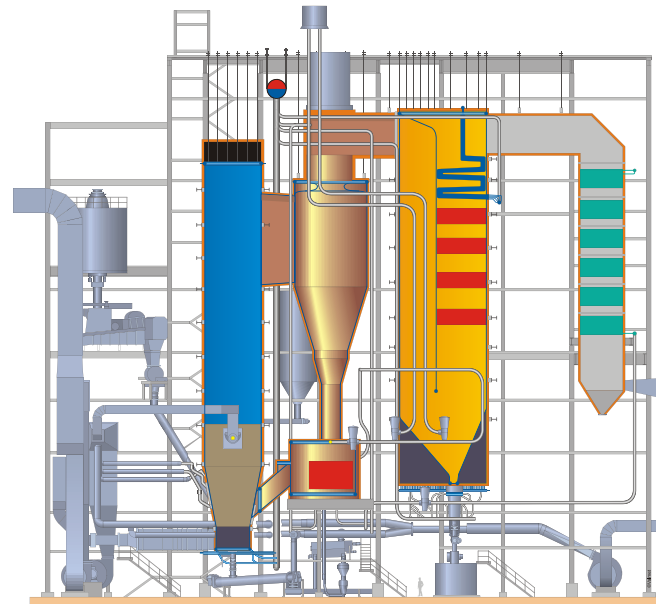
- Grate two units
- CFB single unit

Valmet CFB Boiler for WtE – Refuse Derived Fuel (RDF)



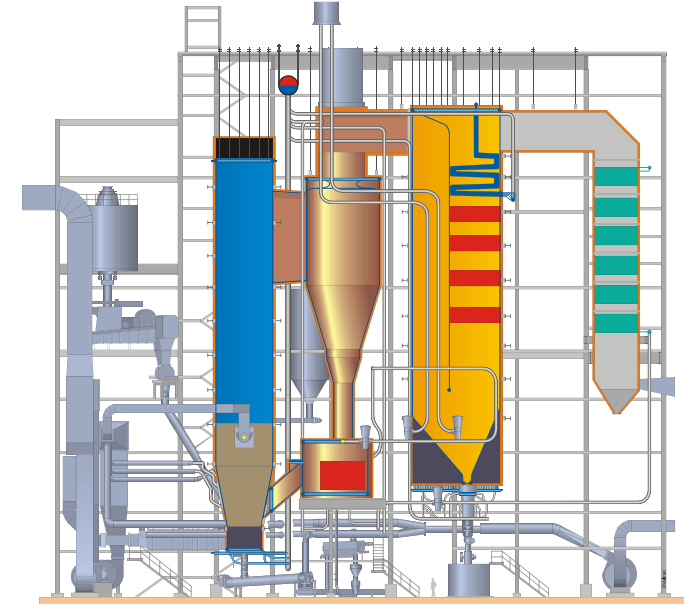
Mälarenergi AB, Västerås, Sweden

Steam 56 kg/s, 74 bar, 470 °C
 444 050 lb/h, 1075 psi, 878 °F
 Fuels RDF (400 kt/a) => ~60 MW_e
 Start-up 2014



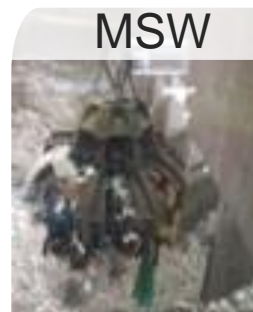
Zibo Green Energy, Zibo, China

Steam 37 kg/s, 80 bar, 520 °C
 293 400 lb/h, 1160 psi, 968 °F
 Fuel RDF (300 kt/a) => ~40 MW_e
 Start-up 2018



Urumchi Jinghuan Environmental & Energy Co, Urumchi, China

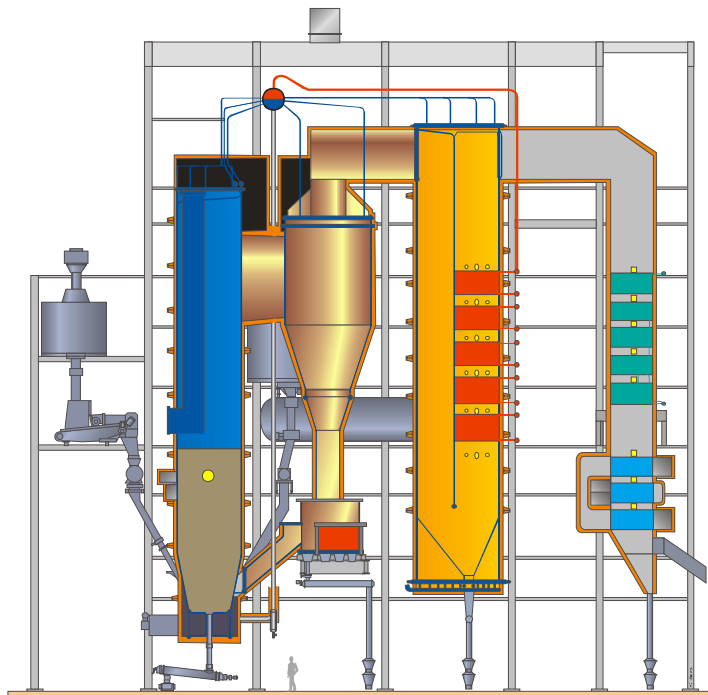
Steam 46 kg/s, 54 bar, 450 °C
 365 000 lb/h, 783 psi, 842 °F
 Fuel 2 x 500 000 t/a MSW => 2 x 45 MW_e
 Start-up 2021



Valmet CFB Boiler for WtE – Paper mill reject (plastics)

S.A. Industrias Celulosa Aragonesa
El Burgo de Ebro, Spain

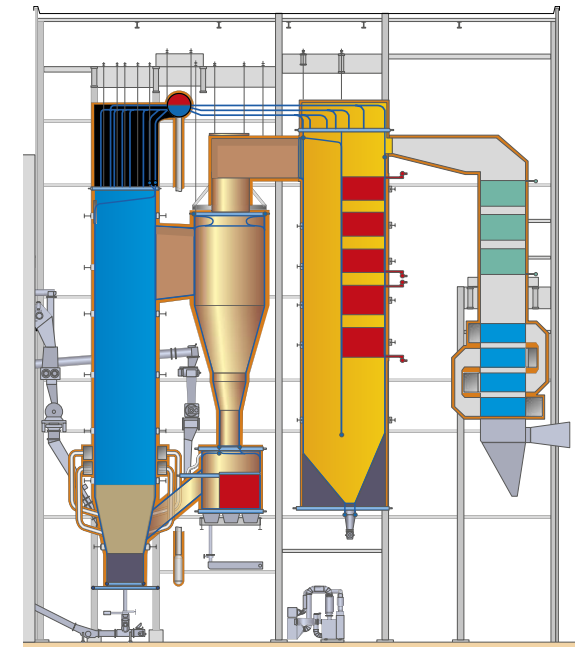
Steam 51 kg/s, 75 bar, 520 °C
405 000 lb/h, 1090 psi, 968°F
Fuels Paper mill reject
Start-up 2011



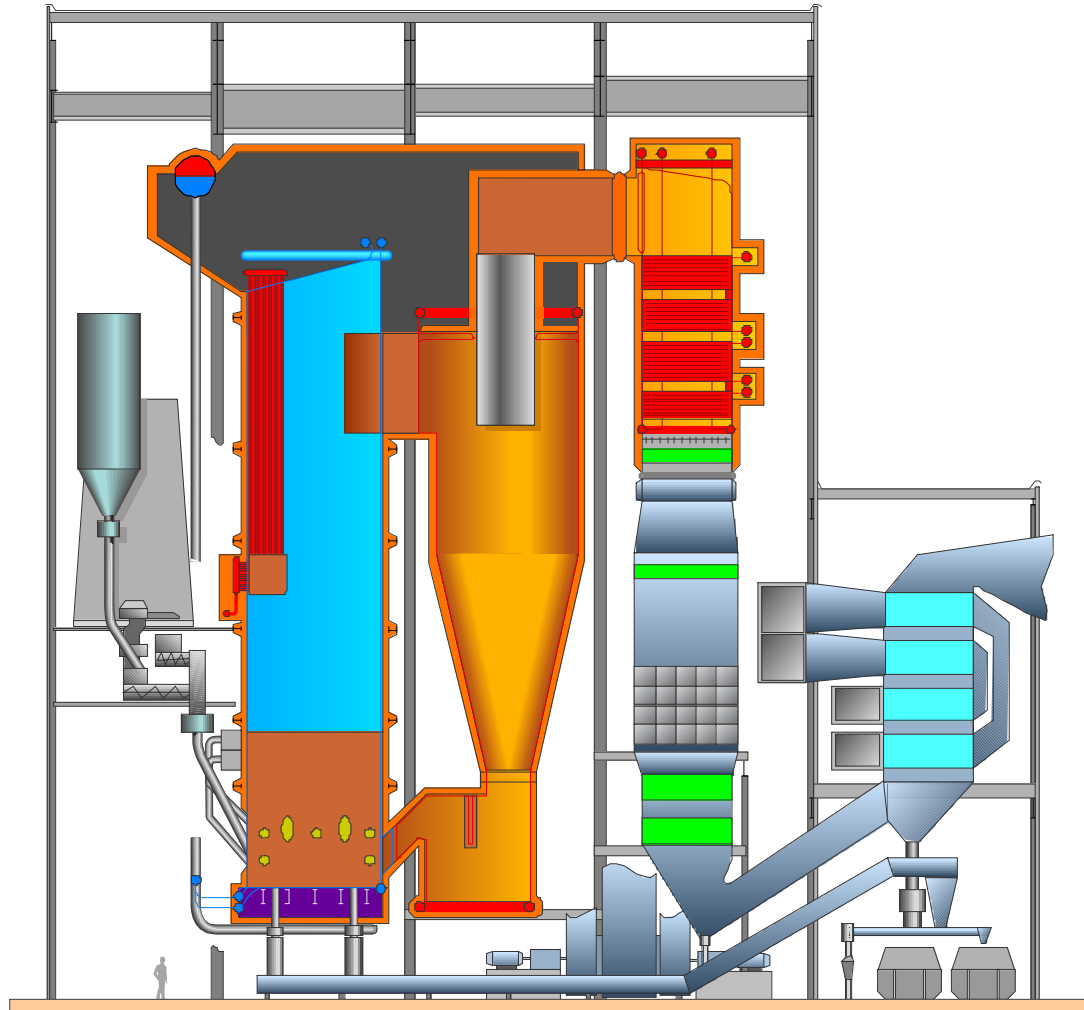
Fuel		Plastic reject
Moisture	wt-%	30
Calorific value LHV	MJ/kg Btu/lb	16.4 7450
Sulfur	wt-%	0,05
Chlorine	wt-%	0,38
Ash	wt-%	10,1

Aituo Eco-Energy Co., Ltd.
Zhejiang, China

Steam 56 kg/s, 94 bar, 540 °C
444 000 lb/h, 1360 psi, 1004°F
Fuels Rejects, waste fabrics
Start-up 2020



Valmet CFB Boiler for WtE – TDF (tire derived fuel)



Norrköpings Energi, Norrköping, Sweden

Steam 42 kg/s, 110 bar, 540 °C
333 000 lb/h, 1595 psi, 1004°F
Fuels wood waste (70%)
tire derived fuel (30%)
Start-up 1993



TDF:
Calorific value 32 MJ/kg
13 900 Btu/lb
Sulfur w-% 1.5

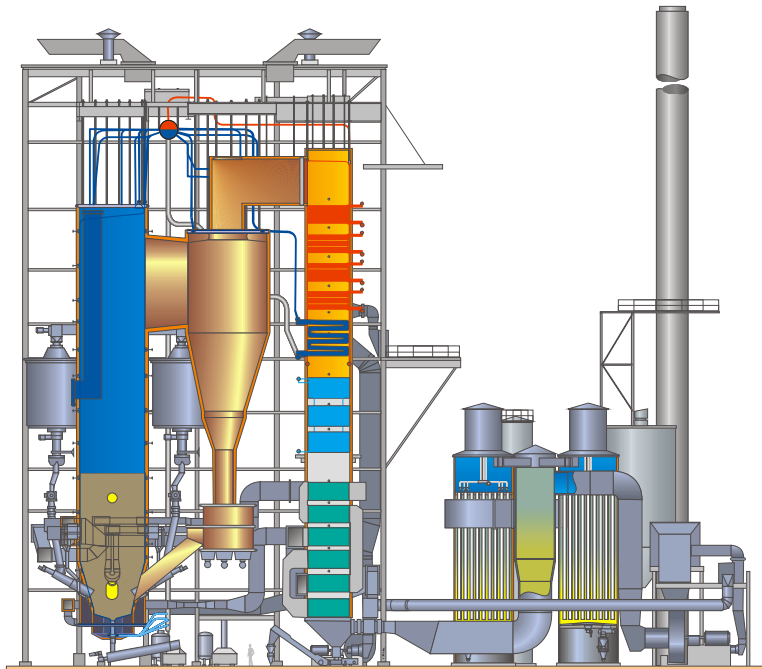
Valmet CFB Boiler for WtE – Recycled wood

RWE Npower Renewables Limited
Markinch Biomass CHP Plant, UK

Steam 61 kg/s, 90 bar, 520 °C
484 000 lb/h, 1300 psi, 968 °F
Fuels Recycled wood
Start-up 2013

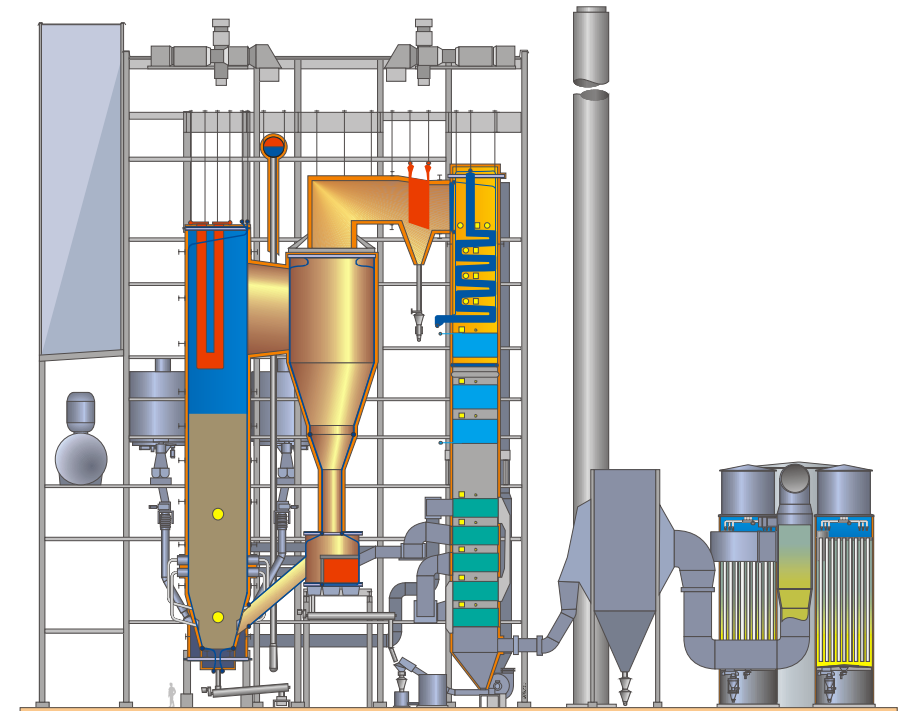


Fuel		Recycled wood
LHV	MJ/kg	13.5
HHV	Btu/lb	6500
Moisture	%	25
Chlorine content	w-%	0.1
Ash content	w-%	3
Lead content	ppm	300
Zinc content	ppm	250



Eneco
Delfzijl, The Netherlands

Steam 50 kg/s, 90 bar, 520 °C
396 000 lb/h, 1300 psi, 968 °F
Fuels Recycled wood
Start-up 2013



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Summary

- Plastic production is continuously growing – also plastic recycling is increasing
- Recycled plastic can be utilized in plastic to plastic or plastic to fuel/chemicals
- Unfortunately none of the chemical recycling processes are at commercial scale yet
- Quick solution for plastic is plastic to power – combustion in CFB is commercial technology
- CFB with residue fuels provides (compared to other technologies):
 - Higher efficiency
 - High reliability
 - Lower emissions
 - Fuel flexibility
 - Competitive CAPEX

