

Commercial scale gasification
to replace fossil fuel in power
generation –
Vaskiluodon Voima140 MW
CFB Gasification Project

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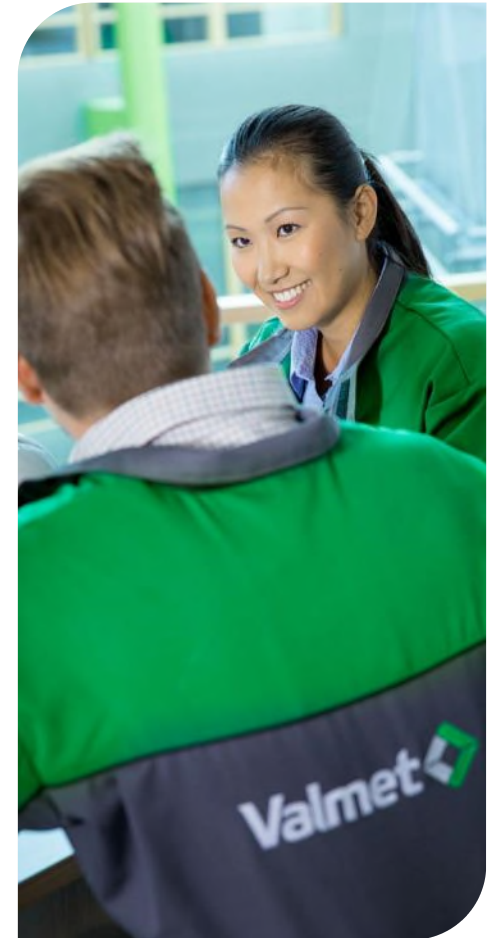
Valmet Gasification technology

Case: Vaskiluodon Voima

- 1 Valmet in brief
- 2 Valmet CFB Gasification technology
- 3 Vaskiluodon Voima Gasification project
- 4 Operational Experiences at Vaskiluoto
- 5 Outlook

Valmet

- A leading provider of technology, automation and services for pulp, paper, and energy industries
 - Unique offering with process technology, automation and services
- 12,000 professionals serving a global customer base
- Net sales EUR 2.8 billion (illustrative for 2014)
- Delivering state-of-the-art technology, automation and services to customers around the world
- Listed on the NASDAQ OMX Helsinki Ltd.



Valmet's key figures

Orders received
EUR ~3,400 million

Net sales
EUR ~2,800 million

Employees ~12,000

Market position

#1-2 Services

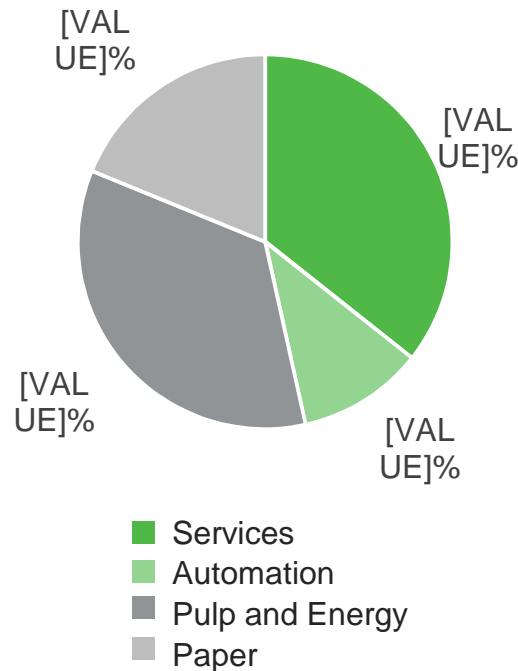
#1-3 Pulp and paper
automation

#1-2 Pulp

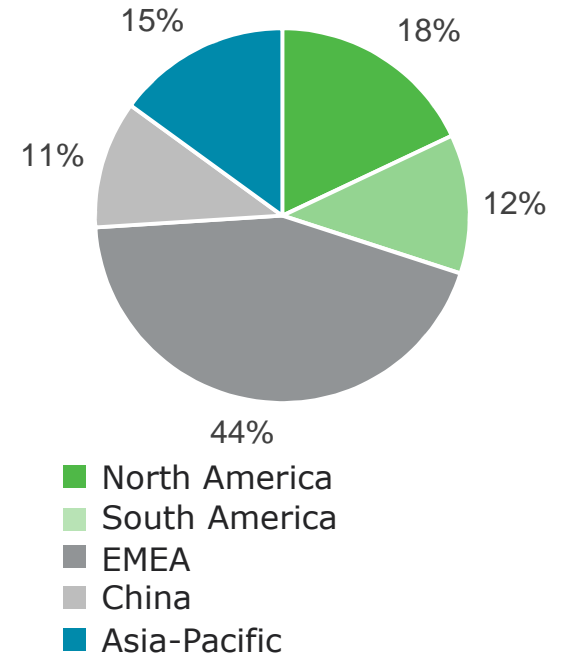
#1-3 Energy

#1-2 Paper, board, tissue

Net sales by
business line



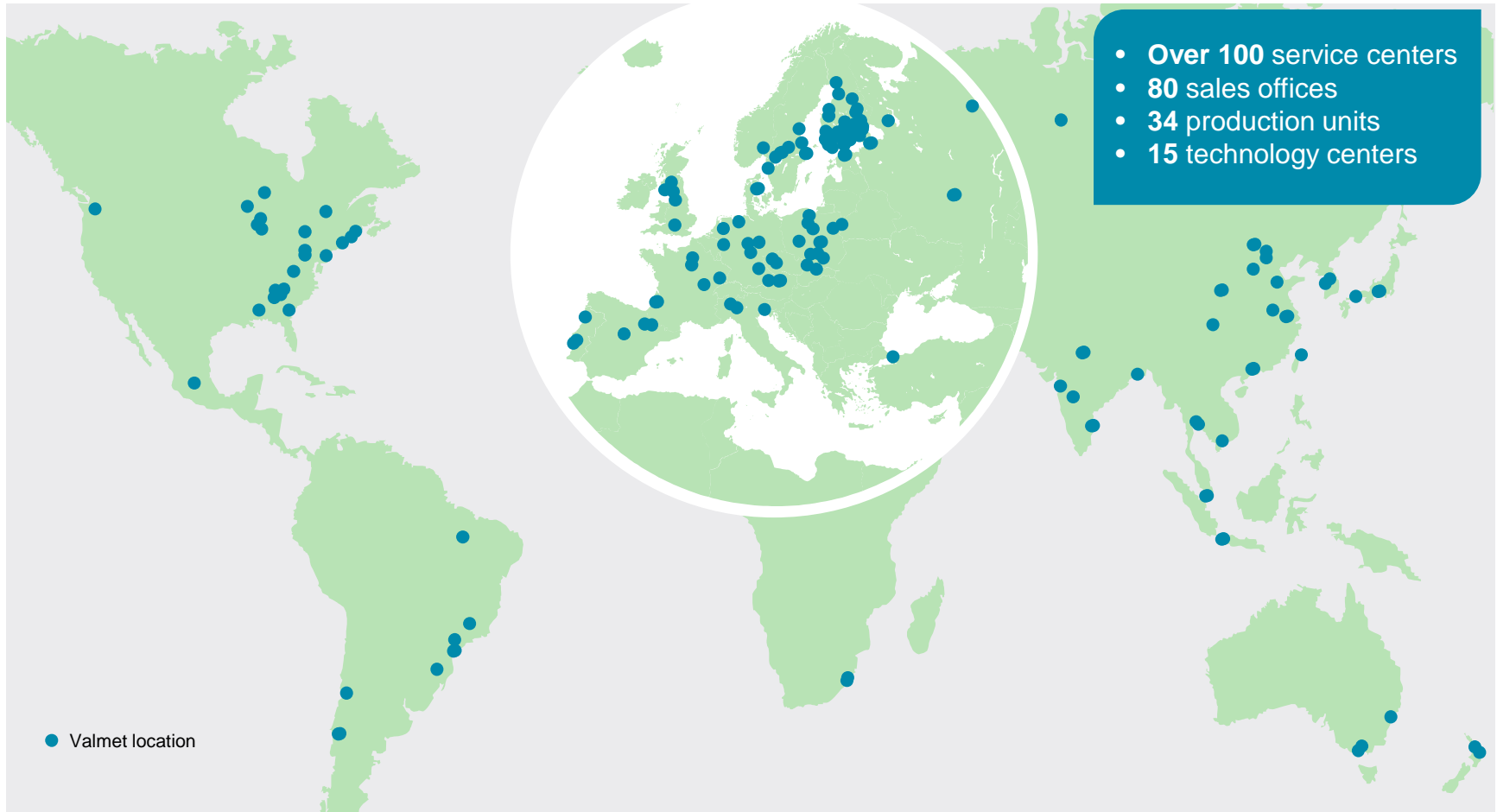
Net sales by
geographic area



1) Combination of Valmet and Metso Process Automation System figures for 2014

Strong global presence close to our customers

130 locations in 33 countries



Valmet
CFB
gasification
technology



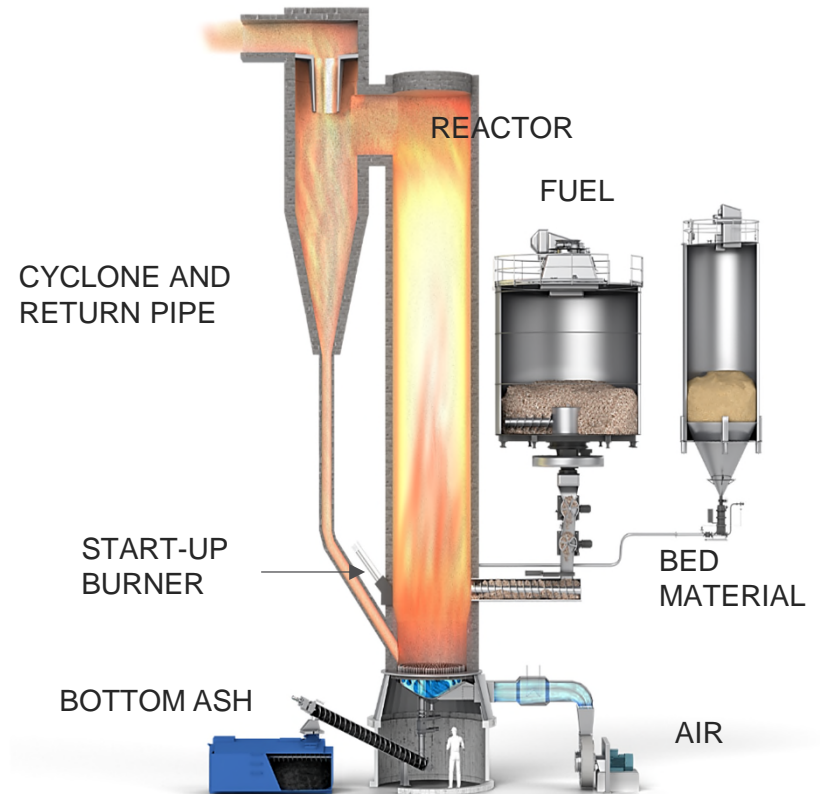
Valmet CFB gasifier

Proven industrial process

CFB Gasifier

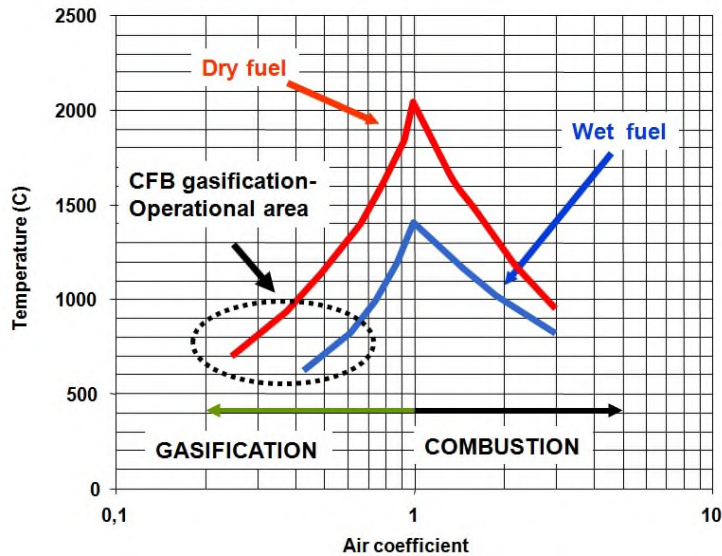
Size	20 – 140 (300) MW _{th}
Fuel	Biomass, waste
Gasification media	Air
Operating temperature	750 – 900 °C
Operating pressure	5 - 30 kPa(g)
Product gas heating value	3 - 7 MJ/nm ³ (LHV)

PRODUCT GAS



Technology

Fuel is the basis

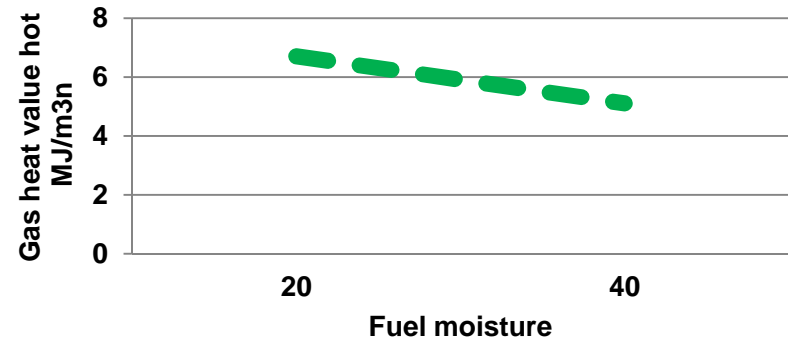


Fuel moisture affects:

- gas heating value
- process capacity
- there is no exact go/no go limit
- if moisture is over 40..50 % the merits of gasification are questionable

Fuel moisture (waste)	20 %	30 %	40 %
Gasifier's max. output	100	89	77
<i>Waste fuel: HHV dry 22,5 MJ/kg, Ash 7,6 % CFB gasifier</i>			

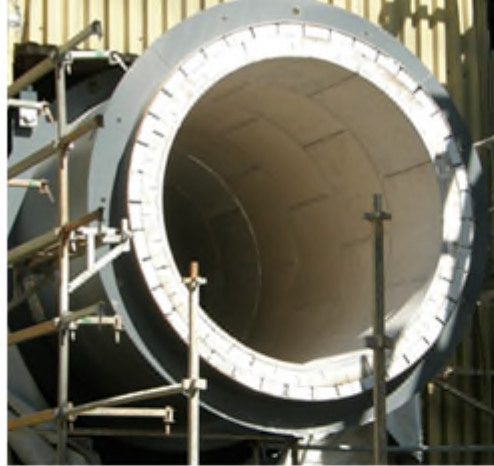
Gas heat value MJ/m³ⁿ hot (incl. sensible heat)



Valmet CFB gasifier

Simplified:

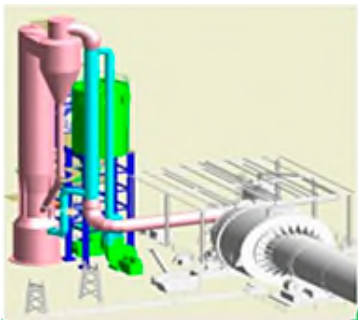
- Bended steel sheets + refractory = gasifier
- Simple structure => maximized shop fabrication



Valmet - CFB gasification offering

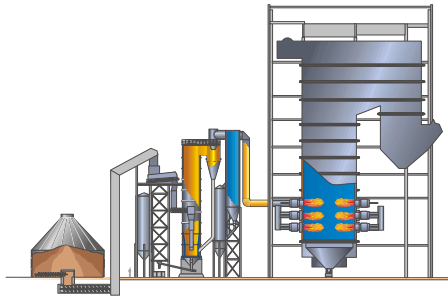
Product gas for industrial kilns

- woody biomass, bark, peat, also waste
- 20 - 110 MW_{fuel} units
- typically includes a dryer
- dusty product gas
- also other types of kilns possible
- gas cleaning if needed



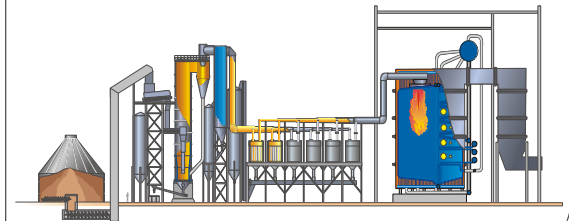
Product gas for power boilers

- woody biomass, bark, peat and waste
- superior electricity efficiency
- existing boilers
- 50 -140 (300) MW_{fuel} units
- if needed can include a dryer
- dusty product gas
- also other types of kilns possible
- gas cleaning as needed



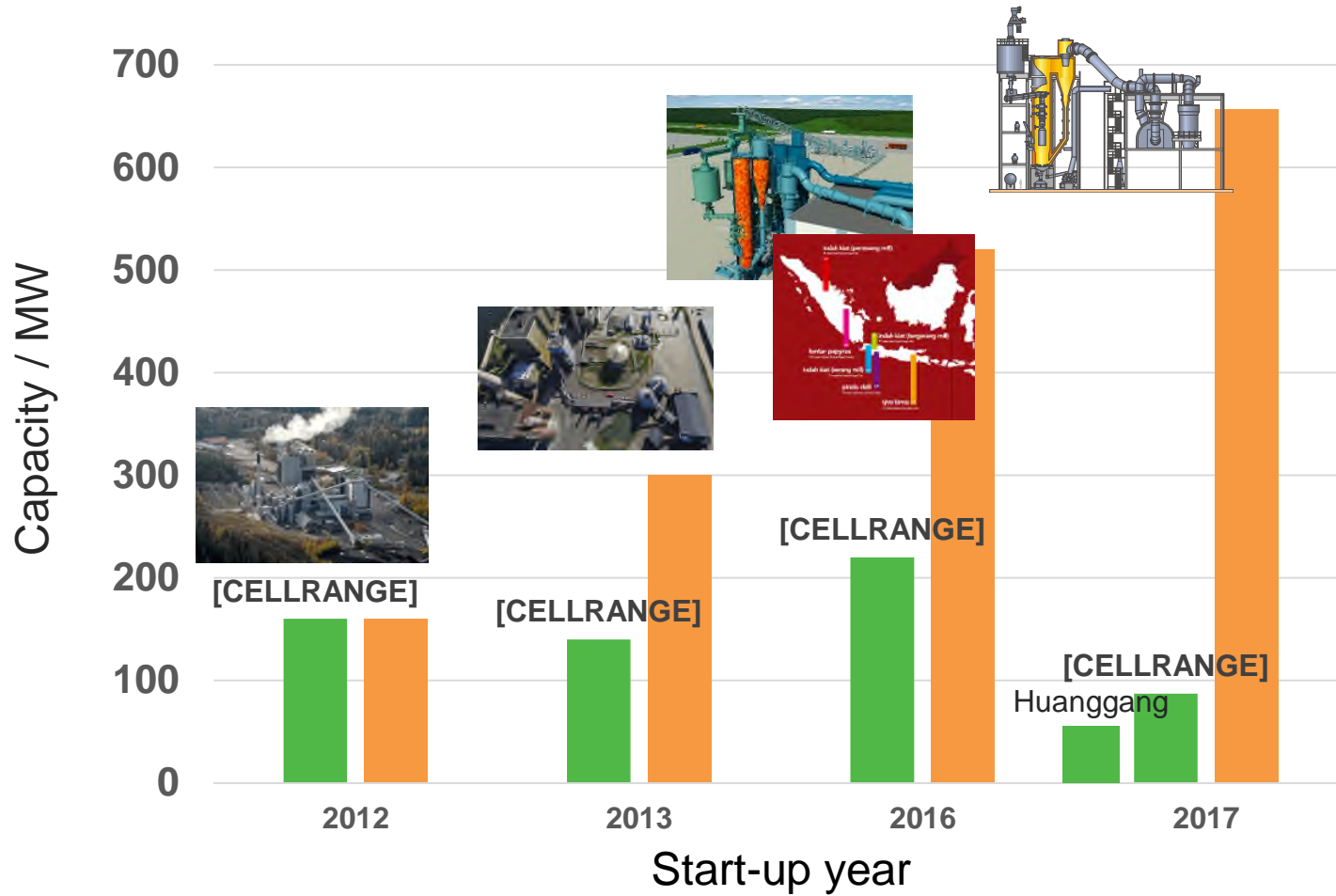
Product gas from waste for power production

- waste-derived fuel
- 50 -150 MW_{fuel}
- high electricity efficiency
- typically a new gas boiler (existing boiler is also an option)
- gas filtering - > clean product gas
- corrosion-free



References

Operational and under construction

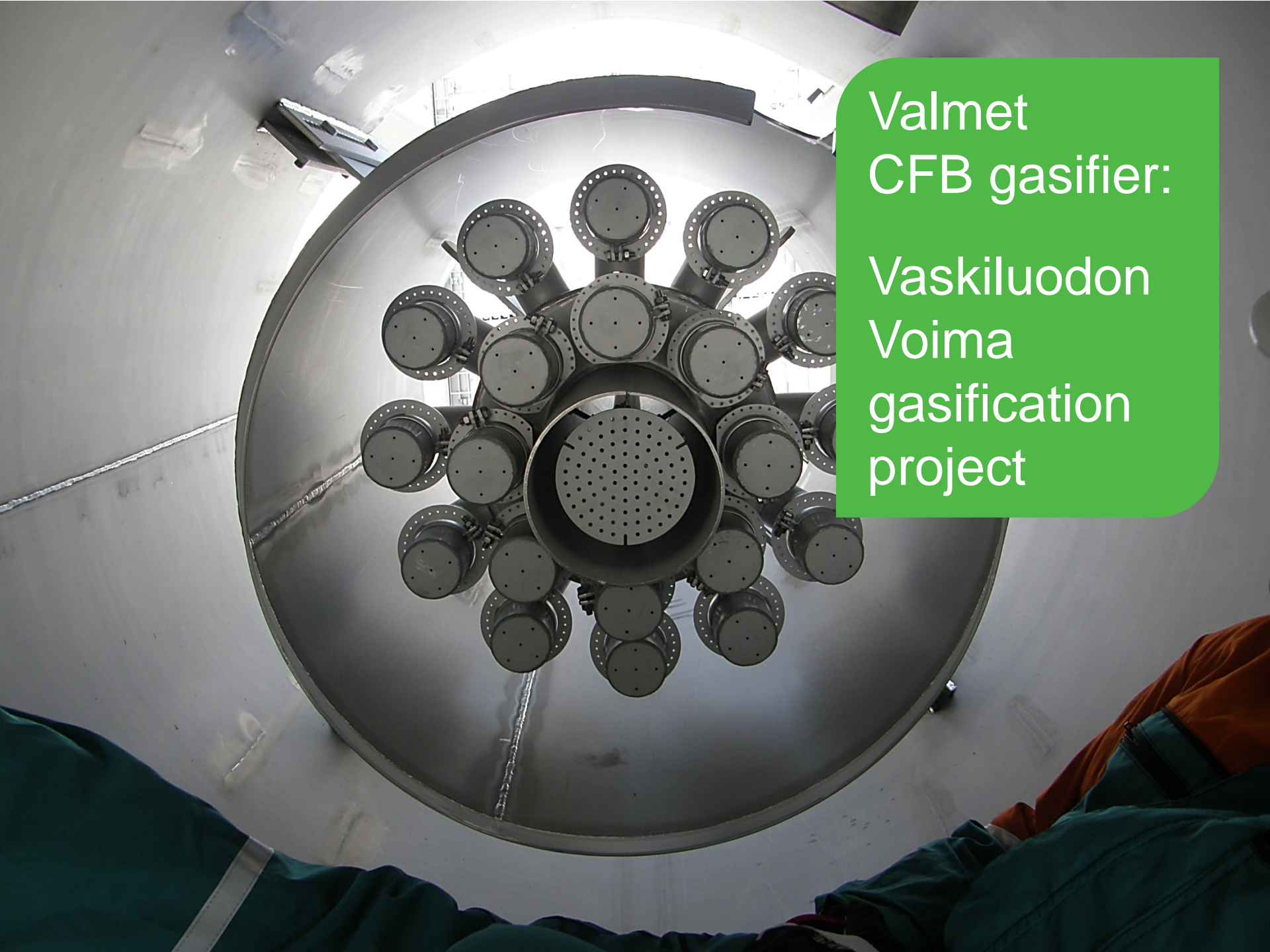


Valmet CFB gasification

Commercially proven solutions:

- Partial or complete fuel change in existing power plants
- High-efficiency WtE technology for electricity production
- Firing of industrial process with gasified biofuels or waste



A large industrial gasifier vessel, likely a CFB (Circulating Fluidized Bed) gasifier, is shown from a top-down perspective. The vessel is cylindrical and has a central distributor with a perforated top. Surrounding the central distributor are numerous smaller, circular ports or nozzles arranged in a circular pattern. The vessel is mounted on a concrete base. The image is taken from a low angle, looking up into the vessel. A green text box is overlaid on the right side of the image.

Valmet
CFB gasifier:
Vaskiluodon
Voima
gasification
project

Vaskiluodon Voima

CFB gasifier experiences

- 140 MW CFB gasifier
- Gas utilized in an existing PC boiler to replace coal
- Fuels:
 - harvesting residues
 - stumps
 - peat
- Delivery time 19 months
- Valmet delivery:
 - fuel yard
 - dryer
 - gasifier
 - boiler modifications
 - automation
- Commercial use Jan 2013



140 MW biomass gasifier, Vaasa

Background and targets
Technology for the conversion
Power plant integration
Operational experience



Biomass gasification in Vaasa – large-scale conversion to renewables

The Vaskiluoto power plant in Vaasa, Finland

View of the plant before the fuel conversion

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



Biomass gasification in Vaasa

Drivers for the project



European CO₂-emission trading
National feed-in tariff for power production using forest biomass
Fossil fuel tax for heat production
Market and policy trend to decrease the use of coal



A decision was made to convert the existing high-efficiency production unit to biomass use instead of constructing a new one.

Targets

- Reduction of fossil CO₂-emissions
- Cost efficient production of power and heat
- To change large amount of coal to local biomass fuel
- To maintain 100% coal firing possibility

Fluidized bed gasification was selected

Low investment

- Only minor modifications were needed for the boiler
- Investment budget 40 M€ for 140 MW fuel replacement capacity

Low operational cost

- Local forest biomass could be utilized
- Peat as back up fuel
- Low parasitic power consumption
- High efficiency bio => electricity

Safe solution

- Fall-back option secured
 - **Possible to keep the original coal firing capacity on-line**

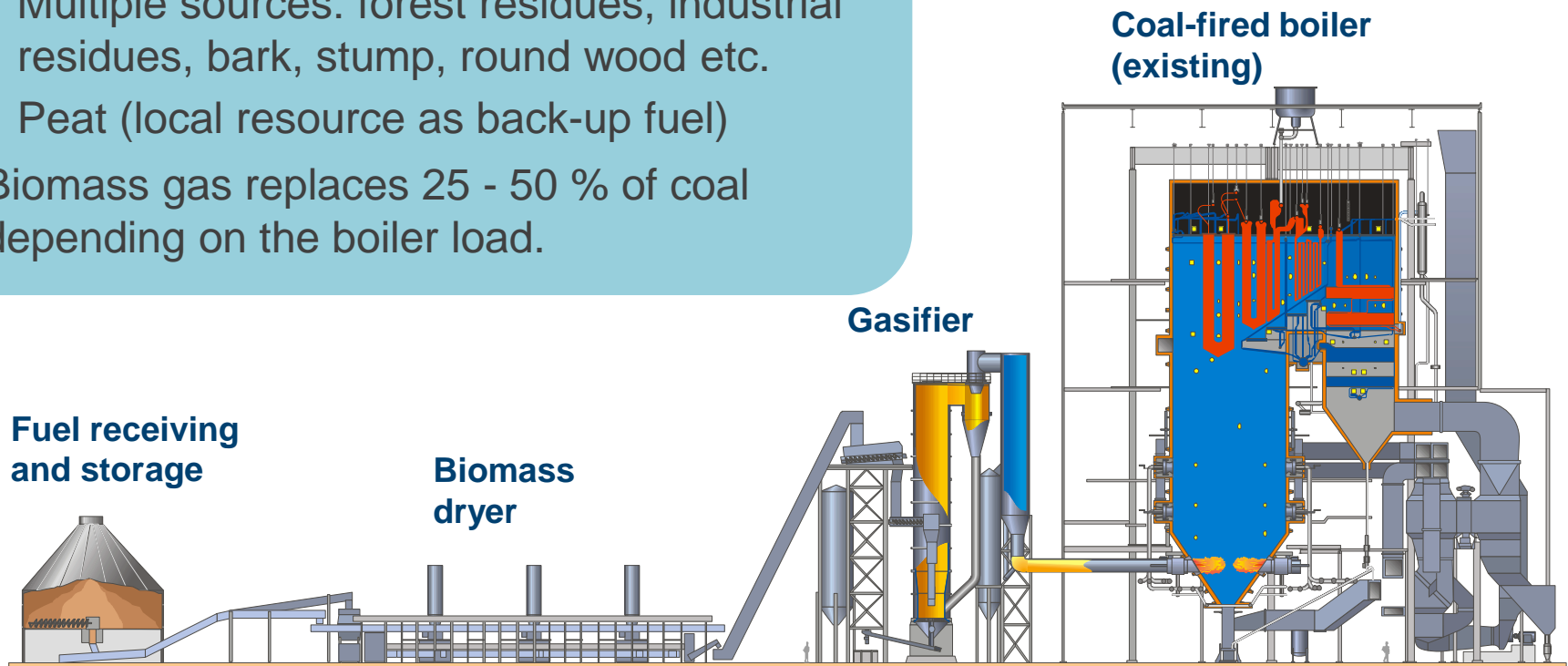


The Vaskiluoto (Vaasa) gasification plant

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 - 50 % of coal depending on the boiler load.



Power plant integration



Belt dryer

Feed moisture 47 %

Output moisture 20 %

Evaporation capacity 10 t_{H₂O}/h

Heat source

District heating water

Biomass gasification in Vaasa – large-scale conversion to renewables

Power plant integration



Process integration

- Product gas to the boiler
- Low temperature heat from the power plant to the wood biomass dryer

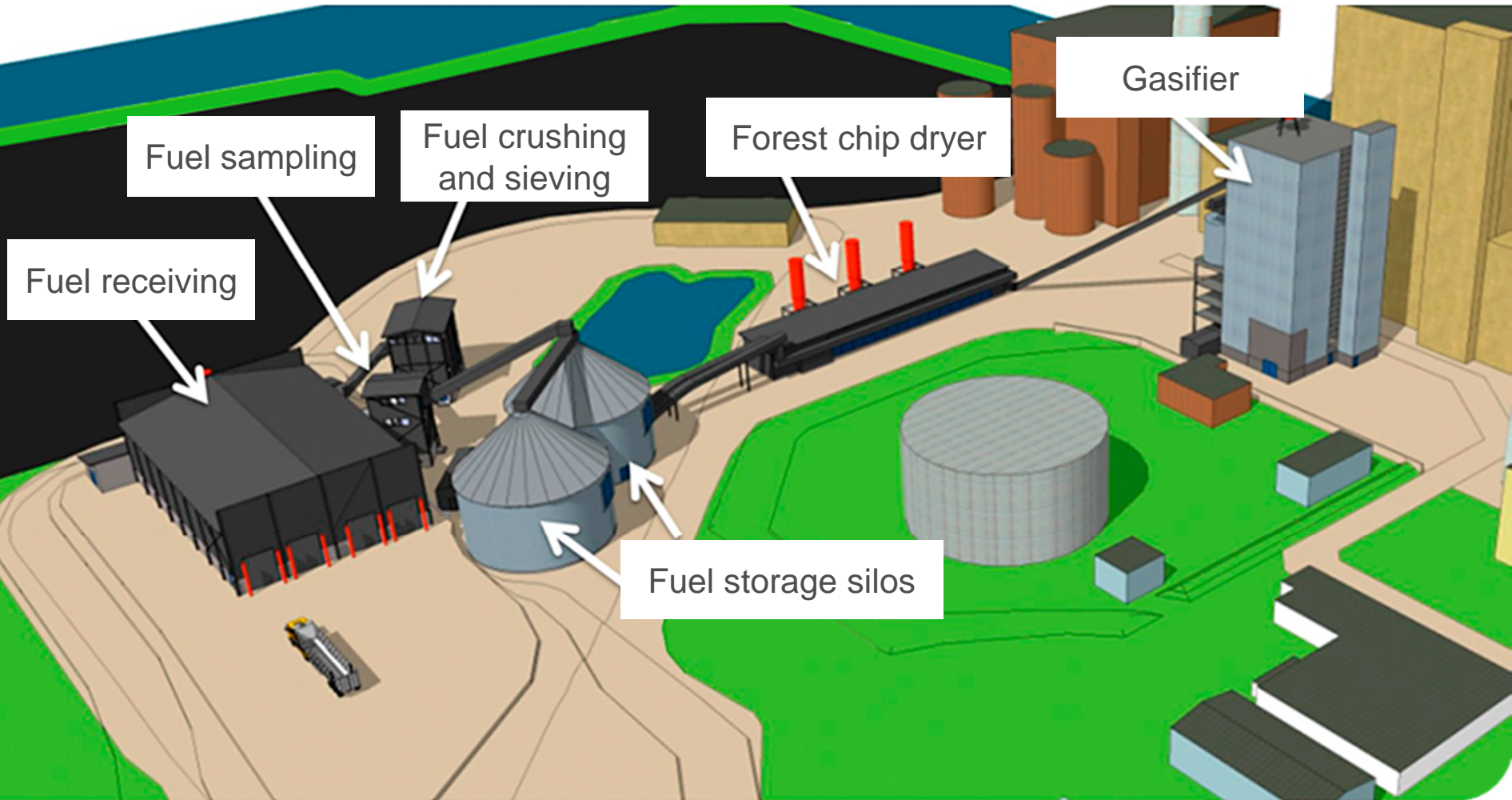
Automation integration

- Automation 100 % in the power plant automation system

Utility integration

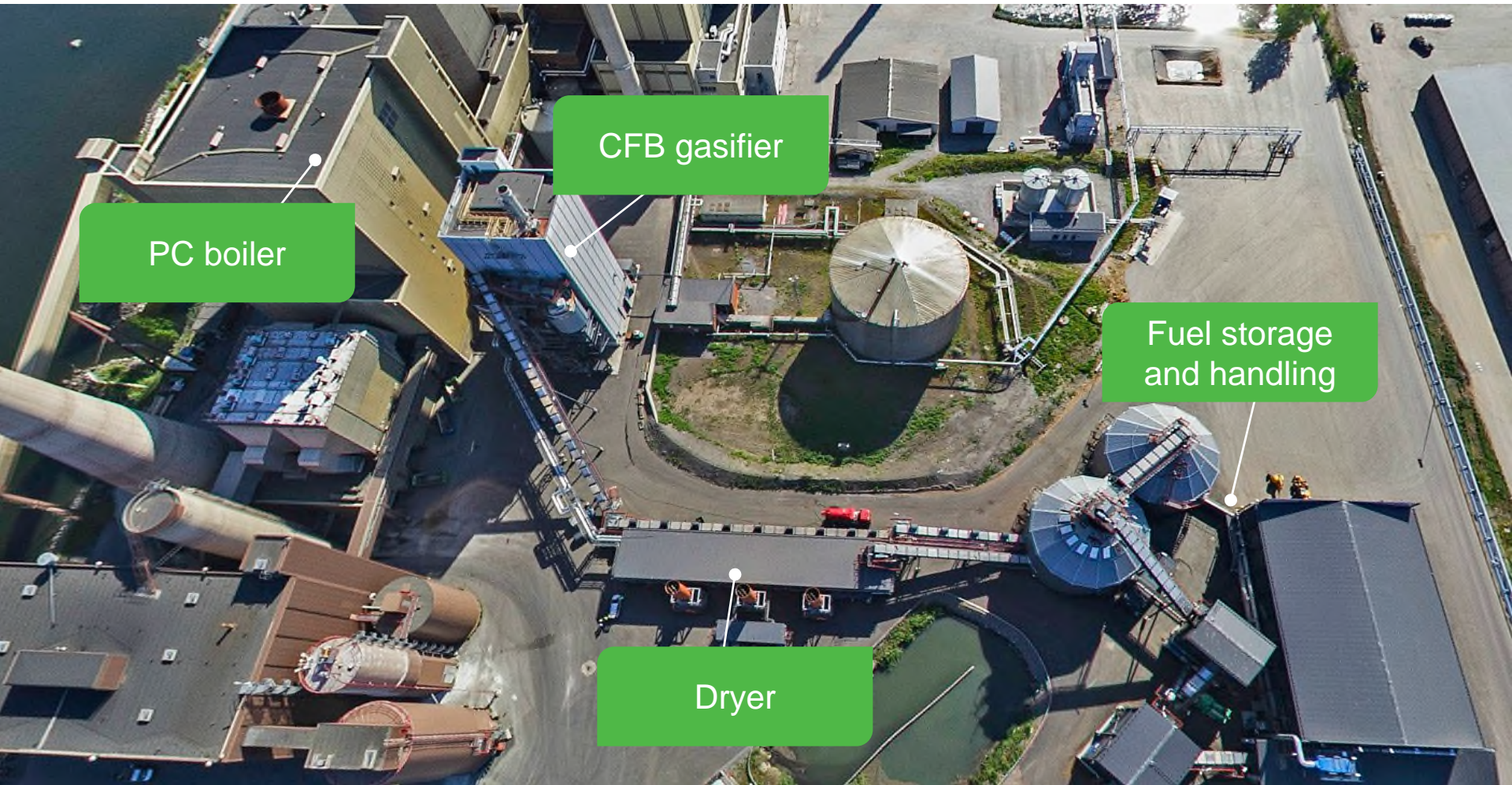
- All utilities from the power plant

Plant layout



Biomass gasification in Vaasa – Large scale conversion to renewables

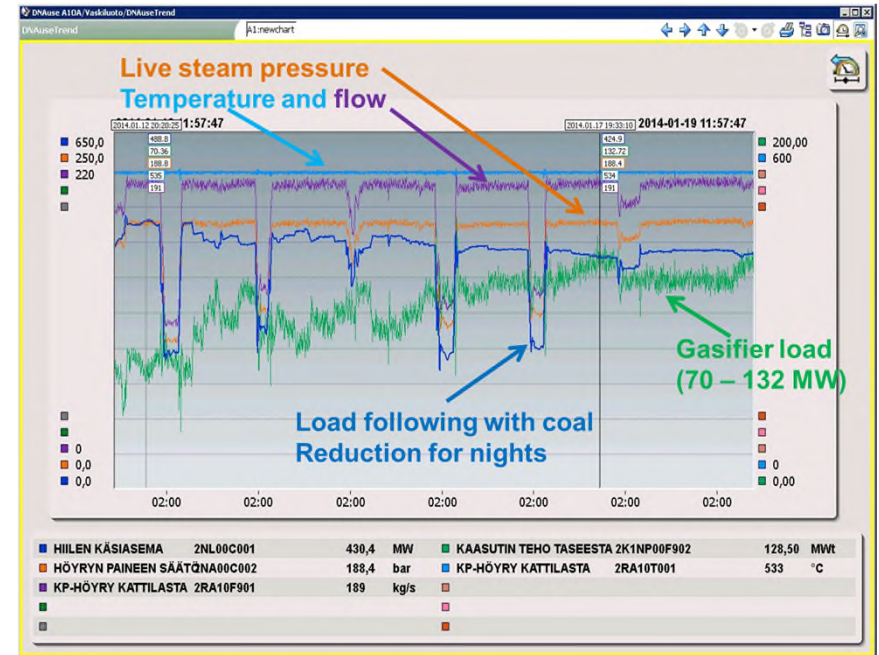
The Vaskiluoto (Vaasa) gasification plant



Operational experience during the first 2 years

1. Safety and operational experiences

- The plant has met all design criteria
- Plant responds promptly and consistently and is easy to operate
- No accidents or safety issues due to the use of gasifier
- The fuel drying process operates well
- The gasifier helps to reduce 230 000 tn/a of CO₂ emissions



Operational experience during the first 2 years

2. Availability

Gasifier

The first operational season 2013/2014: availability 97 %

Disturbances during the first year of operation

- Air preheater imbalance => New flow guides installed
- Torch test failed => Faulty limit switch, replaced
- Air damper leakage => Faulty seal, replaced
- Burner impeller damage => Impeller replaced

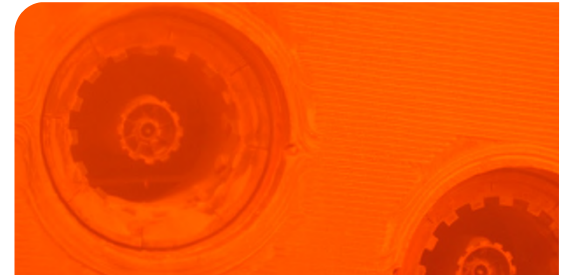
No main boiler outage caused by the gasifier

Heating season 2014/2015: availability improved to 99 %

Fuel yard

Several stops/outages

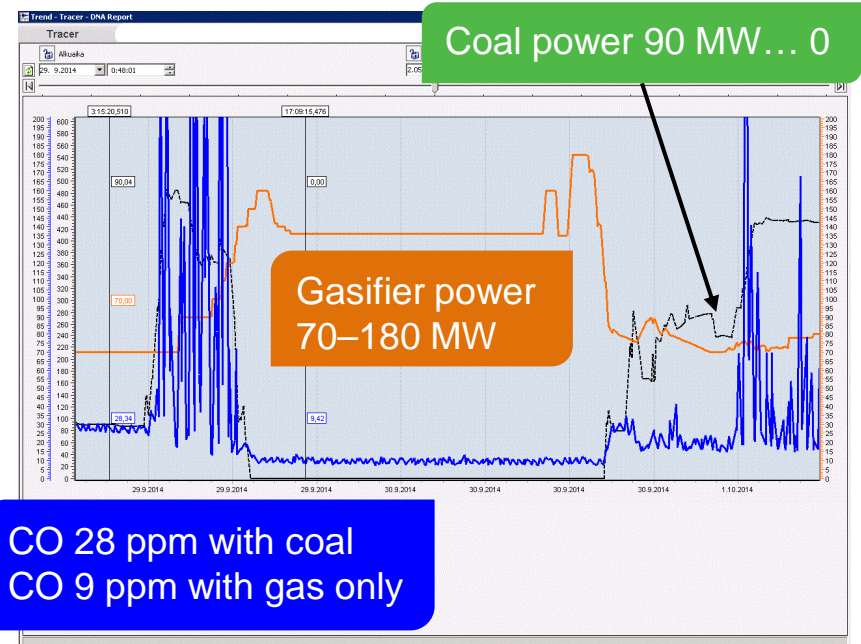
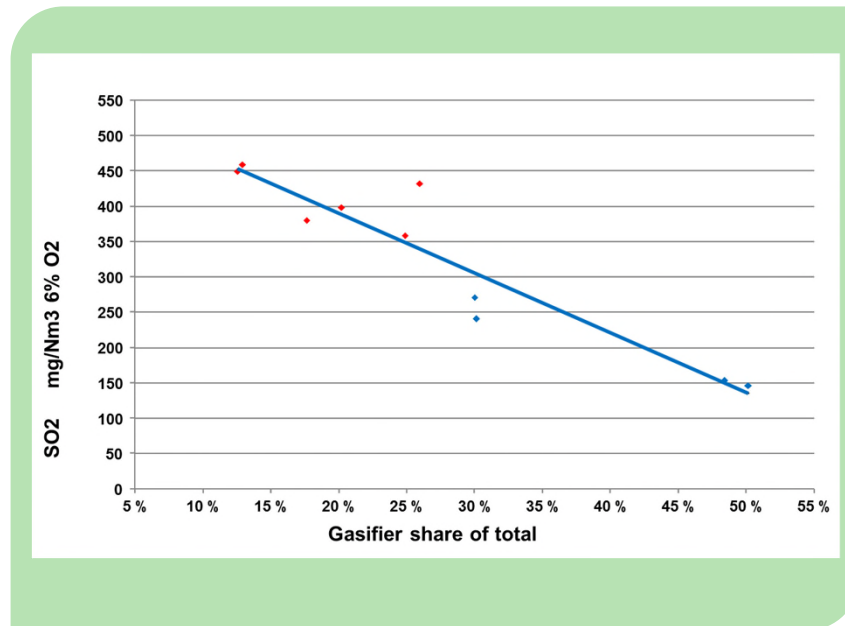
- Not robust enough
- Rebuilds ongoing



Operational experience during the first 2 years

3. Emissions

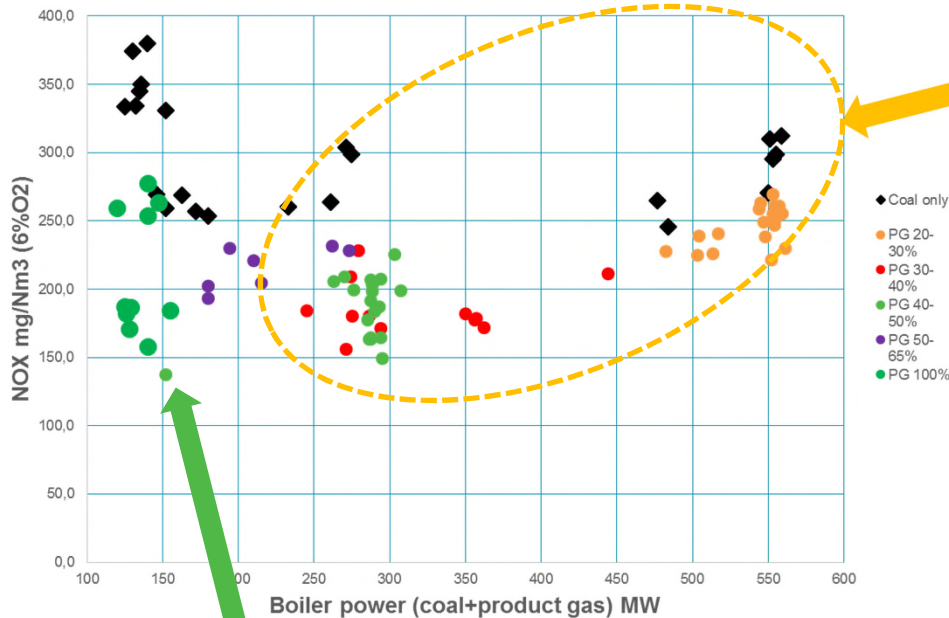
- Reduction of SO₂ (before the final S removal process) is close to proportional to the share of gasification power.



- CO content remains low, below 10 ppm when firing gas only.

Operational experience during the first 2 years

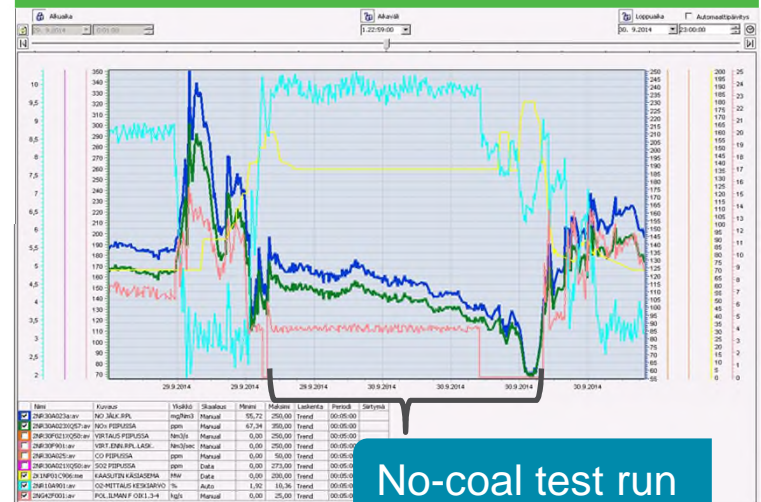
3. Emissions



NO_x emissions are reduced by 20 – 30 % when the share of product gas is increased to 30 – 50 %

When operated with product gas only a further reduction was discovered

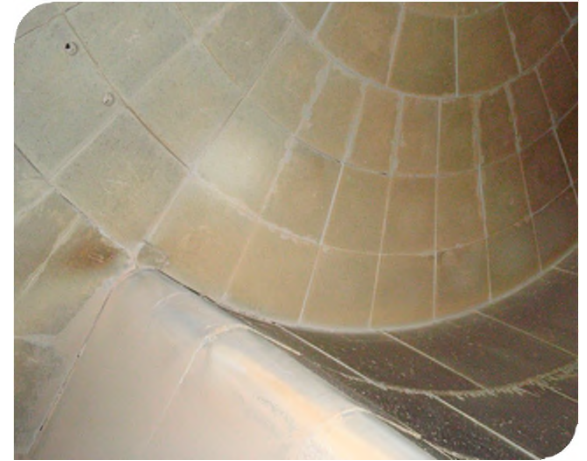
Gasifier power 140



Operational experience during the first 2 years

Maintenance

- No slagging or corrosion induced by the use of product gas has been detected in the main boiler.
- The lining in the gasifier is in excellent condition after two years of operation.
- There is no indication of tar condensation in the gas lines or instruments.
- The fuel and ash handling systems require normal maintenance.
- There is erosion in fuel yard equipment / fuel conveyors and extensive maintenance is required.



Plans for the future development

Key targets of the future development and operation

Improvements for the wood fuel handling

- A new high capacity wood chipping/crushing line and handling terminal 2015
- De-bottlenecking of the fuel system

Operation of the main boiler with gas only

- Successfully tested in 2014
- The gasifier could supply the total fuel feed of the boiler at low loads
- Tests to be continued in 2015, special attention to corrosion and deposits in main boiler
- The power plant is operated according to the market needs, often at partial loads

Increase of the gasifier capacity

- De-bottlenecking and utilisation of the design margins of the demonstration plant

Summary

The Vaasa biomass gasifier

“We are very pleased with the final results of this project and 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

Thank You!



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