



From Fossil to Bioenergy in Large Scale through Gasification

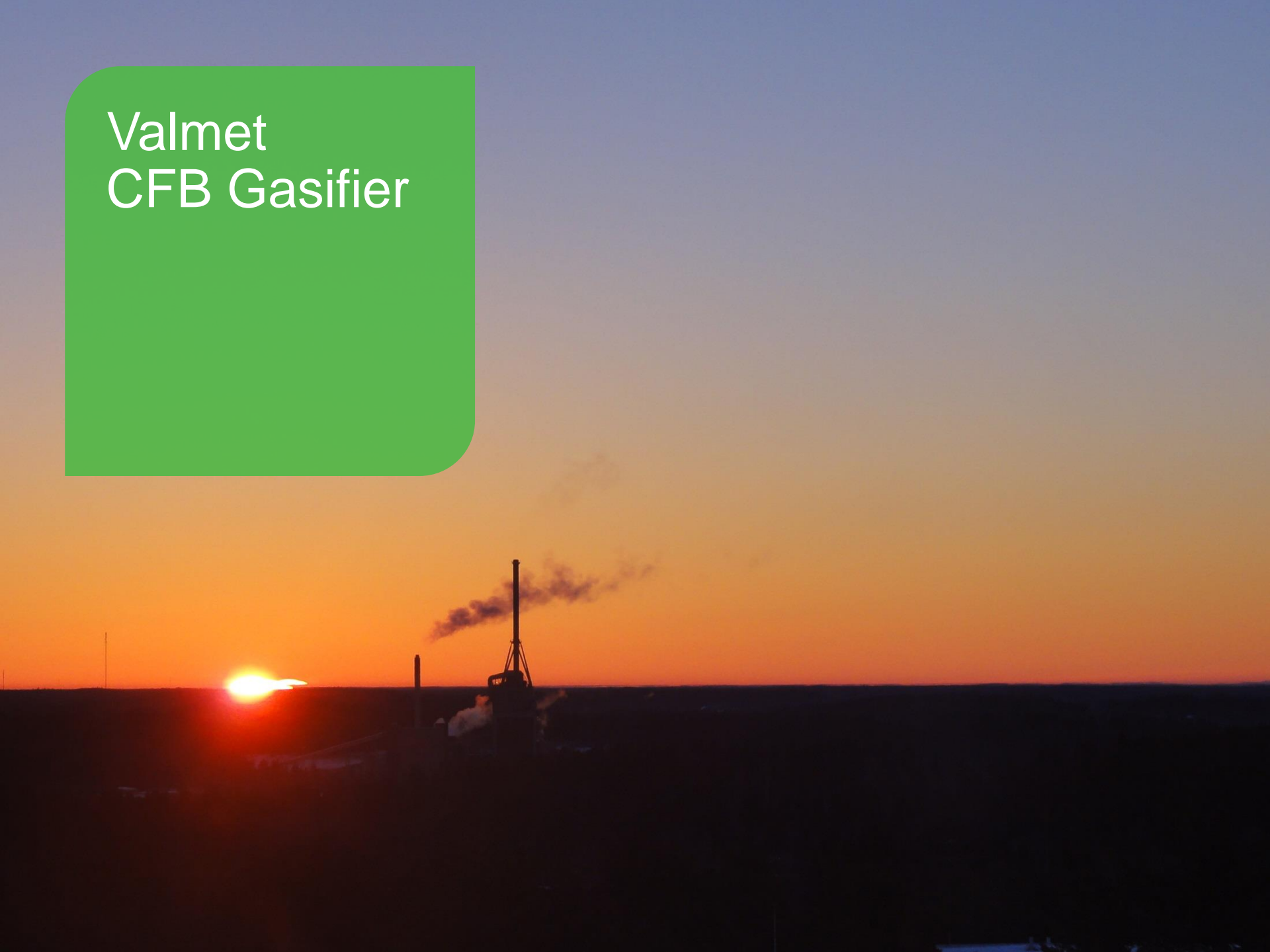
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By:

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Pulp & Energy, North America

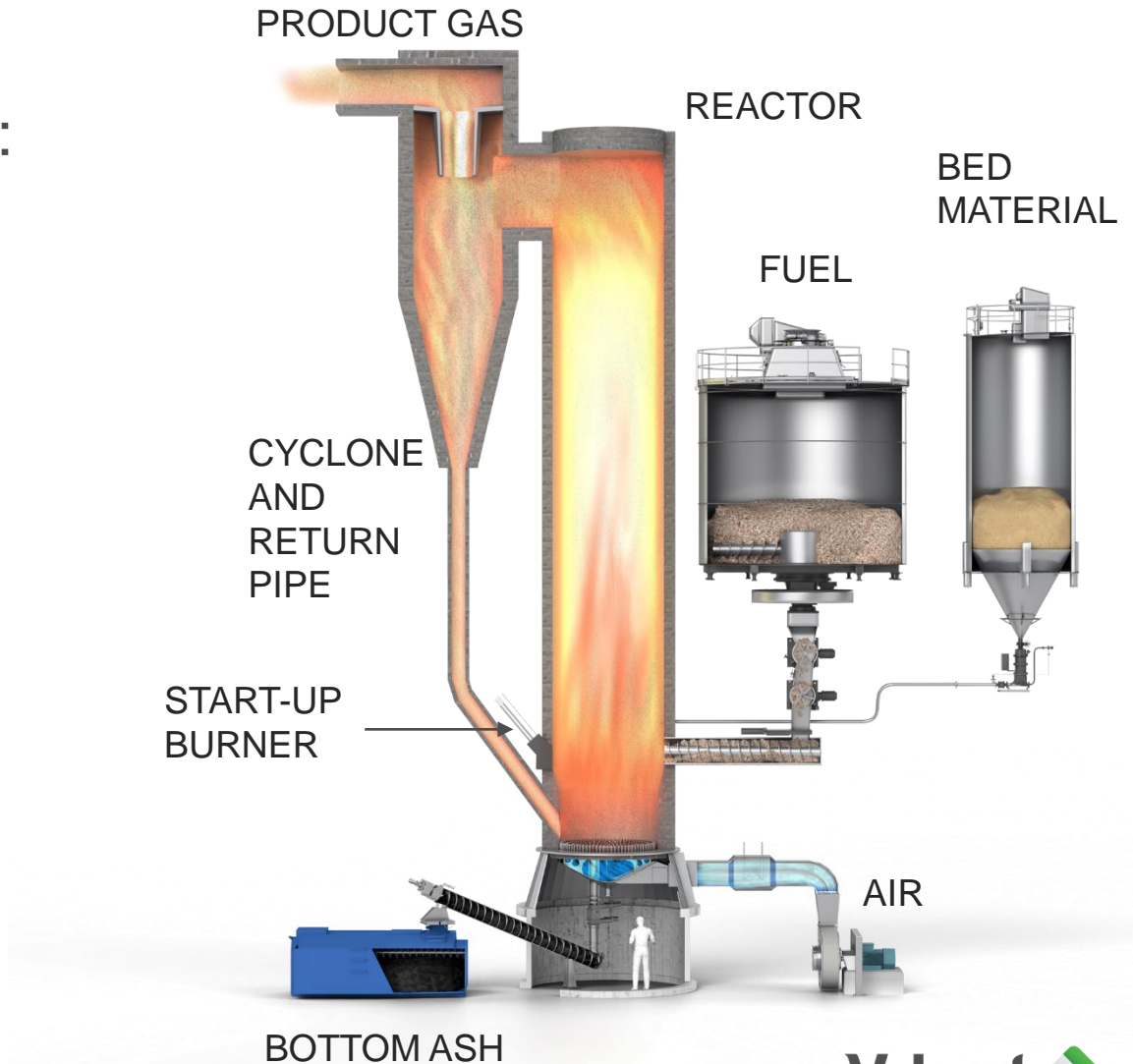
Valmet CFB Gasifier



Valmet CFB Gasifier

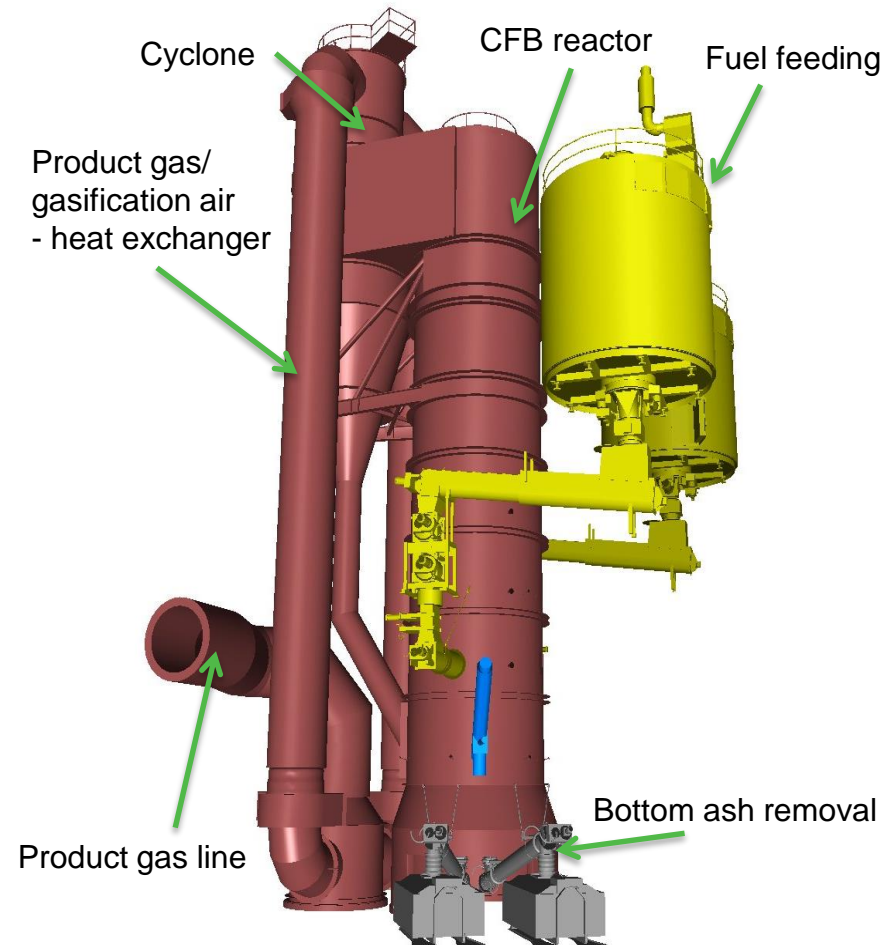
Construction principle:

- Only one air inlet (grid)
- Straight return pipe
- Self standing structure
- Prefabricated refractory



Valmet CFB Gasifier

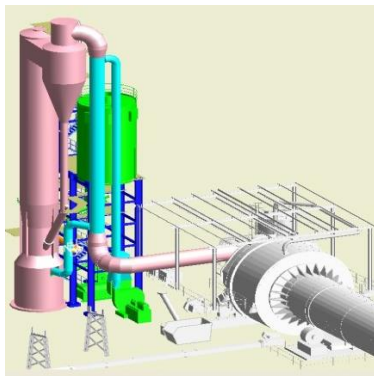
CFB Gasifier	
Size	20 – 140 (300) MWth
Fuel	Biomass, waste (other reactive fuels)
Gasification media	Air
Operating temperature	750 – 900 C (1380 – 1650 F)
Operating pressure	5-30 kPa(g) (0.72 – 4.35 psig)
Product gas heating value	3-7 MJ/nm ³ (LHV) (1300 – 3000 Btu/lb)



Valmet CFB gasification offering

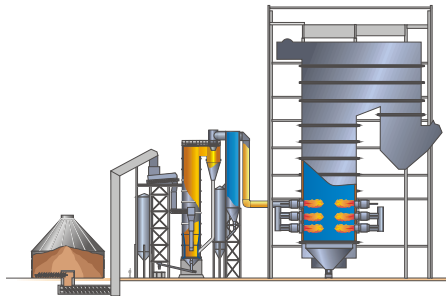
Product gas for industrial kilns

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



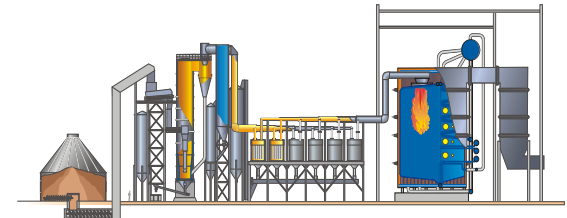
Product gas for power boilers

- Woody biomass, bark, peat and waste
- Superior electrical efficiency
- Existing boilers
- 50 – 140 (300) MW_{fuel} units
- If needed, can include a dryer
- Gas cleaning as needed

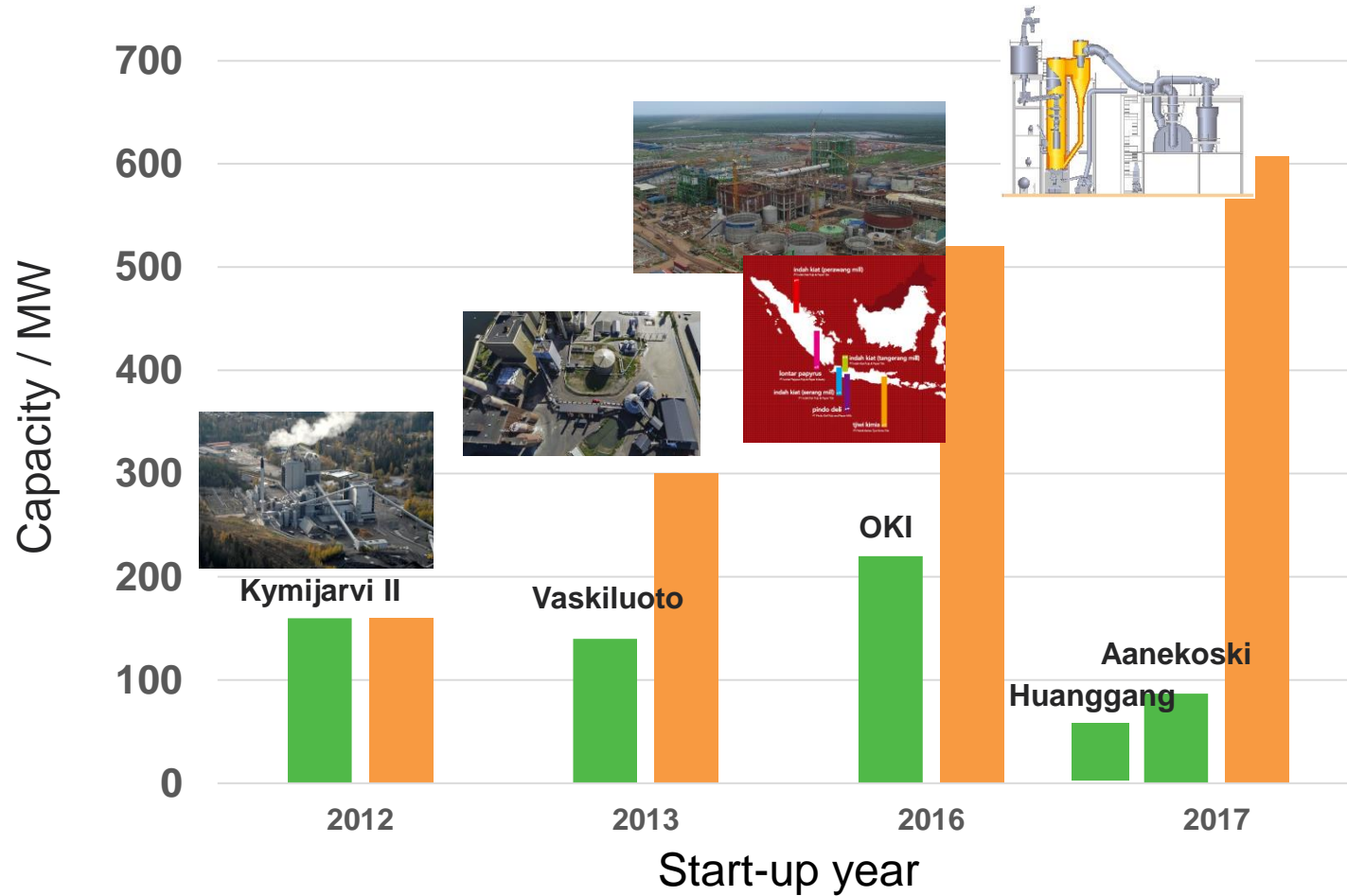


Product gas from waste for power production

- Waste-derived fuel
- 50 – 150 MW_{fuel}
- High electrical efficiency
- Typically a new gas boiler (existing boiler is also an option)
- Gas filtering -> clean product gas
- Corrosion free



Valmet CFB gasification projects



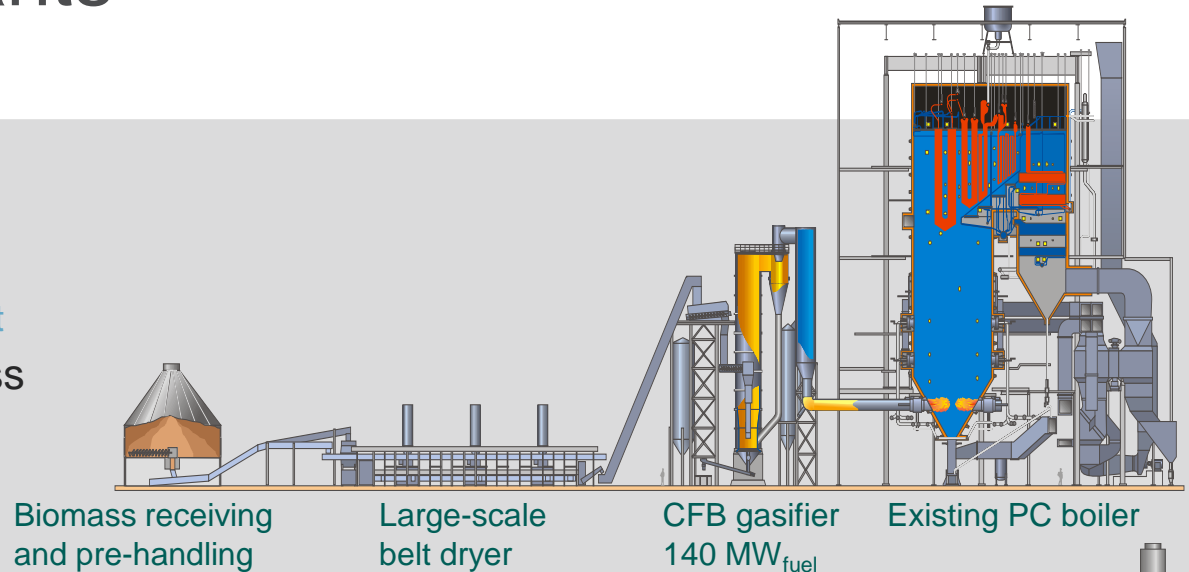
Operational plants



The Vaskiluoto 2 power plant

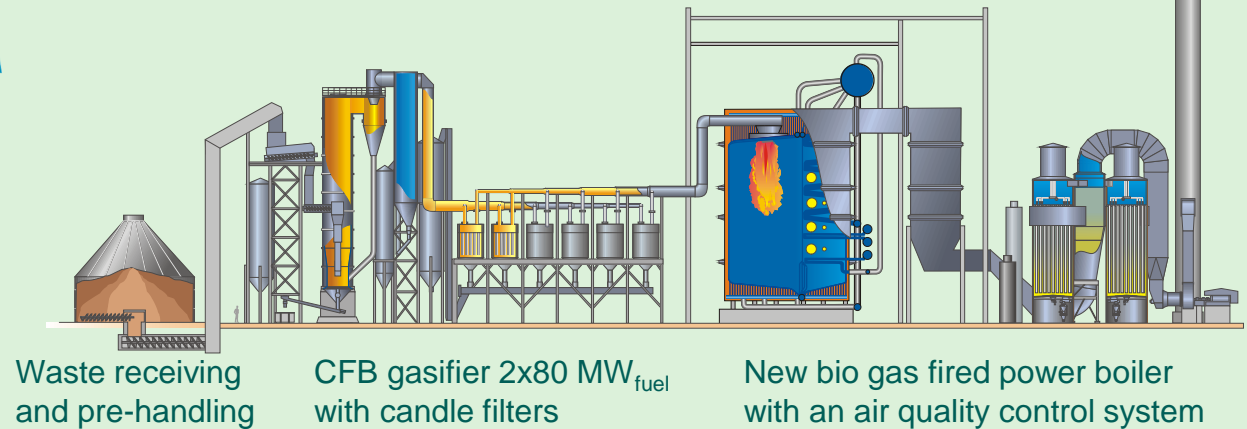
Product gas from biomass
for power boilers

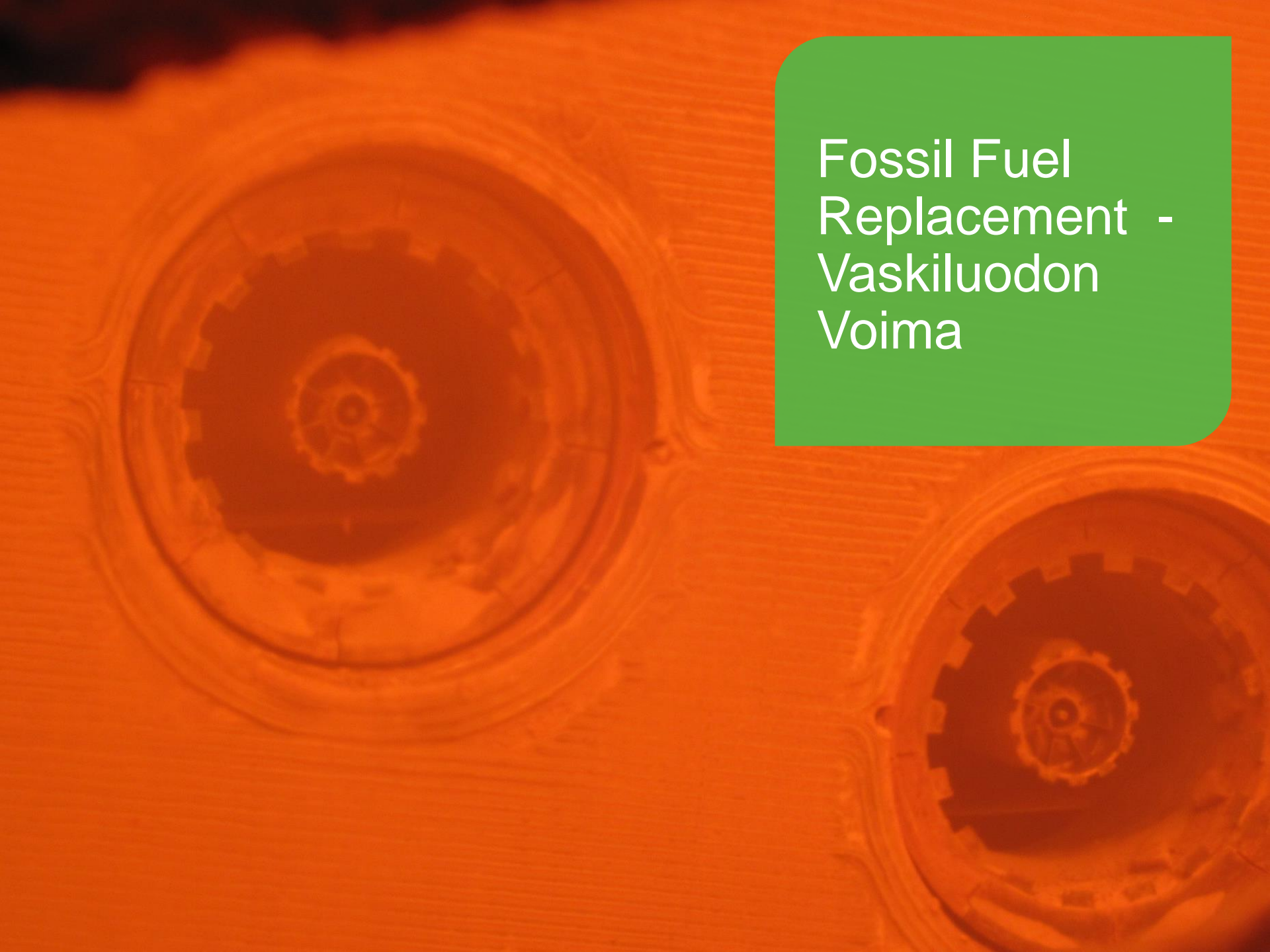
16,000 h+ operation



Product gas from SRF
for power production

25,000 h+ operation





Fossil Fuel Replacement - Vaskiluodon Voima

Vaskiluodon Voima - Valmet gasification plant

View of the plant before the fuel conversion



The Vaskiluoto 2 -unit

- 560 MW_f coal fired boiler
- Pulverized fuel firing
- Benson design
- 185 bar/540 °C + 43 bar/ 570 °C
- ~500,000 t/a coal fired

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 - 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



Alternatives

- Pulverized feed of biofuel to PC burners
- A new boiler for biofuel
- To gasify biofuel and fire the gas in the existing boiler

Vaskiluodon Voima

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

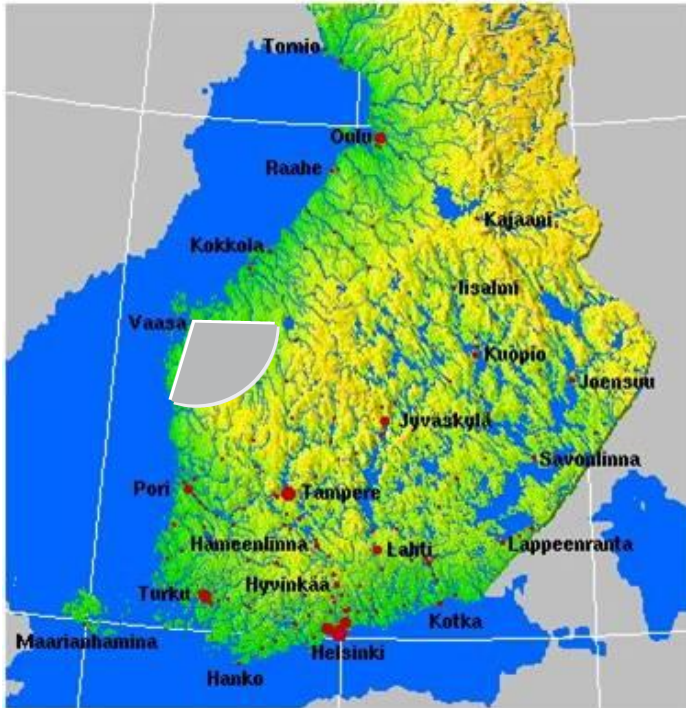
- Local forest biomass could be utilized
- Peat as back up fuel
- Low parasitic power consumption
- High-efficiency bio => electricity

Safe solution

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



Bio fuels for the gasification plant



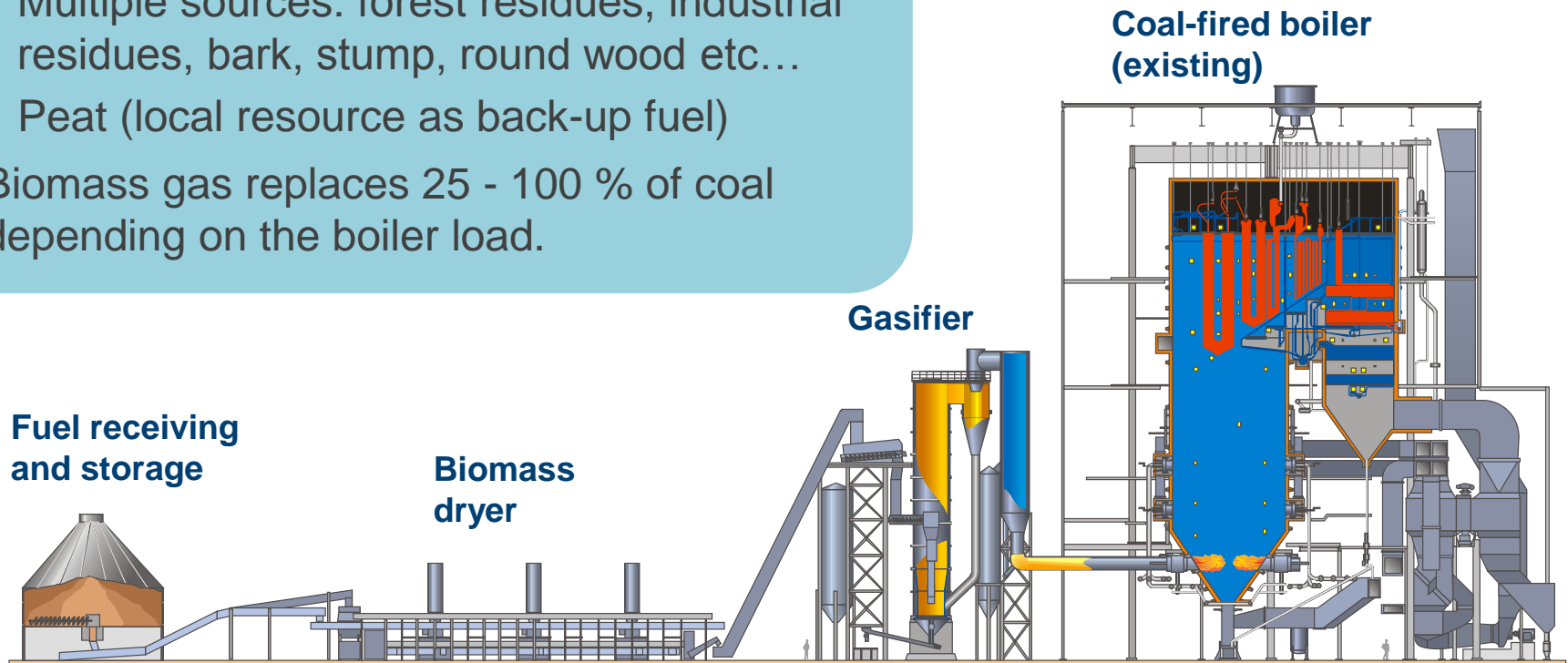
- The fuel required for the gasification plant (900 GWh/a) is procured locally within 100 kilometers of the plant:
 - Forest chips 50–100 %
 - Peat 0–50 %
 - Recycled construction wood chips 0-10 %
- By-products of wood-processing industry are also possible fuels (sawdust and bark)

Vaskiluodon Voima - Valmet gasification plant

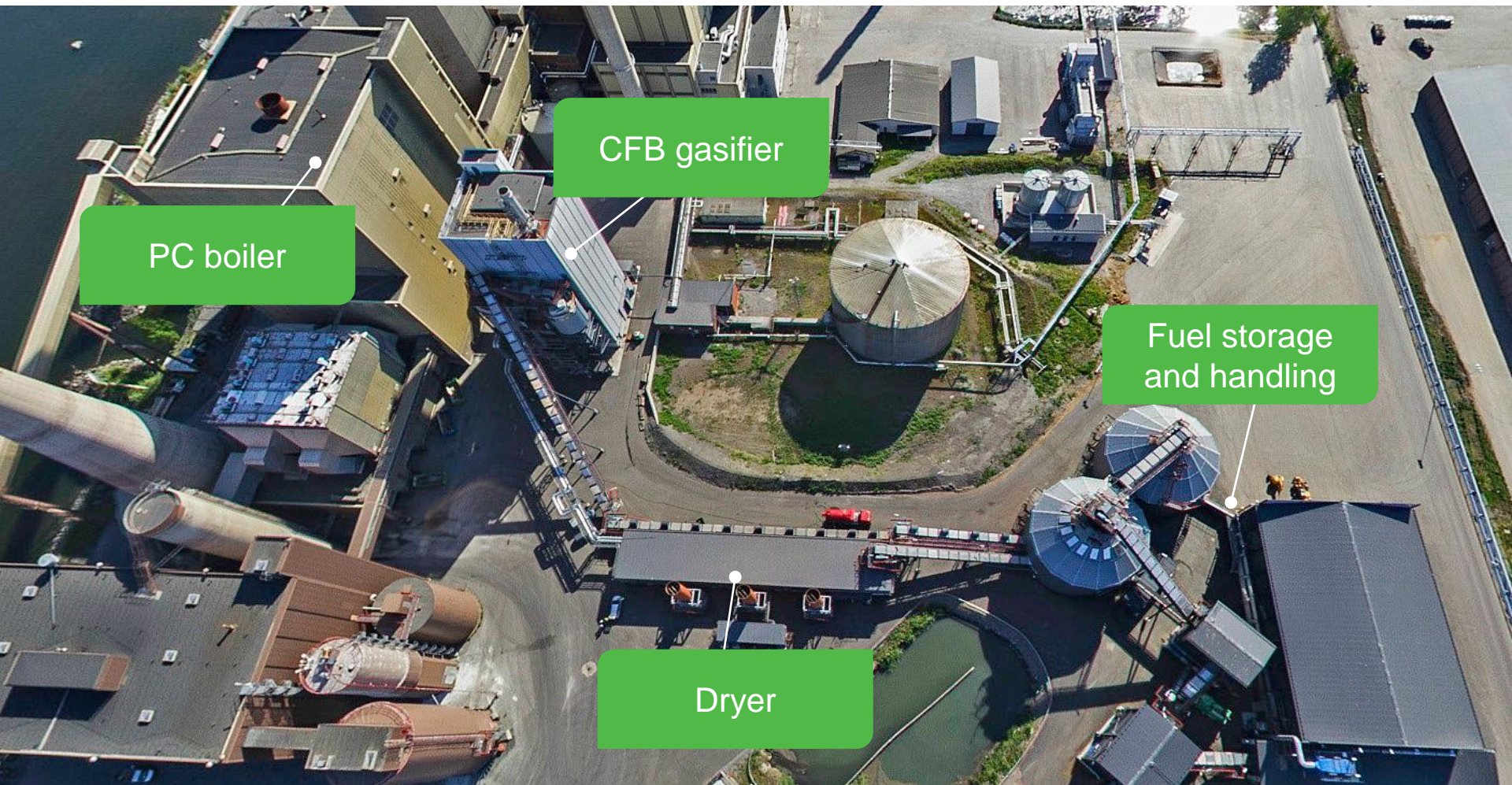
Biomass feed 140 MW

- 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.



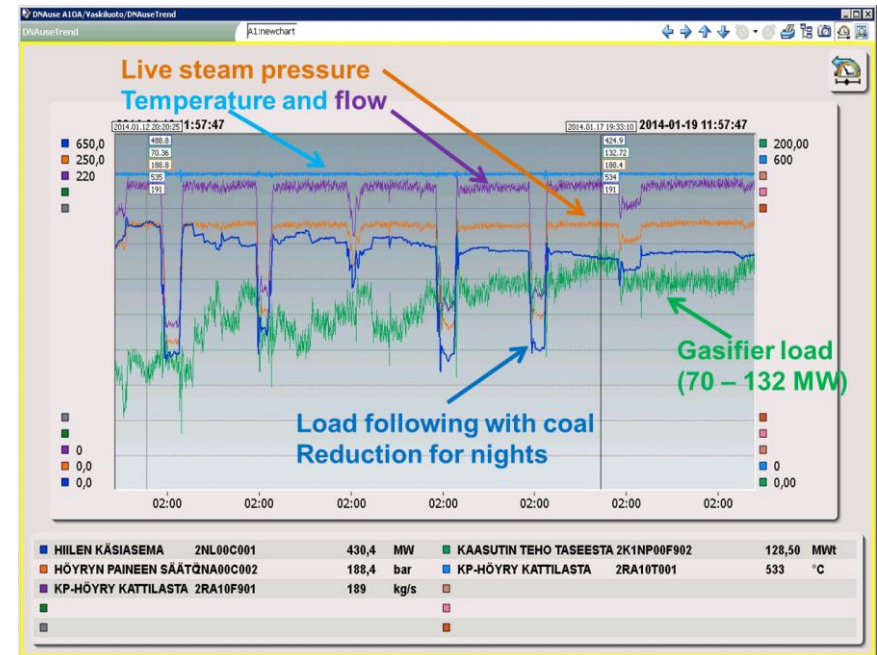
Vaskiluodon Voima - Valmet gasification plant



Vaskiluodon Voima - Valmet gasification plant

Safety and operational experiences

- Today commercial operation over 16 000 hrs.
- 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 (equivalent to emissions from 70,000 cars)



Vaskiluodon Voima - Valmet gasification plant

Operation 2013 -2015

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 raise to 180 MW in 2015

Boiler operation with product gas only demonstrated 2015

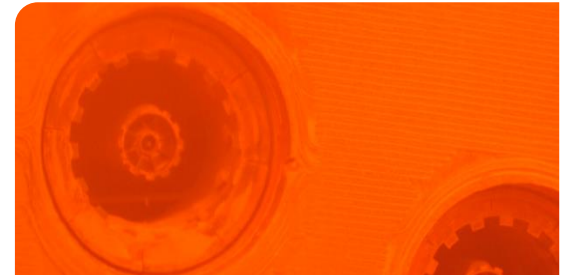
Use of demolition wood initiated in 2014

Fuel yard

Several stops/outages

- Not robust enough => Rebuilds done

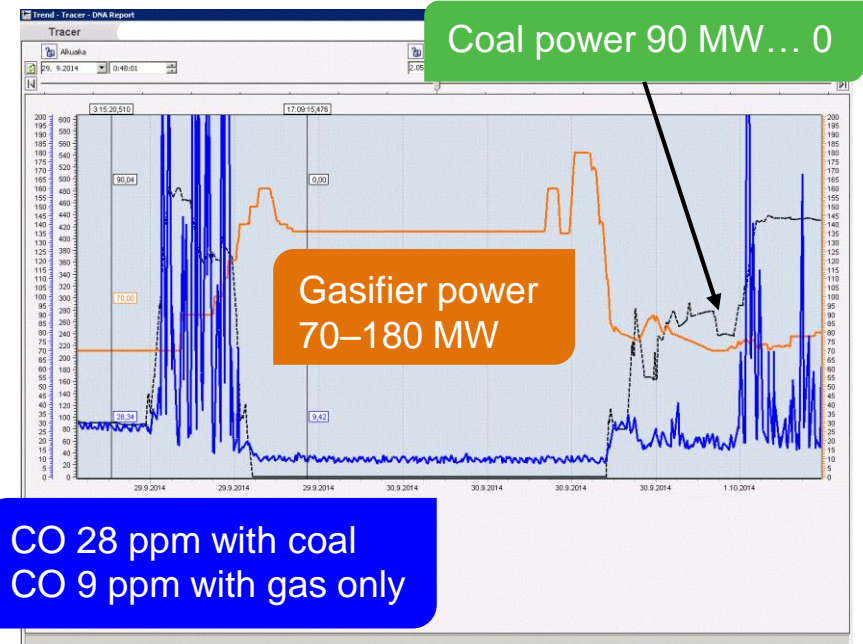
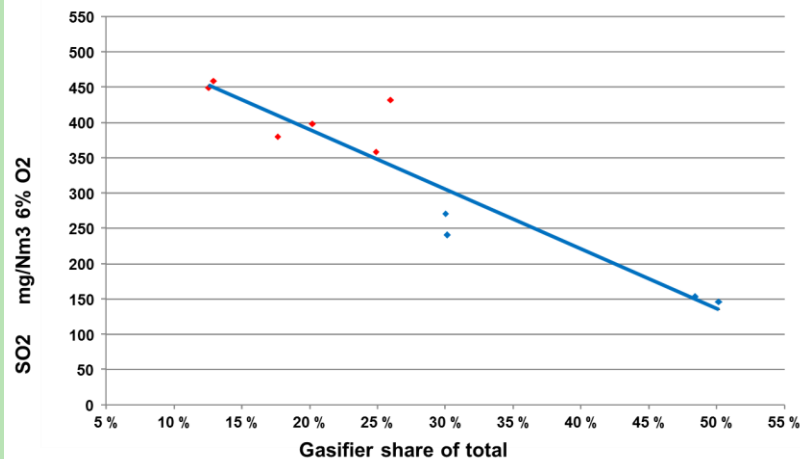
New wood chipper installed (now possible to use also round wood as a fuel)



Vaskiluodon Voima - Valmet gasification plant

Emissions

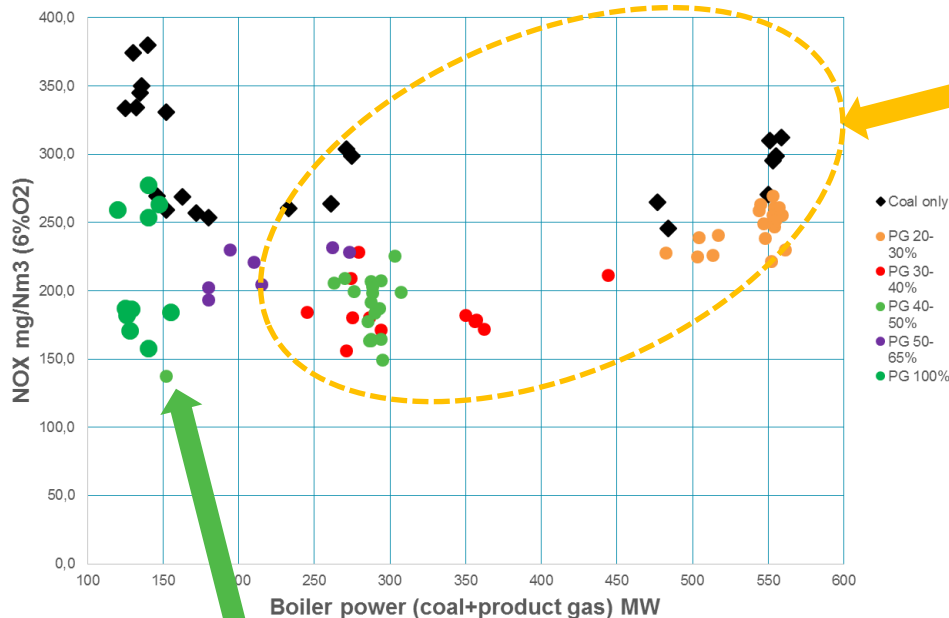
- Reduction of SO₂ (before the final S removal process) is close to proportional to the share of gasification power.



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

Vaskiluodon Voima - Valmet gasification plant

Emissions

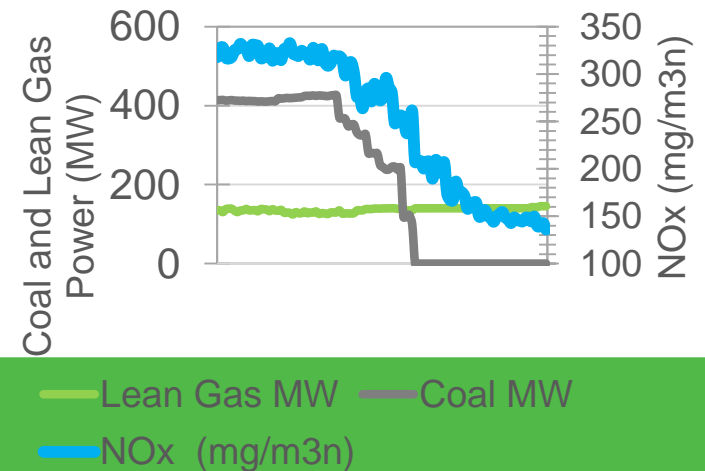


When operated with product gas only a further reduction was discovered

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

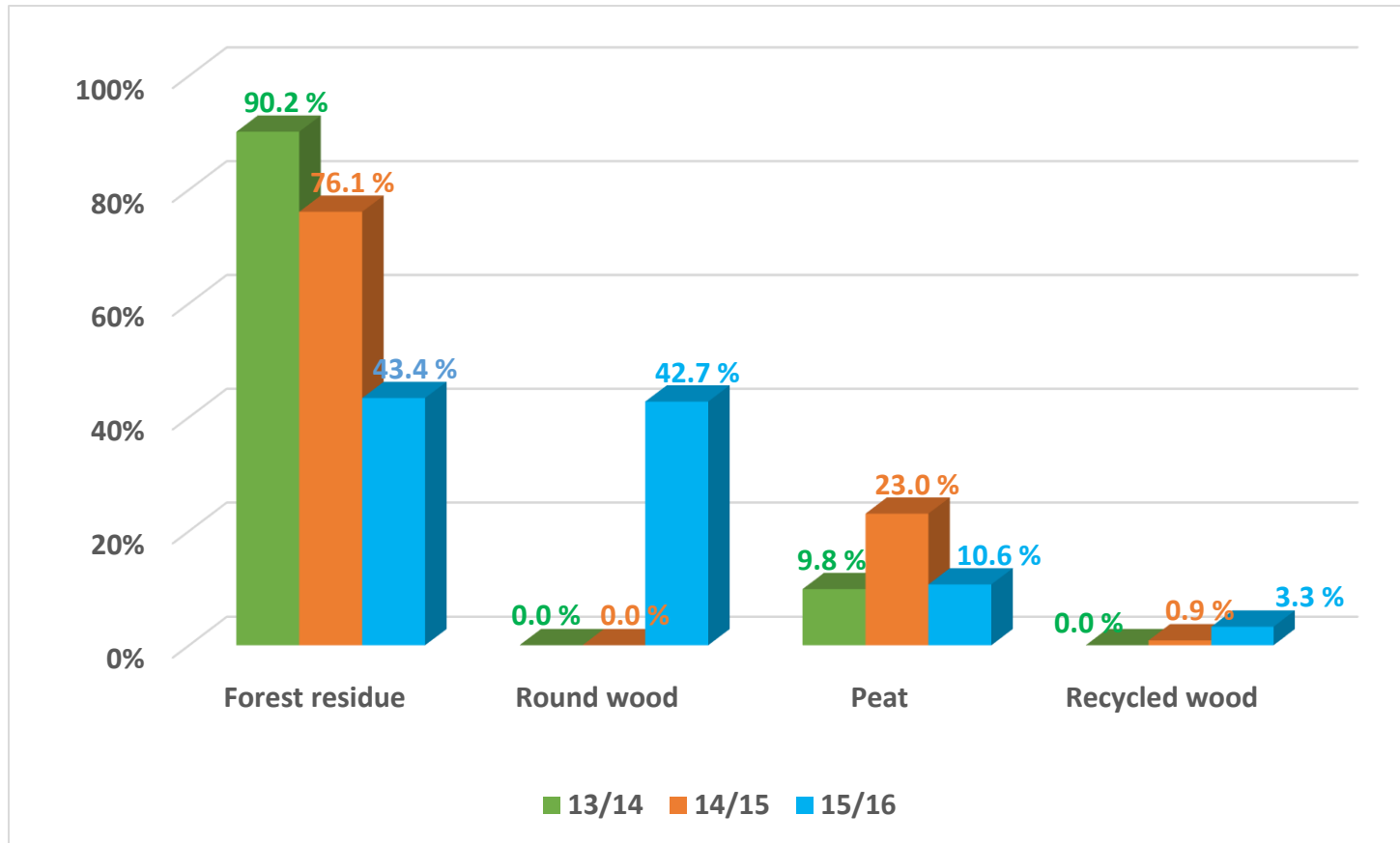
Gasifier power 140

Testrun with no- coal



Vaskiluodon Voima - Valmet gasification plant

Annual fuel consumption



Operational experience during the first 3 years

Summary

- The plant has met all design criteria
 - Availability first year 97% => the following year 99%
 - Today 16,000 h of operation
 - Design capacity met (exceeded)
 - CO, SO₂ and NO_x emissions reduced
- Plant responds promptly and consistently and is easy to operate
- No lining failures of corrosion/erosion in gasifier. Erosion in fuel yard equipment.
- The fuel drying process operates well
- The gasifier helps to reduce 230,000 tn/a of CO₂ emissions
- Main boiler operated with gasifier only



Summary

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