



**Valmet CFB gasifier
IEA Task 33 – Bioenergy
Workshop on Waste
Gasification**

Birmingham, UK

26.11.2019

Juhani Isaksson

Overview

- 1 What should we do with coal ?
- Fuel Replacement with Biomass Gasification
- 3 RDF Gasification
- 4 Valmet CFB Gasifier
- 5 Summary

EU is reducing GHG emissions

2020 Energy Strategy



By 2020, the EU aims to reduce its greenhouse gas emissions by at least 20%, increase the share of renewable energy to at least 20% of consumption, and achieve energy savings of 20% or more. All EU countries must also achieve a 10% share of renewable energy in their transport sector.

Through the attainment of these targets, the EU can help combat climate change and air pollution, decrease its dependence on foreign fossil fuels, and keep energy affordable for consumers and businesses.

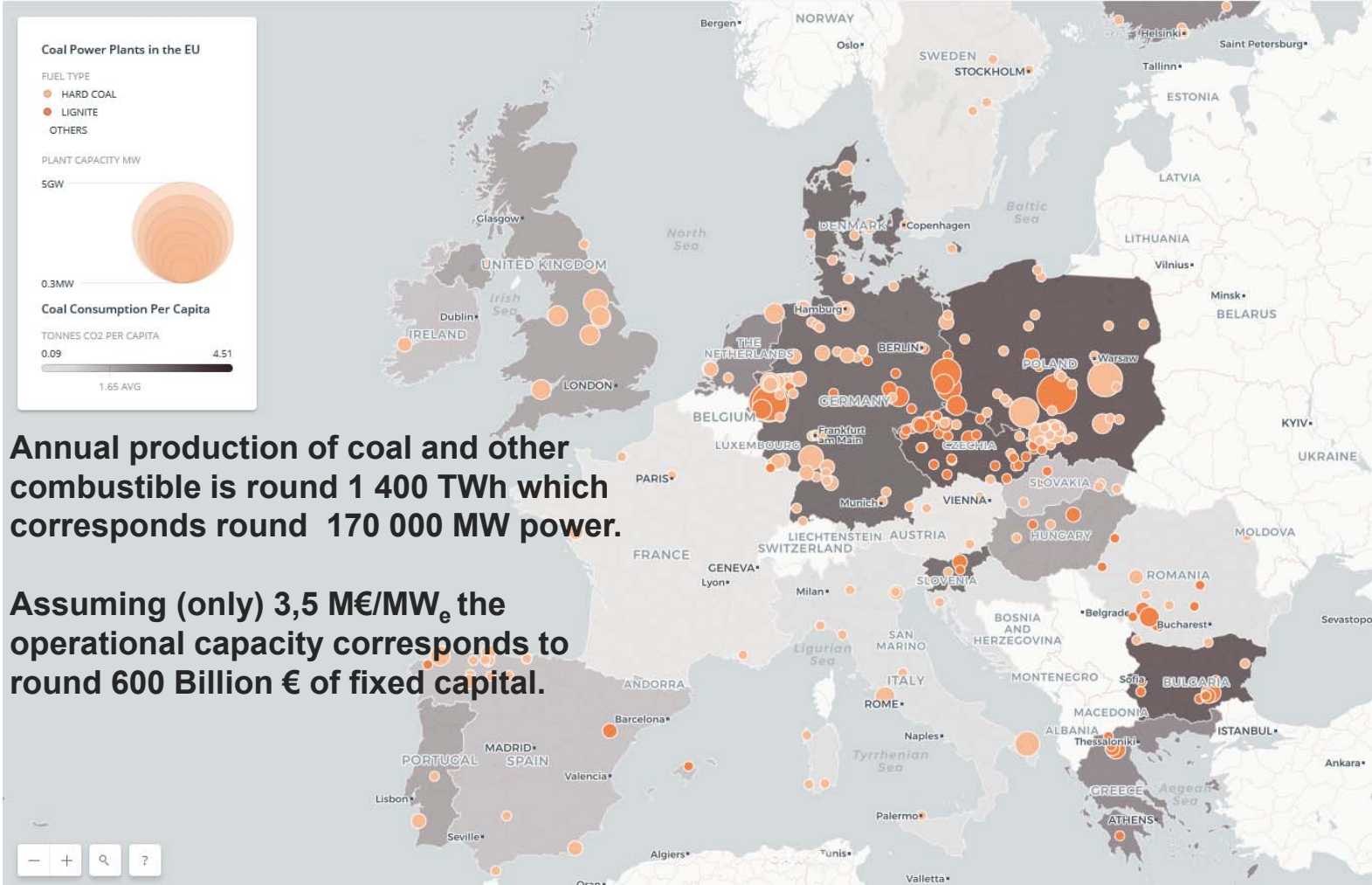
The use of coal in general is reducing

EU-28 Gross inland consumption of hard coal 1990-2016 (1990=100)



<http://ec.europa.eu/eurostat/>

There is still a lot of coal based power production in the EU



Annual production of coal and other combustibles is around 1 400 TWh which corresponds to around 170 000 MW power.

Assuming (only) 3,5 M€/MWe the operational capacity corresponds to around 600 Billion € of fixed capital.

<https://climateanalytics.carto.com>

What should we do with the plants ?

Just keep operating ?



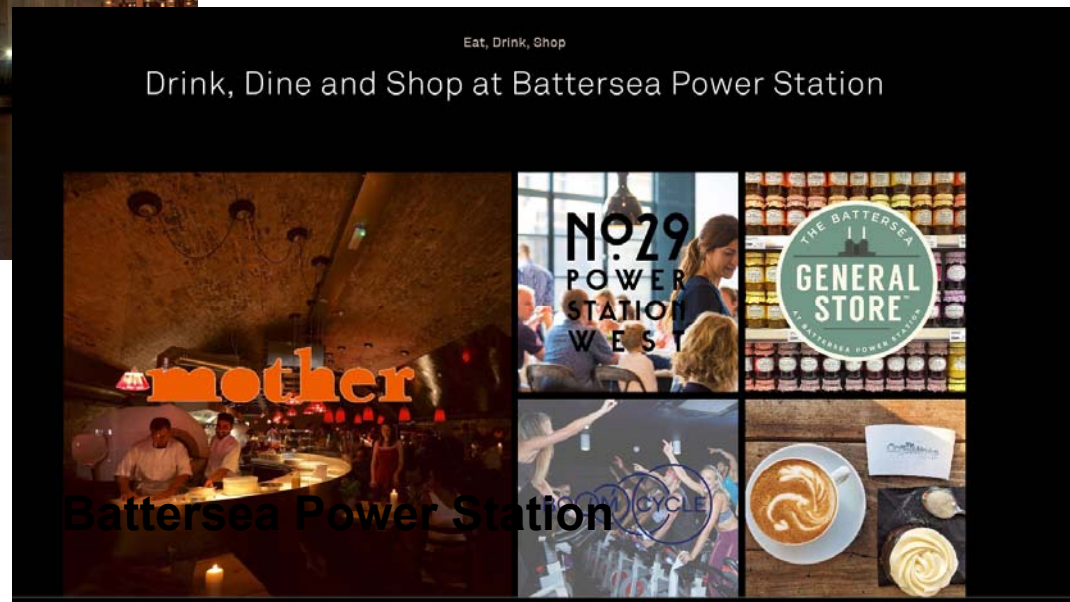
What should we do with the plants ?

Cockenzie Power Station Demolition (Scotland)



What should we do with the plants ?

Rebuild for shopping centers ?



Or replace coal with biomass ?

Vaskiluodon Voima Oy gasification project

The Vaskiluoto 2 -unit

- 560 MW_f coal fired boiler
- Pulverized fuel firing
- Benson design
- 185 bar/540 °C +
43 bar/ 570 °C

Output capacity

- 230 MW_e
- 175 MW CHP heat

Commissioning of the unit

- Boiler 1983
- Turbine plant 1998

Production

- Electric power 0.9 – 1.7 TW_h/a
- District heating to municipal net 450 GW_h/a



Vaskiluodon Voima Oy Gasification Project

Existing 560 MW coal-fired power plant

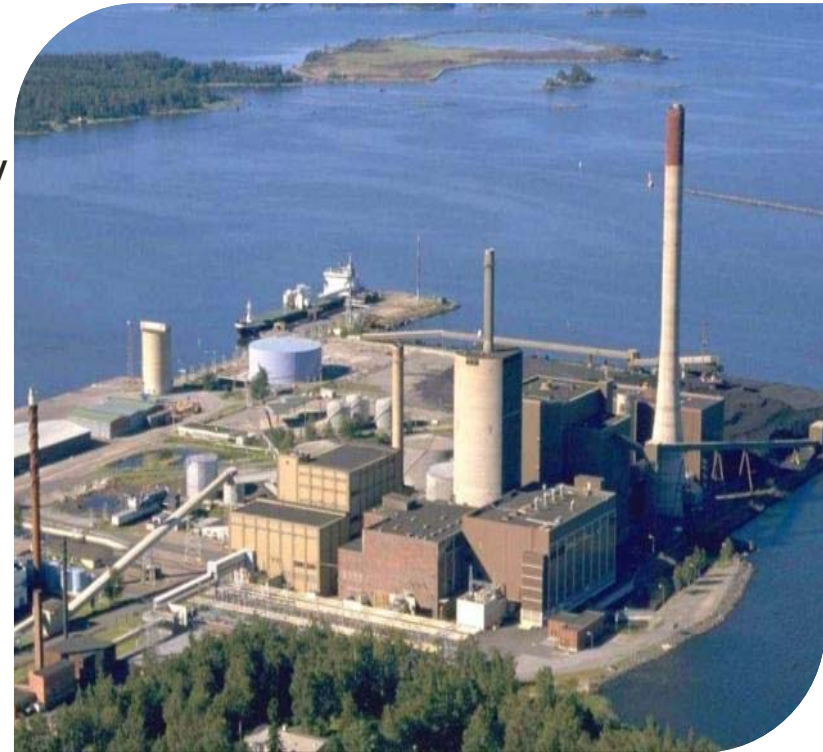
- Adjoined a 140 MW biomass gasifier and dryer
- Up to 40 percent replacement of coal by local fuel sources

Schedule

- Contract signed June 2011
- Plant operational 12/2012

Total project cost < 40 M€

- below 700 €/kWe

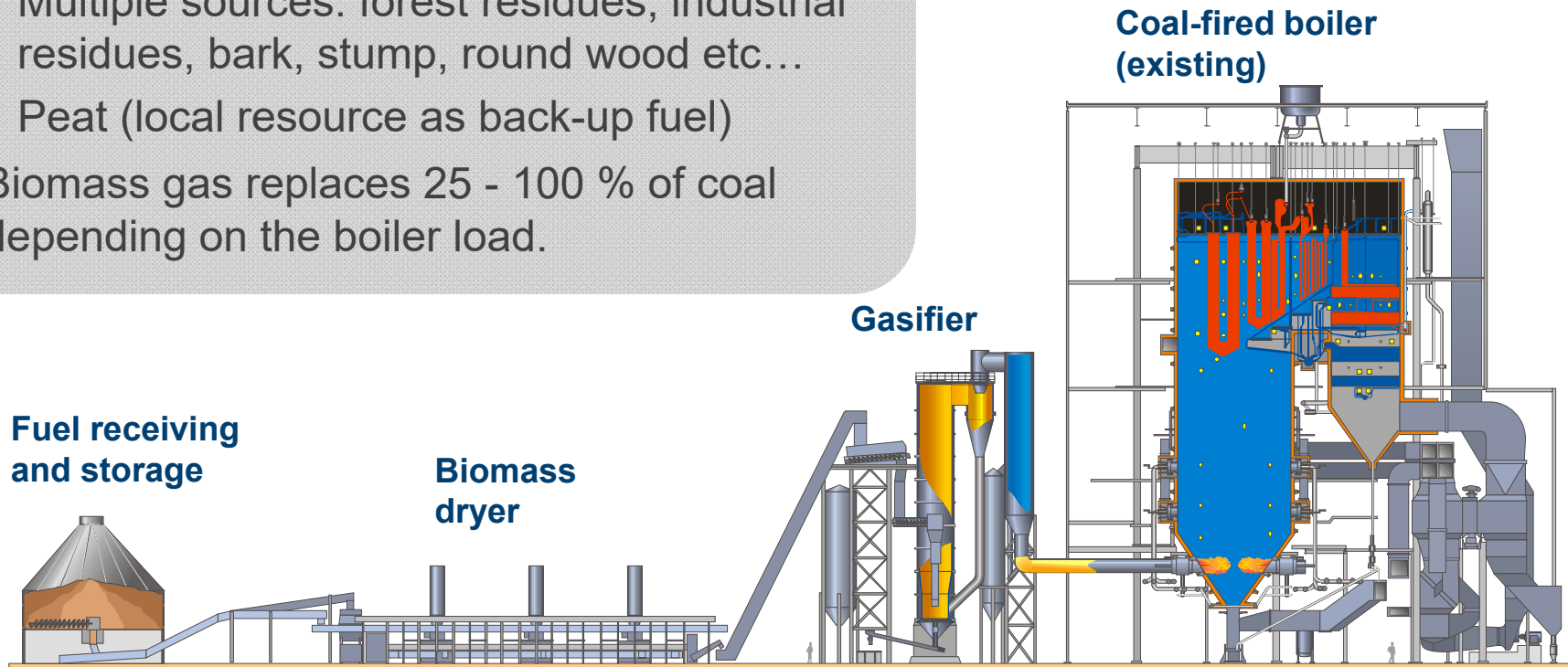


Vaskiluodon Voima - Valmet Gasification Plant

Biomass feed 140 MW

- Chipped or crushed wood biomass
- Multiple sources: forest residues, industrial residues, bark, stump, round wood etc...
- Peat (local resource as back-up fuel)

Biomass gas replaces 25 - 100 % of coal depending on the boiler load.



Vaskiluodon Voima - Valmet Gasification Plant

Commercial Operation from 2013

Gasifier

The first operational season 2013/2014: availability 97 %

Heating season 2014/2015: availability improved to 99 %

Heating season 2015/2016: availability 98 %

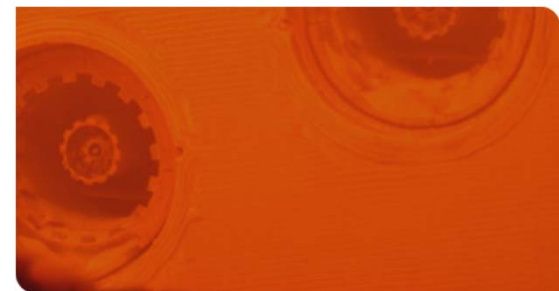
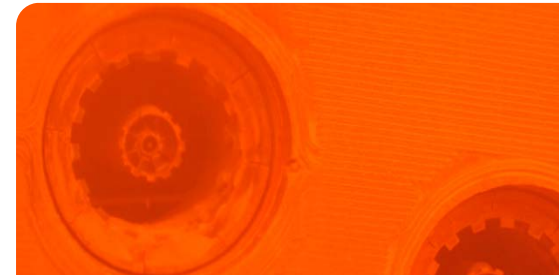
⇒ No main boiler outage caused by the gasifier

Capacity increase to 180 MW in 2015

Boiler operation with only product gas demonstrated 2015

Use of demolition wood tested in 2014

In full commercial operation



The Vaasa biomass gasifier

“We are very pleased with the final results of this project and would like to thank all our suppliers for the fine co-operation!”

Matti Tiilikka – Vaskiluodon Voima

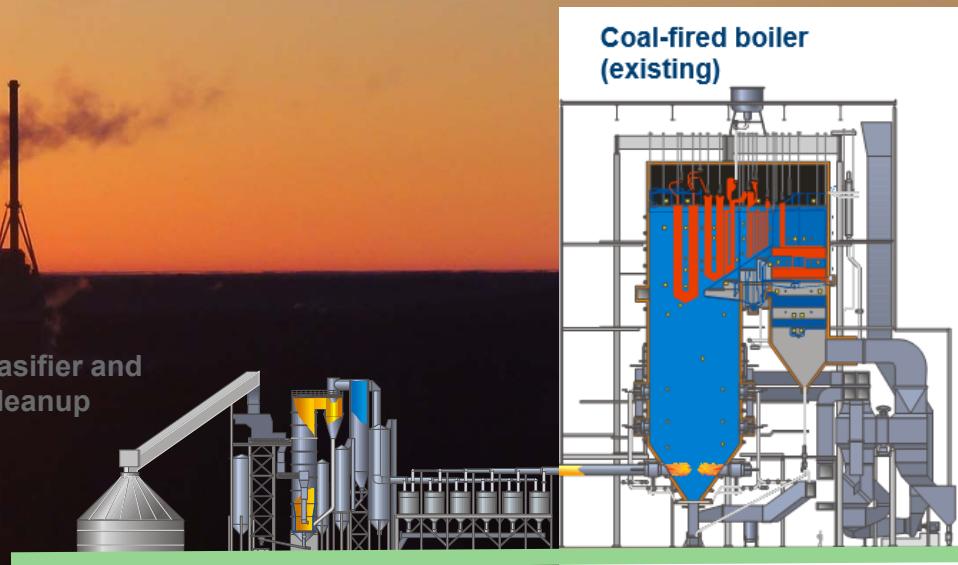
- A major, cost effective power plant fuel conversion from coal to wood biomass
- Short implementation time
- Existing, pulverized fuel fired boiler was utilized with minimal changes
- Thermal integration utilizes low temperature heat from the power plant for fuel drying
- Up to 40% fuel to power efficiency for wood biomass in a condensing mode

Or replace coal with waste ?

Fossil Fuel
Replacement
with
RDF/SRF in
Existing
Plants

Add-on gasifier and
hot gas cleanup

Coal-fired boiler
(existing)



Kymijärvi II - Waste Gasification plant

Highest efficiency for Energy-from-Waste

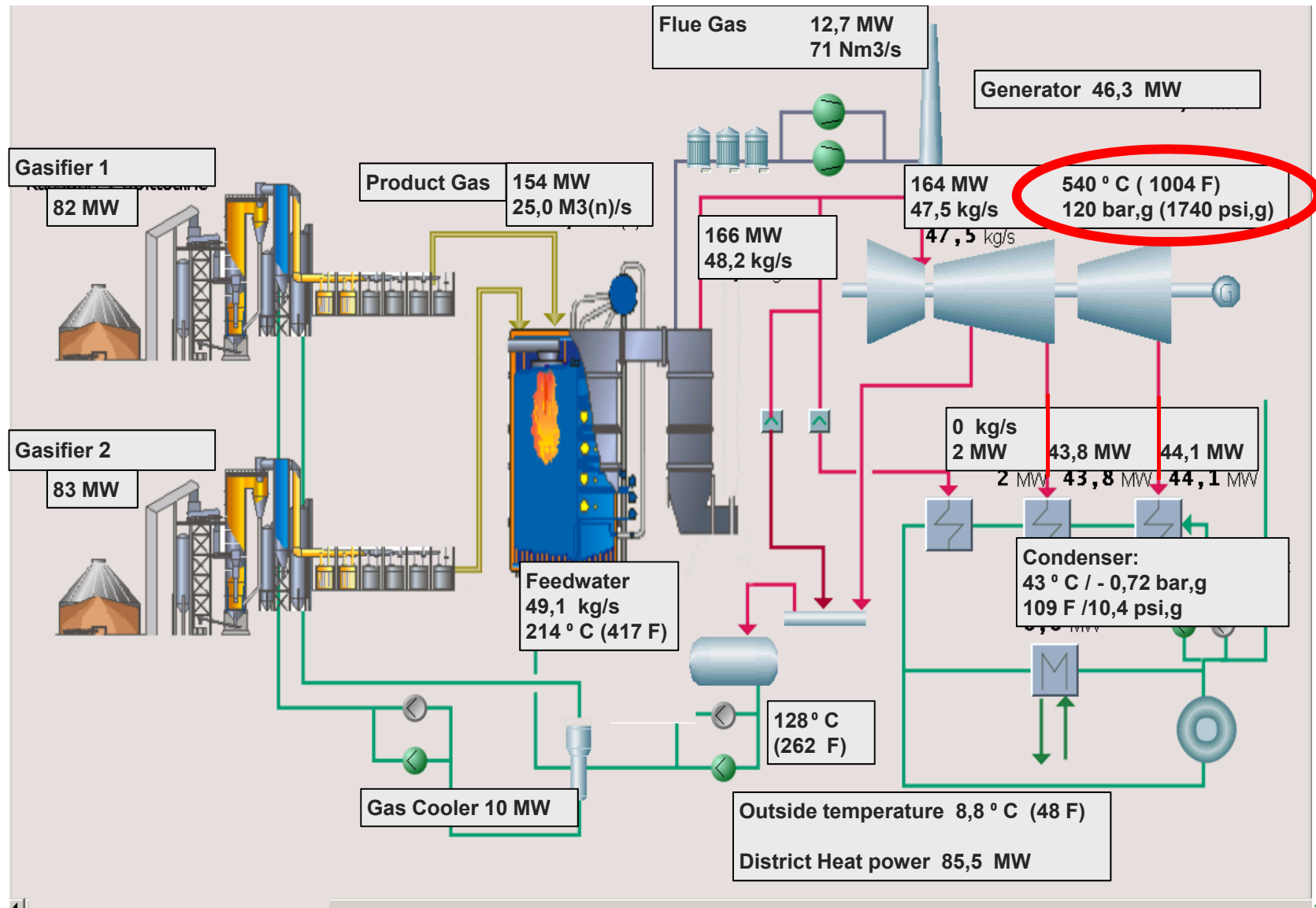
- World's largest waste gasification power plant in operation
- Processes 250 ktpa of waste fuels (RDF & contaminated wood) to produce:
 - 50 MW of electricity
 - 90 MW of district heat
 - CHP efficiency of 87,5 %
 - Total investment ~ 160 M €
- In commercial operation since 27.6.2012
- Over 1 million ton of gasified waste on Sept 2016

Lahti Energia, Lahti, Finland
Start-up 2012

Climate Act
Award
2012

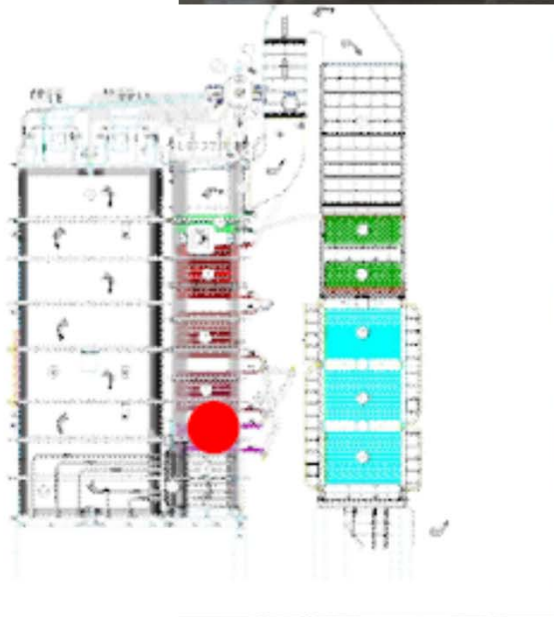


Kymijärvi II - Valmet CFB Gasification Process

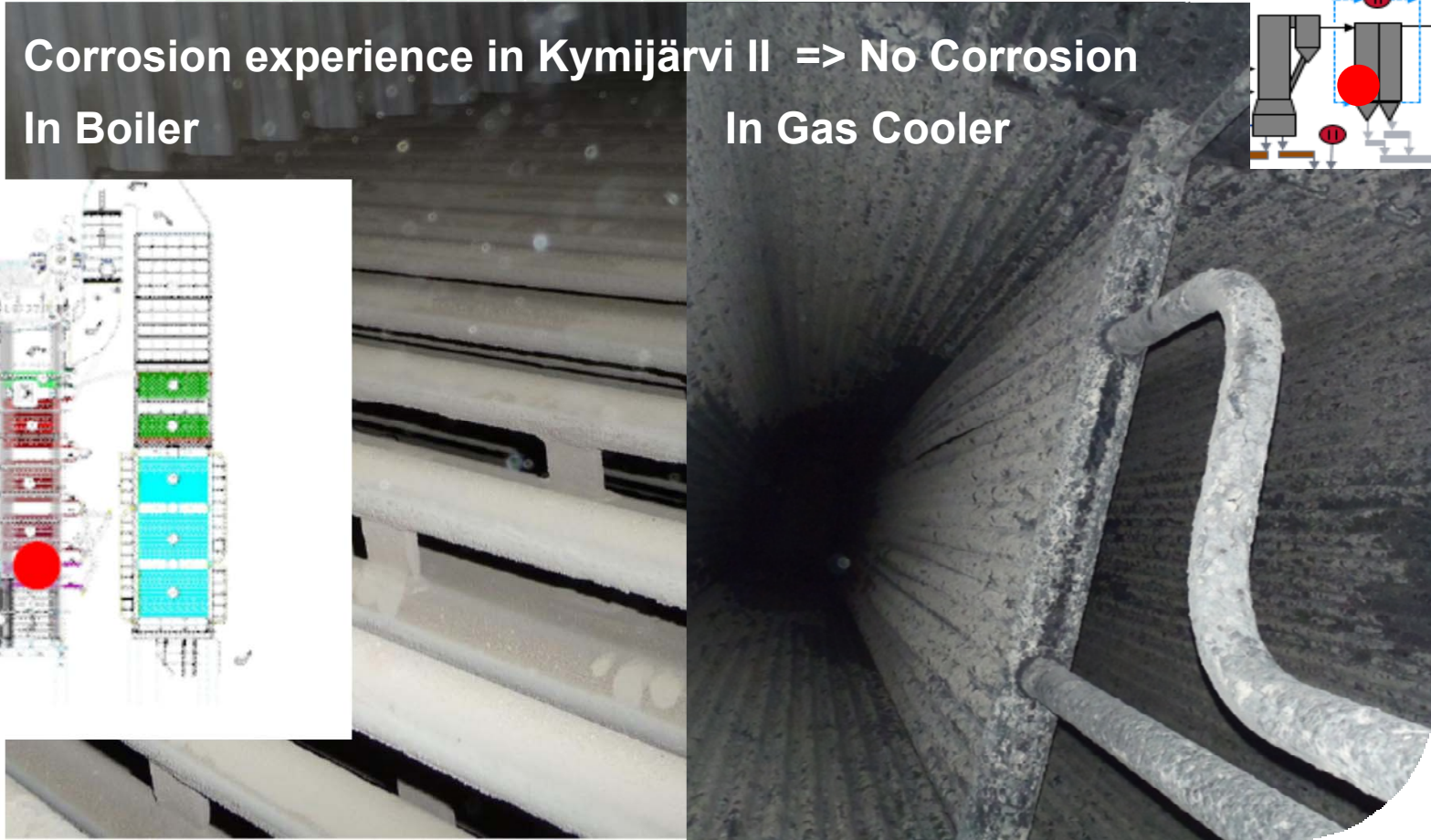
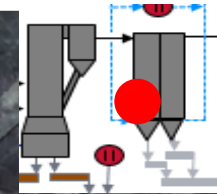


Valmet Waste Gasification Solution for Corrosion

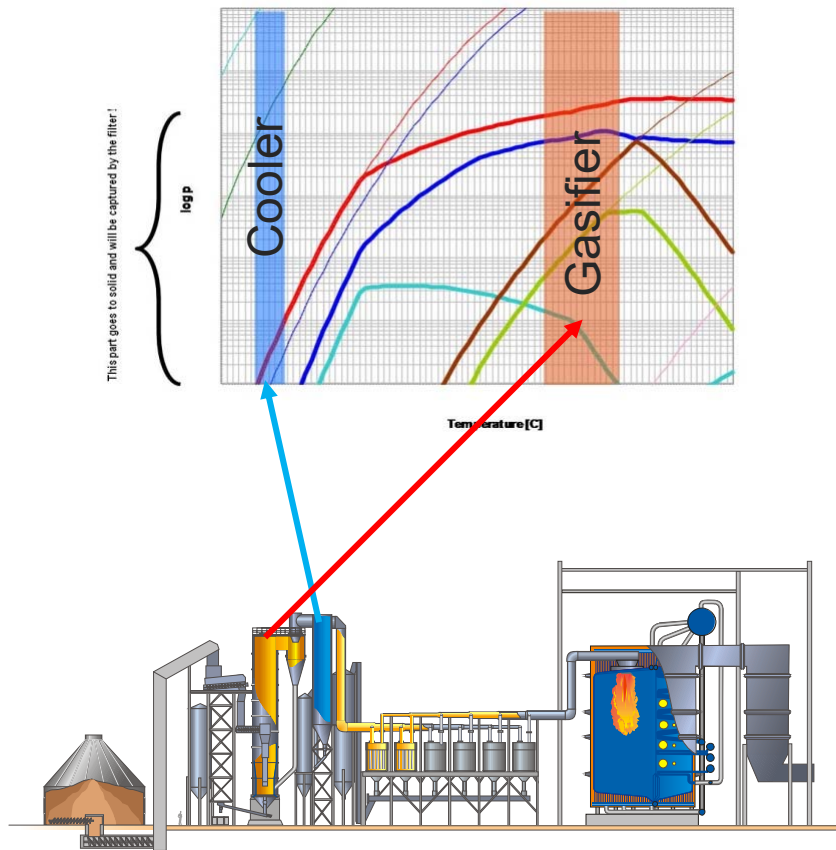
Corrosion experience in Kymijärvi II => No Corrosion
In Boiler



In Gas Cooler



Valmet CFB Gasifier Solution for Corrosion



❑ Cooler

- ✓ Temperature low enough to avoid corrosion in cooler
- ✓ Temperature high enough to avoid clogging
- ✓ Condensing of corrosive components into dust

❑ Filter

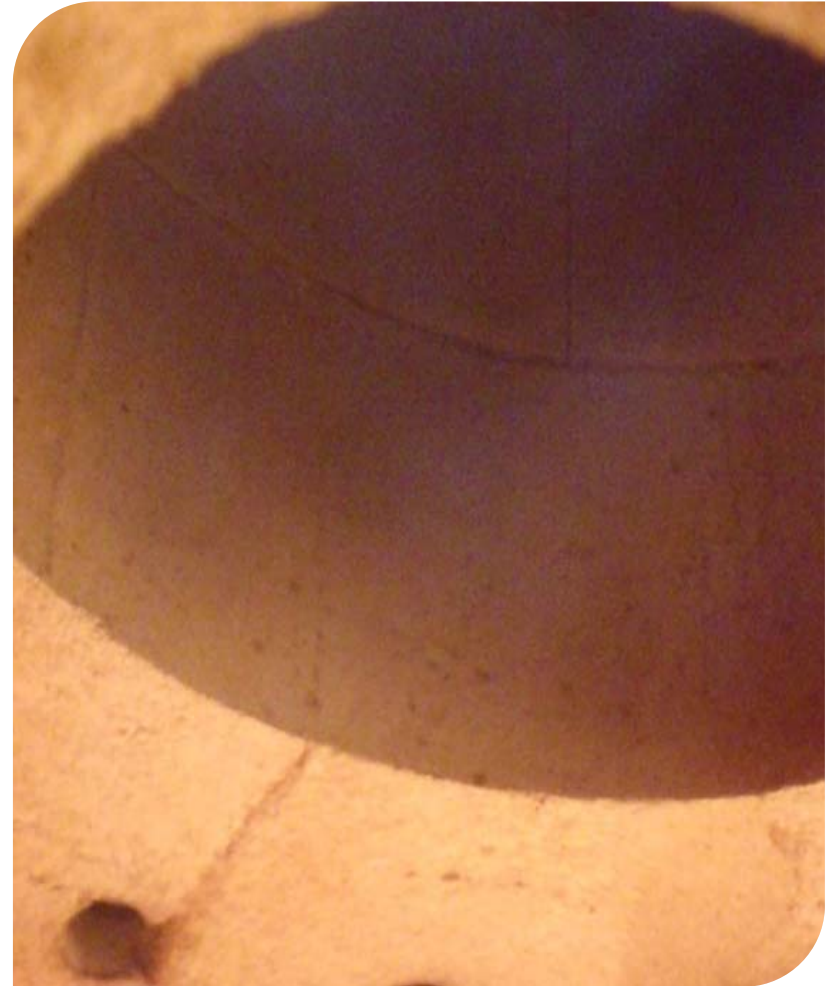
- ✓ High enough filtration efficiency for corrosive components
- ❑ Avoid tar condensation

❑ Boiler

- ✓ No hot corrosion with high steam parameters (540 C 121 bar) found during 3 years of operation.

Kymijärvi II - Operational Experiences

- Over 7 yers of commercial operation
- Stable and easy to control
- Compliance with WID (also with 2 s 850 °C)
 - No need for support fuel
- No corrosion detected
- Availability challenges during the first year
 - Need to change hot filter operational modes (start-up/shutdown)
 - Fuel properties improved (metal/streamers)
 - Filter regeneration process developed
 - Operational routines improved



Kymijärvi II - Fuel properties

- The table below shows numbers of some selected fuel properties based on monthly combined samples.
- The plant has reached full capacity with the fuel range shown in the table.
- No need of support fuel

	LHV, ar	Moisture	Ash	C	S	Cl	Na+K
	MJ/kg	%	%, in ds	%, in ds	%, in ds	%, in ds	%, in ds
Predicted design	16,1	21,0	7,6	55,5	0,15	0,60	0,20
Experienced average	14,2	26,8	9,4	50,2	0,3	0,48	0,16
Experienced min	10,8	19,0	5,3	44,4	0,2	0,11	0,09
Experienced max	17,5	37,5	15,5	57,0	0,6	1,3	0,35

Kymijärvi II – Emissions

Emission	Limit 0,5h average and unit	Measured
NO _x	400 mg/Nm ³	150 - 220
SO ₂	200 mg/Nm ³	30 - 60
CO	100 mg/Nm ³	1 - 4
Dust	30 mg/Nm ³	< 1*
HCl	60 mg/Nm ³	2 - 8
HF	4 mg/Nm ³	< 1*
TOC	20 mg/Nm ³	< 1*
PCDD/F Compounds	0,1 ng/Nm ³	< 0,001
Hg	50 µg/Nm ³	0,1* - 1,2
Cd+Tl	50 µg/Nm ³	< 0,7*
Sb+As+Co+Cr+Cu+Mn+Ni+Pb+V	500 µg/Nm ³	< 8

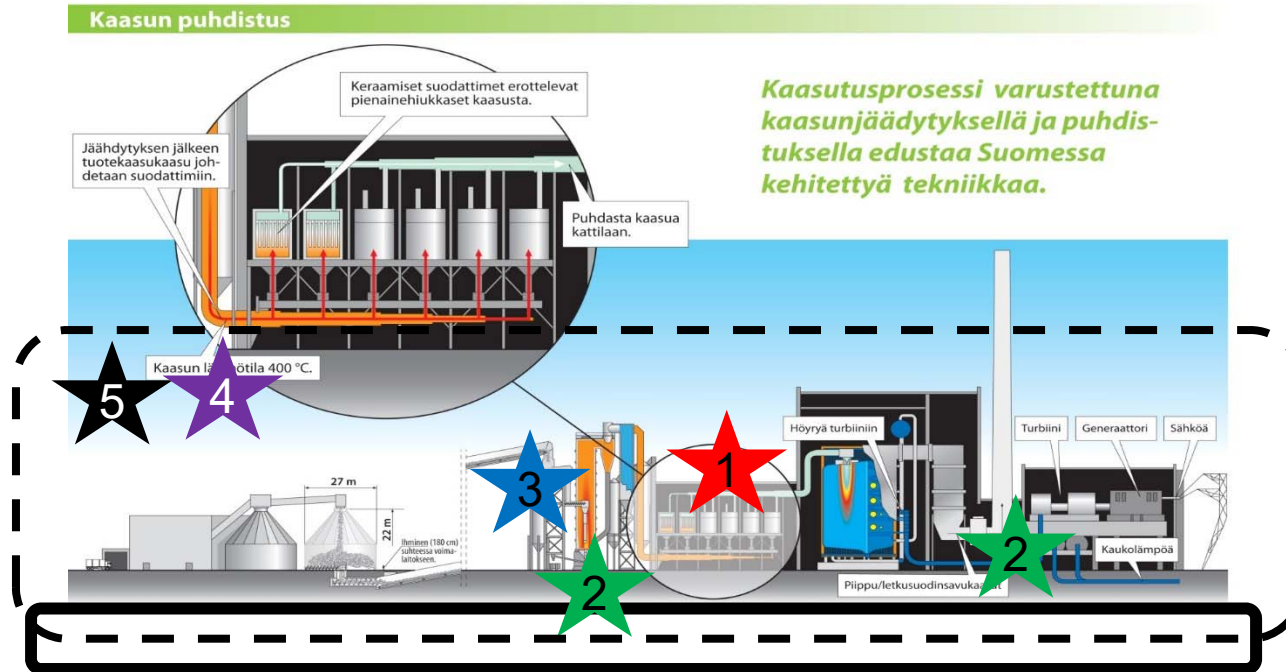
* Means the measured value is below analysis detection limit

Plant meets all EU emission limits set for waste fired plant

Annual emissions

	2013	2014	2015	2016	2017	2018
Particles (t)	0,03	0,2	0,2	0,5	0,6	0,7
CO2 (t)	106 800	84 602	82 863	85 019	73 953	89 497
NOx (t)	239	365	411	436	437	456
SO2 (t)	57	85	79	96	103	108
CO (t)	0,15	0,08	0,16	0,3	0,5	0,3
HCl (t)	8,5	15,5	16,5	8	13	20
TOC (t)	0,85	0,75	0,53	1,4	1,3	1,2
Hg (kg)	0,22	0,25	0,03	0,59	0,1	0,47
HF (t)	0,33	0,36	0,28	0,28	0,27	0,29
PCDD+PCDF (g)	0	0	0	0	0	0

Kymijärvi II – Waste to Energy Plant Main improvements



1. Filter regeneration unit
2. Recirculation of bottom ash and chemical in APC
3. Rotary feeders and fuel feeding
4. Control and operational practices
5. Safety and maintenance practices

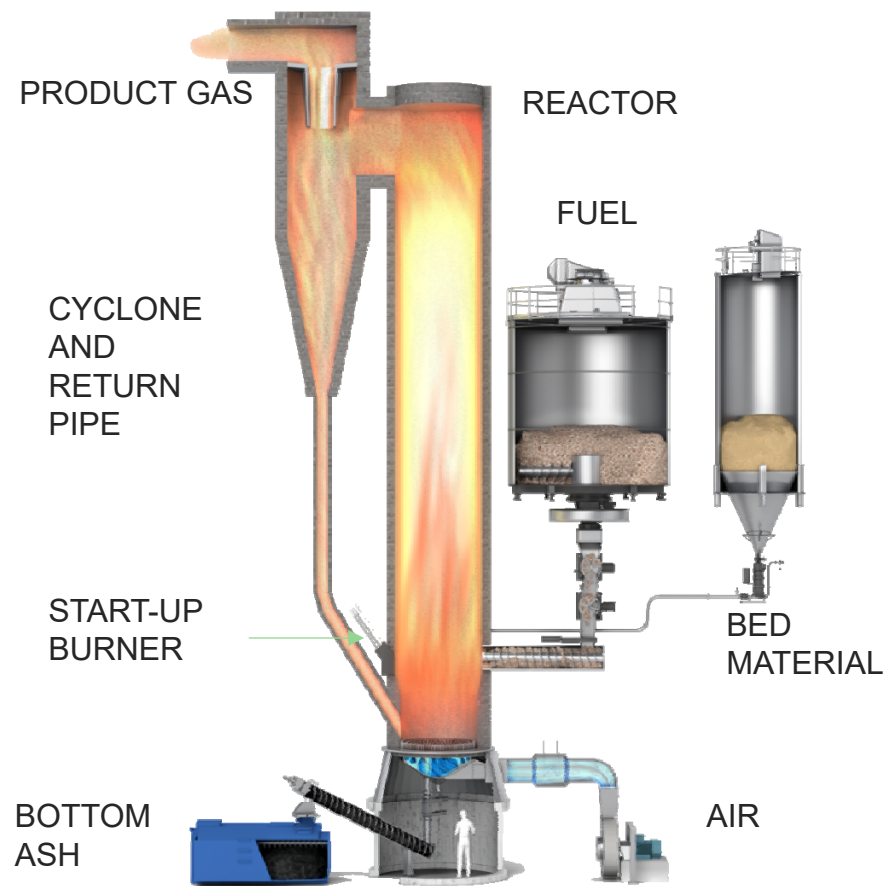
Valmet CFB Gasifier

Large scale process equipment to turn biomass, waste and other reactive solid fuels into gas.



Valmet CFB Gasifier

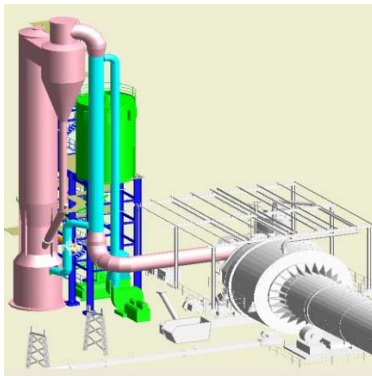
Capacity Range	
Size	20 – 140 (300) MW _{th}
Fuel	Biomass, waste (RDF)
Gasification media	Air
Operating temperature	750 – 900 °C
Operating pressure	5-30 kPa(g)
Gas heating value	3-7 MJ/nm ³ (LHV)
Applications	<ul style="list-style-type: none"> • RDF/SRF gasification for power generation • Biomass gasification for power generation • Biomass gasification for industrial furnaces



Valmet CFB Gasifier - application

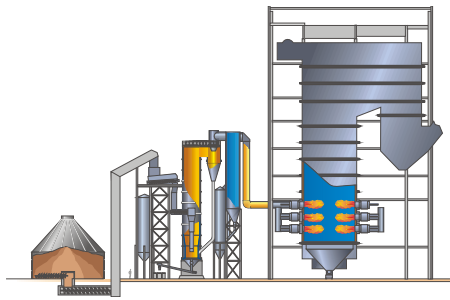
Product gas for industrial kilns

- Woody biomass, bark, peat and waste
- 20 – 110 MW_{fuel} units
- Typically includes a dryer
- Dusty product gas
- References for Limekilns
- Other types of kilns also possible



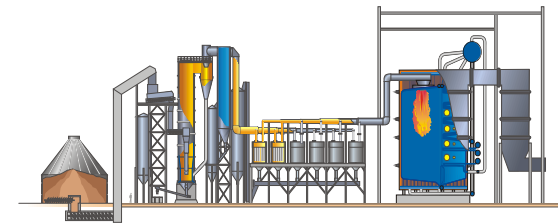
Product gas for power boilers

- Woody biomass, bark, peat and waste
- Superior electrical efficiency
- **Existing boilers**
- 50 – 300 MW_{fuel} units
- If needed, can include a dryer
- Gas cleaning as needed



Product gas from waste for power production

- Waste-derived fuel
- 50 – 150 MW_{fuel}
- High electrical efficiency
- Typically a new gas boiler (existing boiler is also an option)



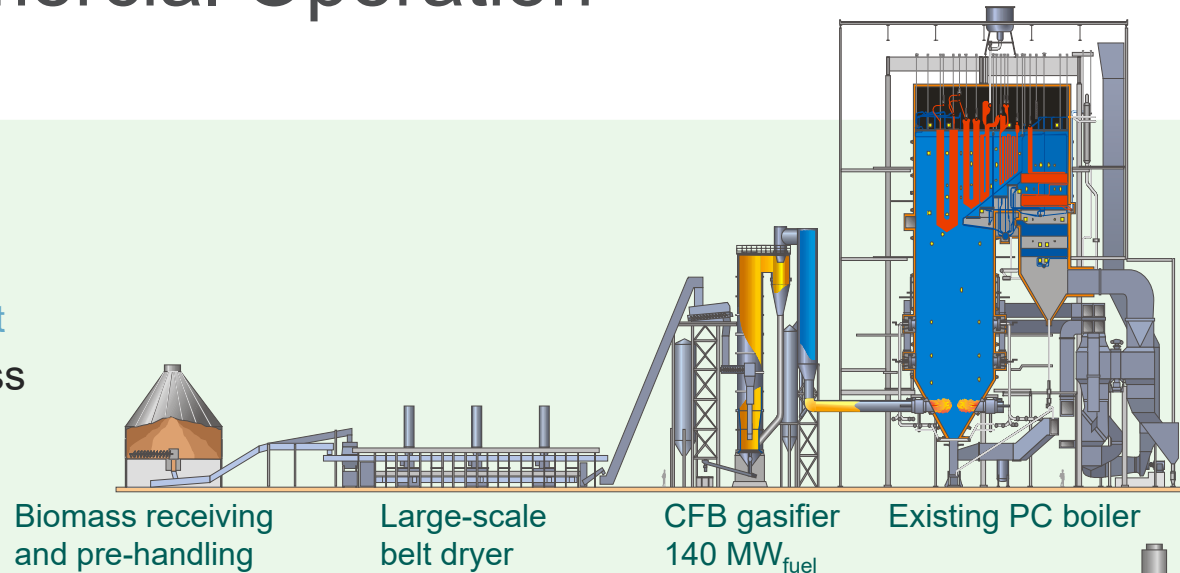
Plants in Commercial Operation



The Vaskiluoto 2 power plant

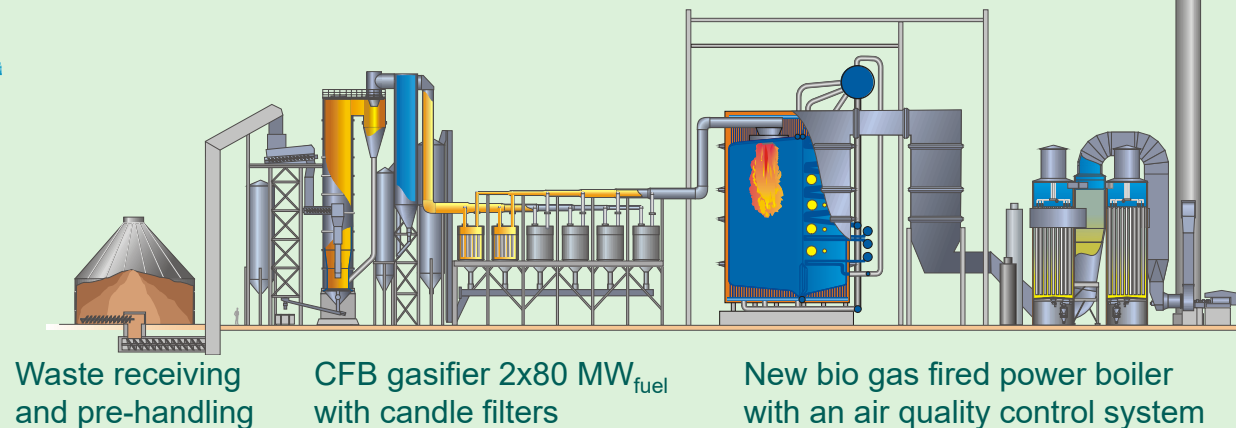
Product gas from biomass
for power boilers

Commercial Jan 2013



Product gas from SRF
for power production

Commercial May 2012



Plants in Commercial Operation



Chenming Huanggang, China, 2018 In Operation

Application: Lime kiln
Gasifier 50 MW (900 tpd lime)
Dryer evaporation 12 ton/h water



Metsä Fibre Äänekoski, Finland, 2017 In operation

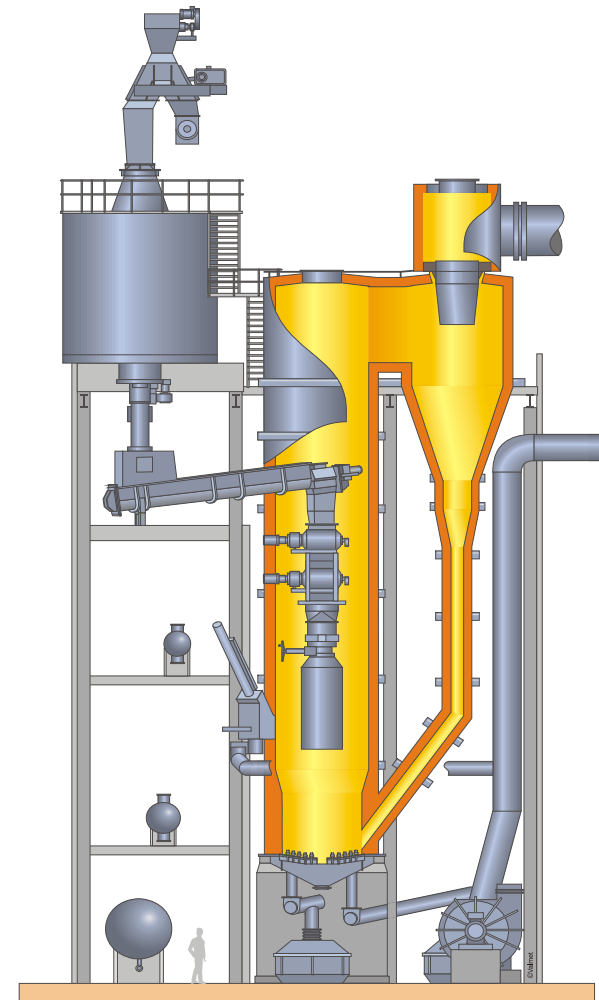
Application: Lime kiln
Gasifier 87 MW (1200 tpd lime)
Dryer evaporation 23 ton/h water



APP OKI, Indonesia, 2017 In operation

Application: Lime kiln
Gasifier 2 x 110MW (1250 tpd lime)
Dryer evaporation 2 x 19 ton/h water

- ✓ Confidential customer 2 * 87 MW, in operation 2021
- ✓ Värö - 27 MW gasifier, 25 years operation retired 2014

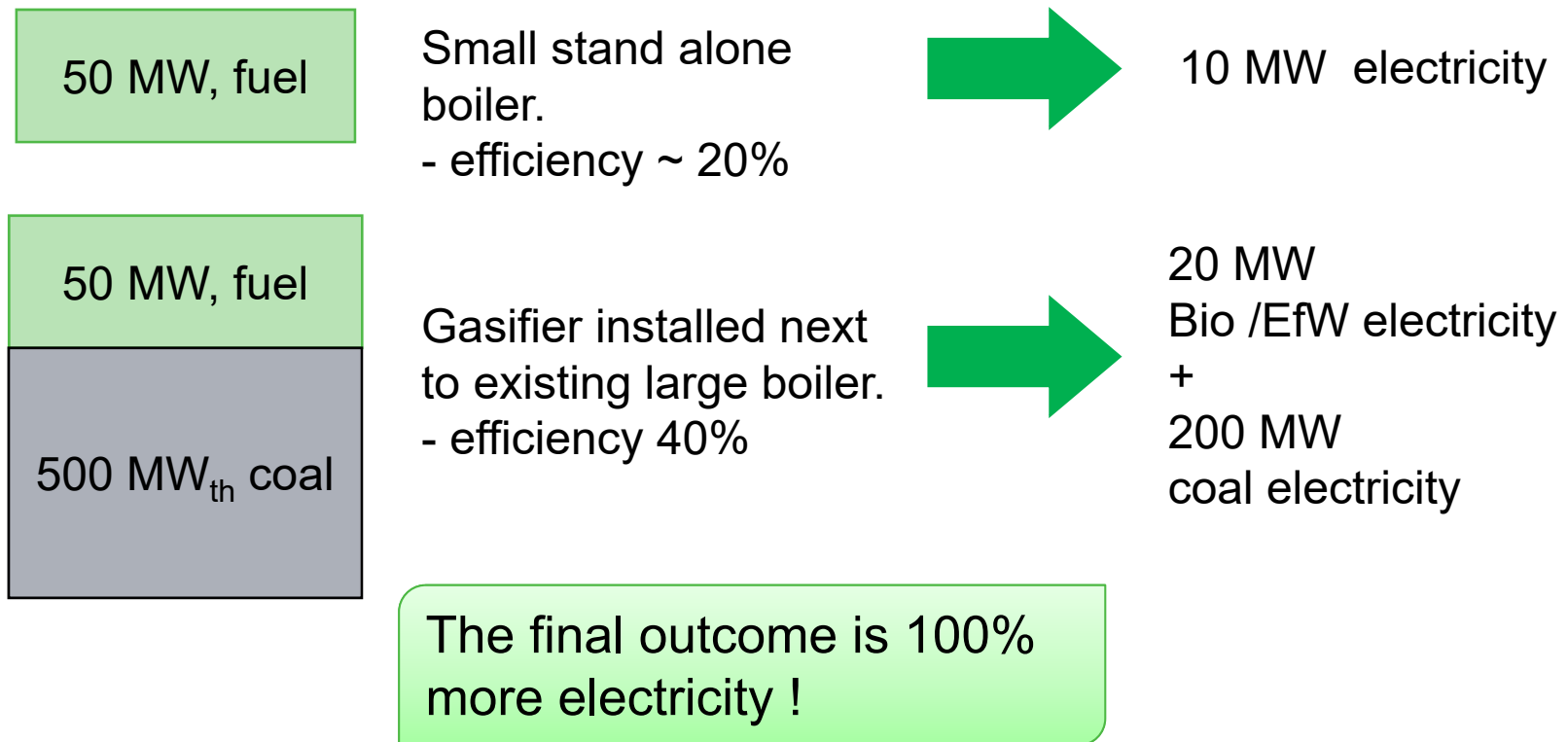


Summary Fossil Fuel Replacement in Existing Plants



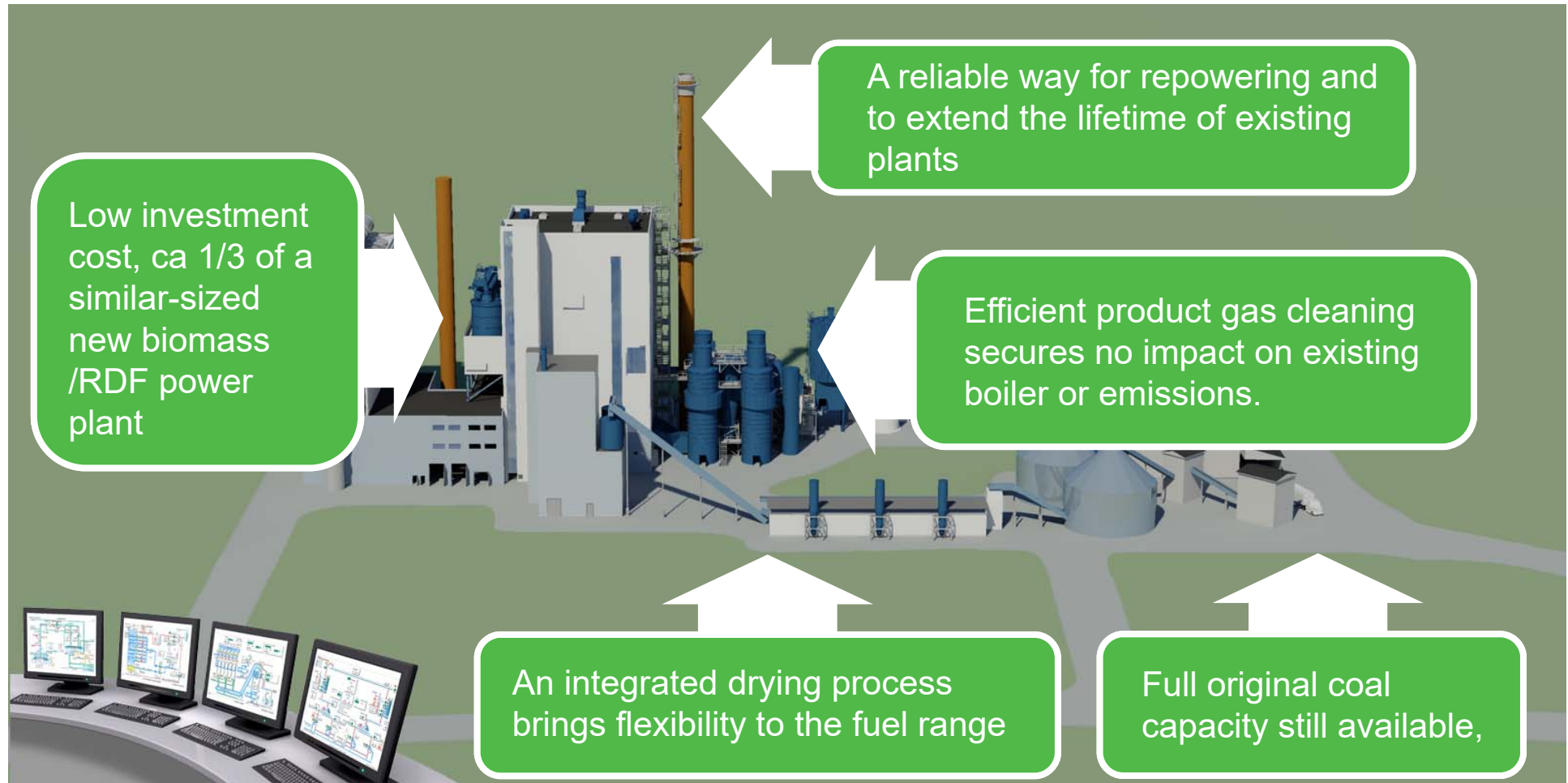
Gasification for co-firing

Example: 100 000 tn/a RDF or bio ~ 50 MW_{th} available at the district



- An efficient way to use biomass or waste fuels and reduce GHG emissions
- Investment is reduced compared to a new EfW facility by 40 -60 %

Benefits of the fuel conversion with CFB gasification



Valmet CFB Gasifier for RDF / SRF

Summary

Commercially proven :

- High-efficiency WtE technology for electricity production
- Partial or complete fuel change in existing power plants
- Cost competitive solution, reuse of existing capital will reduce the investment by 60-70 %





Thank you

juhani.isaksson@valmet.com

