Gasification of biomass and waste for production of power: The cases in Lathi and Vaasa

Metso Power, Claes Breitholtz

Metso is a global supplier of sustainable technology and services

Pulp and paper

Process solutions,
mac
for p
pap
incl
che
solutions

Process automation and flow control solutions

Power generation

Process solutions,
services
uction
iquid fuels
ation and
flow control solutions

Valmet

Mining

Mining and minerals processing equipment and systems; wear and spare parts and service solutions

2014-01-01: Two independent companies are formed

Recycling

Metal recy

Solid-wast
solutions

Construction

g
ns;
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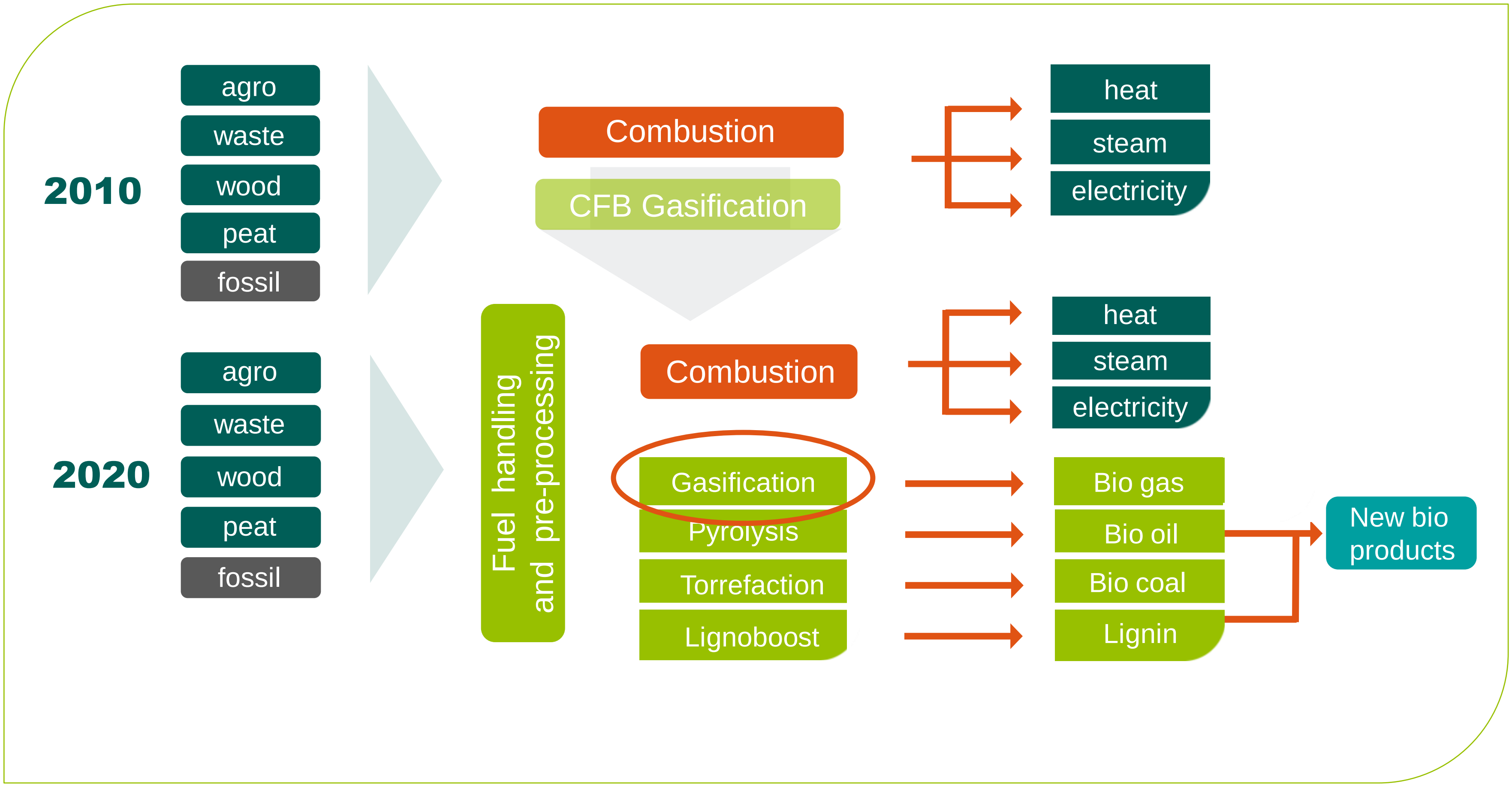
Oil and gas

Automation and flow control solutions

More value from biomass



Metso's CFB gasifier

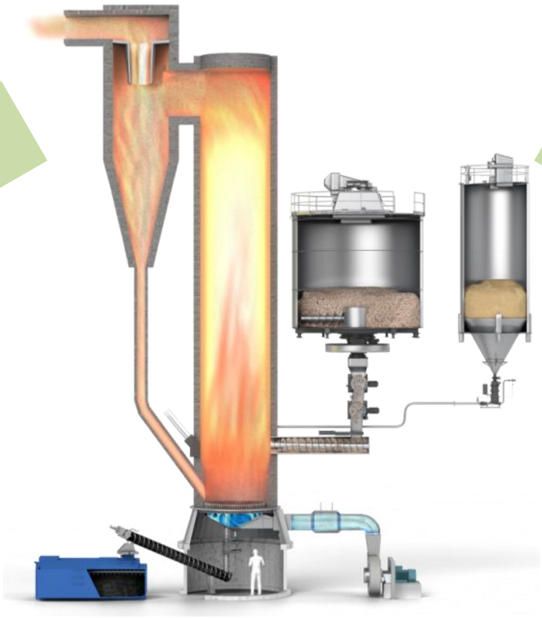
Industrial experience

Tampella Power
- 15 MWth pressurized FB gasifier and gas cleaning
- Piloting ended 1996

Metso BFB & CFB boilers
- Fluidized bed technology
- Project execution resources

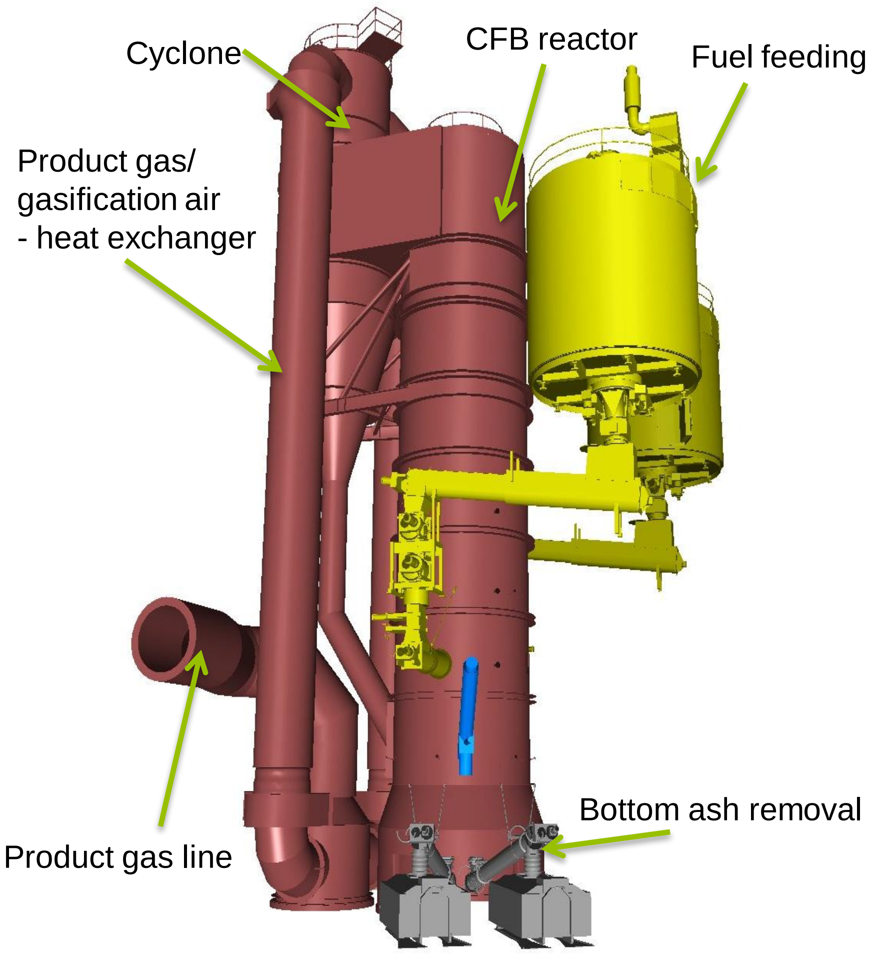
Götaverken
- Atmospheric CFB gasification
- Värö project start-up 1987

New gasification development
- Own process dimensioning tools
- Dryer technology
- Product gas filtration tests



Metso's CFB gasifier

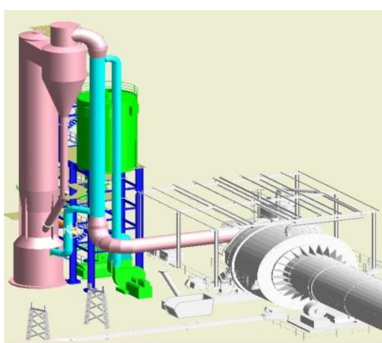
CFB Gasifier	
Size	20 – 140 (300) MWth
Fuel	Biomass, waste
Gasification media	Air
Operating temperature	750 – 900 C
Operating pressure	5-30 kPa(g)
Product gas heating value	3-7 MJ/m^{3}n (LHV)



Metso’s gasification solutions

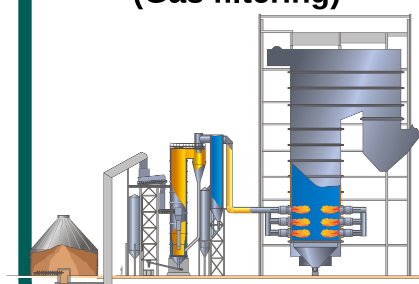
Product gas for industrial kilns

- Sawdust, forest residues, fresh wood, bark
- 20 – 80 MW_{fuel} units
- Typically includes a dryer
- Dusty product gas
- Also other types of kilns possible



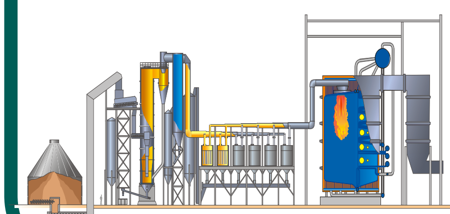
Product gas for power boilers

- Woody biomass, bark, peat, straw…
- Superior electricity efficiency
- (Existing) power boilers
- 50 – 150 MW_{fuel} units
- Typically includes a dryer
- (Gas filtering)



Product gas from waste for power production

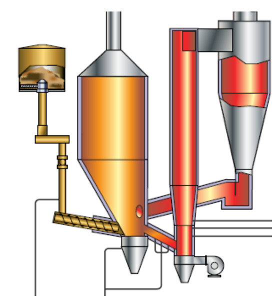
- Waste-derived fuel
- High electricity efficiency
- Typically a new gas boiler
- Gas filtering -> clean product gas
- 50 – 100 MW_{fuel} units or multiple units connected to a boiler



Indirect gasification of biofuels

- Suitable for clean biofuels

•Suitable for cases HIGH HEATING VALUE GAS is needed (SNG, refinery feed motors)



CFB Biomass Gasification

Vaskiluodon Voima, Vasa, Finland

Vaskiluodon Voima Oy gasification project

Enables to replace a large share of coal with biomass

- Existing 560 MW coal-fired power plant from 1982
  - electricity 230 MW
  - district heating 170 MW, approximately 90% of the district heat needs in Vaasa region
- 140 MW biomass gasifier and dryer
- Up to 40 percent replacement of coal
- The project in a nut shell
  - Contract signed June 2011
  - Plant operational 12/2012
  - Total project cost < 40 M€

Co-firing is an efficient way to use biomass

Example:100 MW of bio fuel available at the district

100 MW, fuel

Small boiler
efficiency 30 %

30 MW
green electricity

100 MW, fuel

400 MW coal

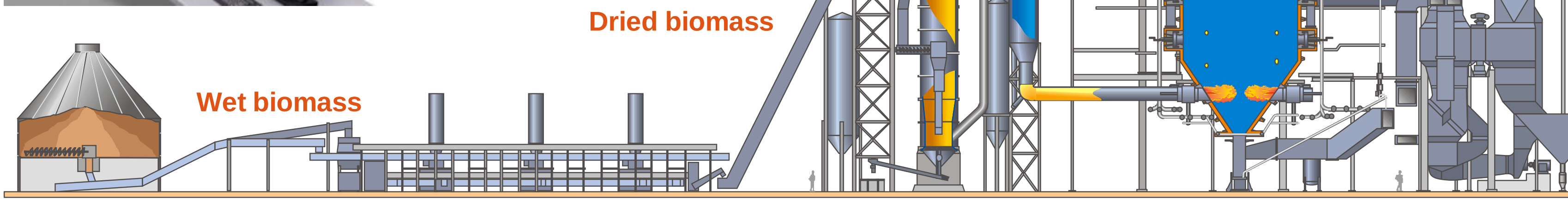
Large boiler
efficiency 40 %

40 MW
green electricity
+
160 MW
coal electricity

The final outcome is 33 %
more green electricity !

Vaskiluodon Voima biomass gasification plant

Instrumentation, electrification and automation



Biomass receiving and pre-handling

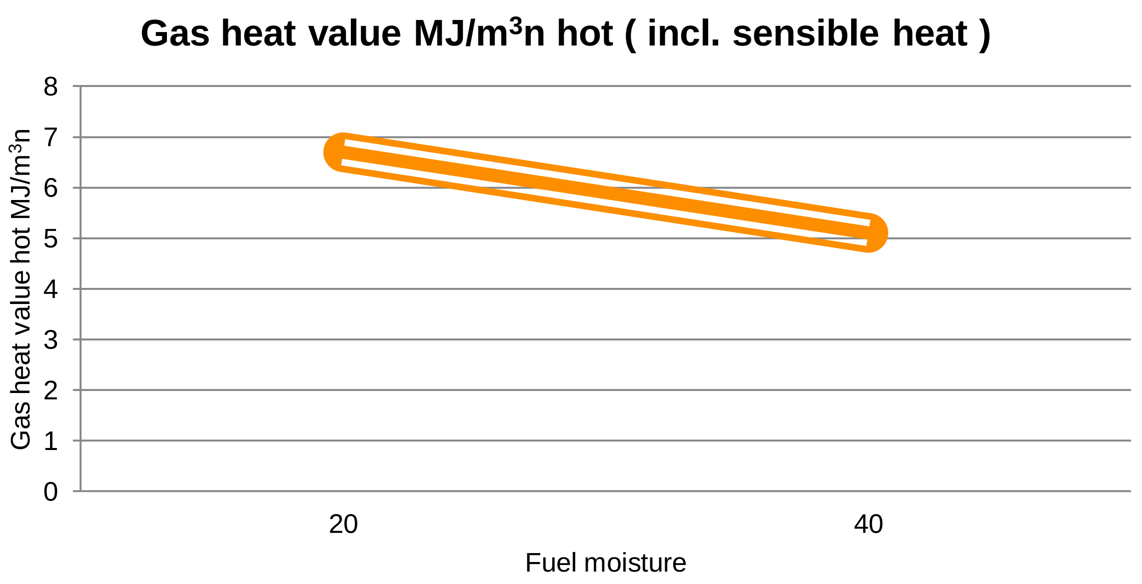
Large-scale belt dryer

CFB gasifier 140 MW_{fuel}

Existing PC boiler modifications and new burners

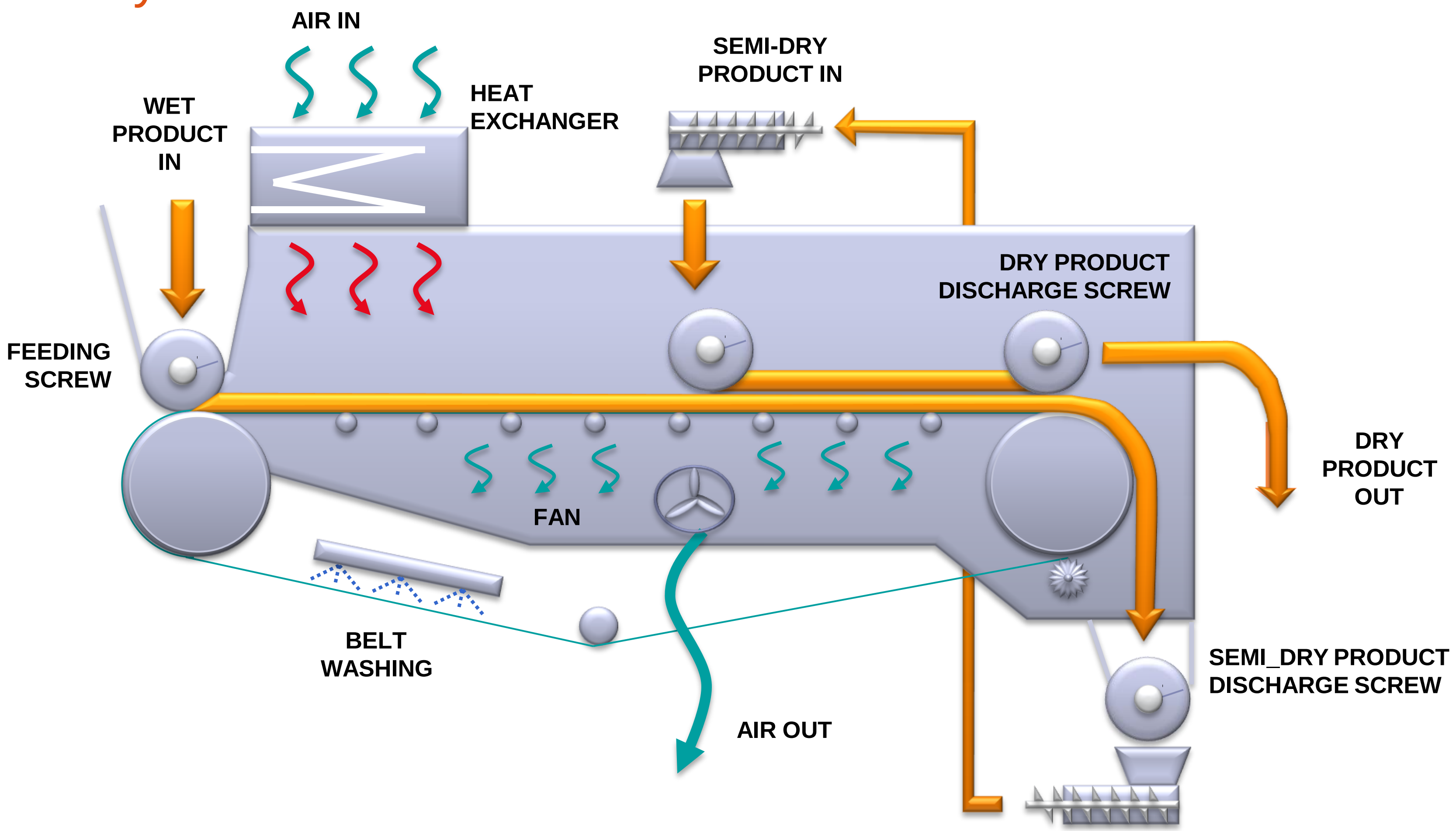
Fuel moisture vs. gasifier output

Fuel moisture	20% (Design point)	30%	40%
Gasifier max output %	100	89	77
Example case: Waste fuel, HHV dry 22,5 MJ/kg, Ash 7,6%			



Metso belt dryer for biomass

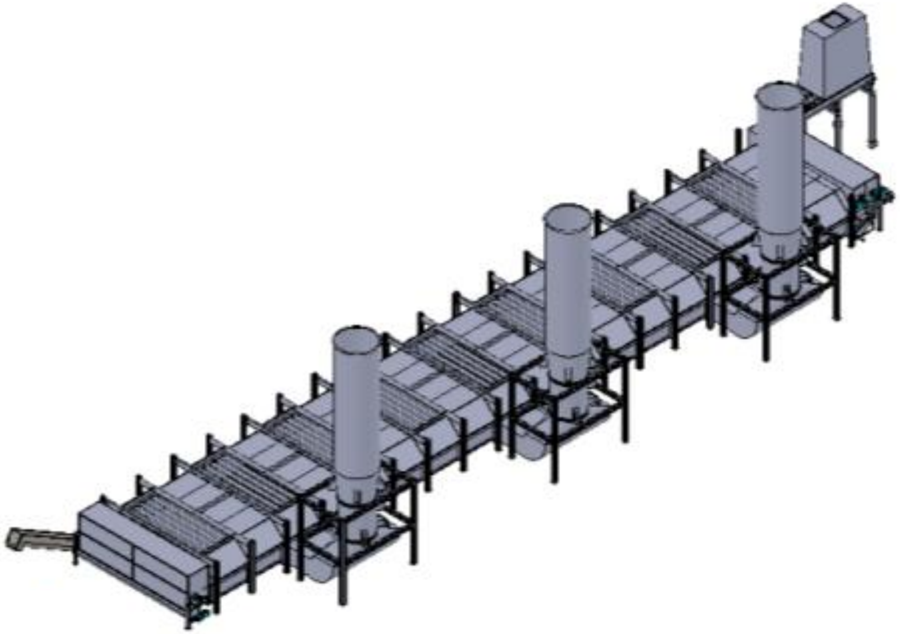
Double layer



Biomass dryer

Vaskiluodon Voima

Start-up	2012
Process	Gasification (140 MW)
Materal	Forest resudues (chips)
Size	274 m^2 / 2 950 ft^2
Layer type	Single
Heat source	Water/glycol-50% 73 - 85°C / 163 - 185°F
Capacity	10 metric tons/h of evaporated water



Benefits of adding a biomass gasifier into a existing coal-fired plant

- → Produces electricity from biofuels with high efficiency
- → Replaces fossil fuel with biomass in large scale
- → Increases fuel flexibility
- → Original coal capacity can be kept
- → Reduces CO_2 emission economically
- → Relatively low investment cost
- → Short delivery time and minimized production interference

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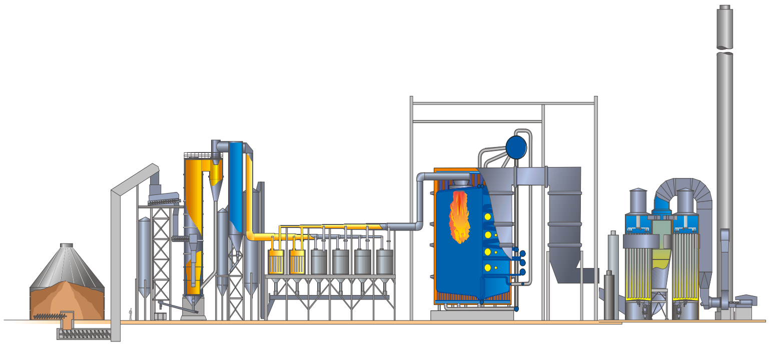
CFB Waste Gasification

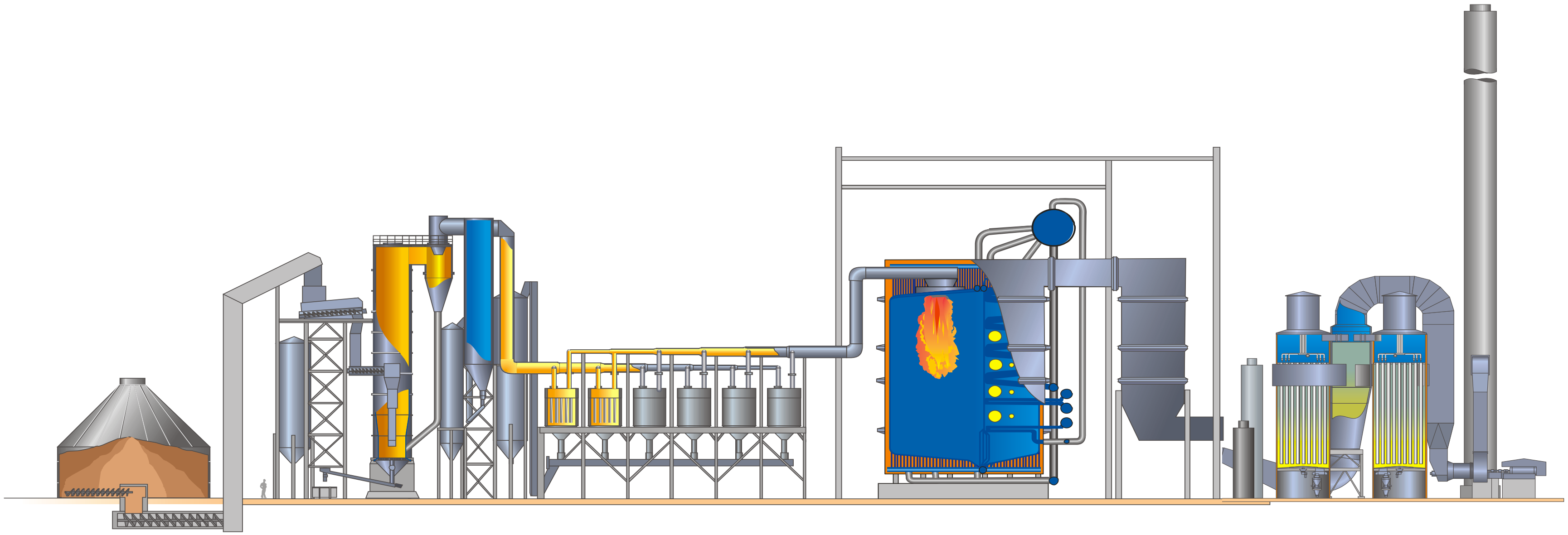
Lahti Energia Oy, Lahti, Finland

Full scale demonstration of gasification of SRF for production of electricity and heat

- 160 MW/ 250 000 ton/a SRF to gasification
- Electricity production: 50 MW
- District heating: 90 MW
- Electricity efficiency (net): 31%
- Total investment: 160 M€



Lahti waste gasification plant



SRF receiving and pre-handling

2 x 80 MW_{th} gasifiers

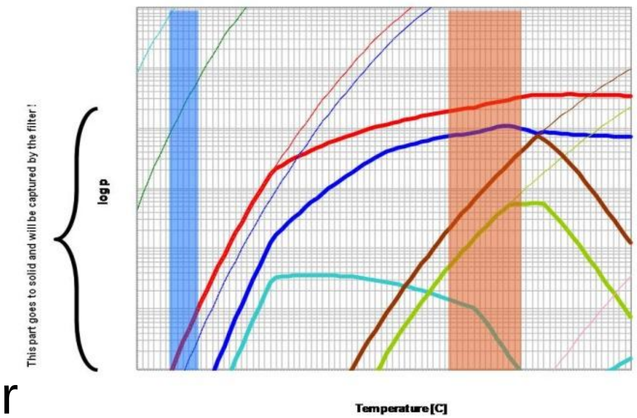
Gas cooler and filter

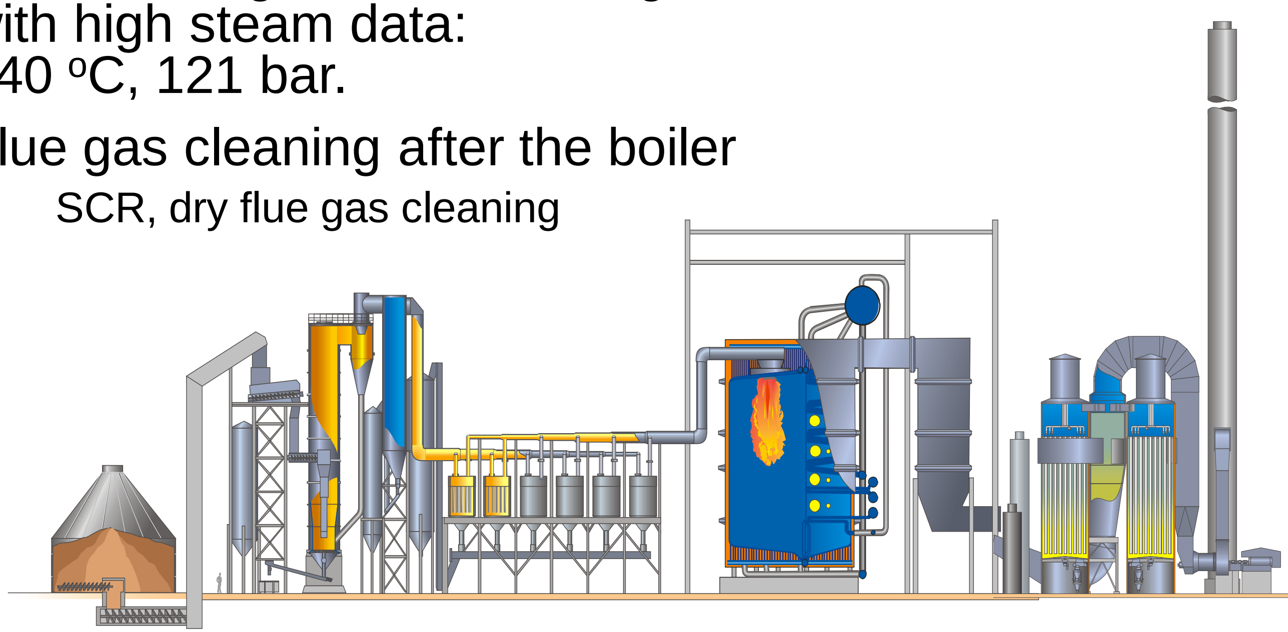
Gas boiler: 121 bar, 540 C

SCR & dry flue gas cleaning

Gas cleaning enables high steam parameters

- Gasification at 850 - 900ºC
- The gas is cooled to about 400ºC
  - The corrosive components condense and form particles
- Filtering of the gas
  - The corrosive components are separated from the gas
- The fliterad gas is burnt in a gas boiler with high steam data:
  540 ºC, 121 bar.
- Flue gas cleaning after the boiler
  - SCR, dry flue gas cleaning





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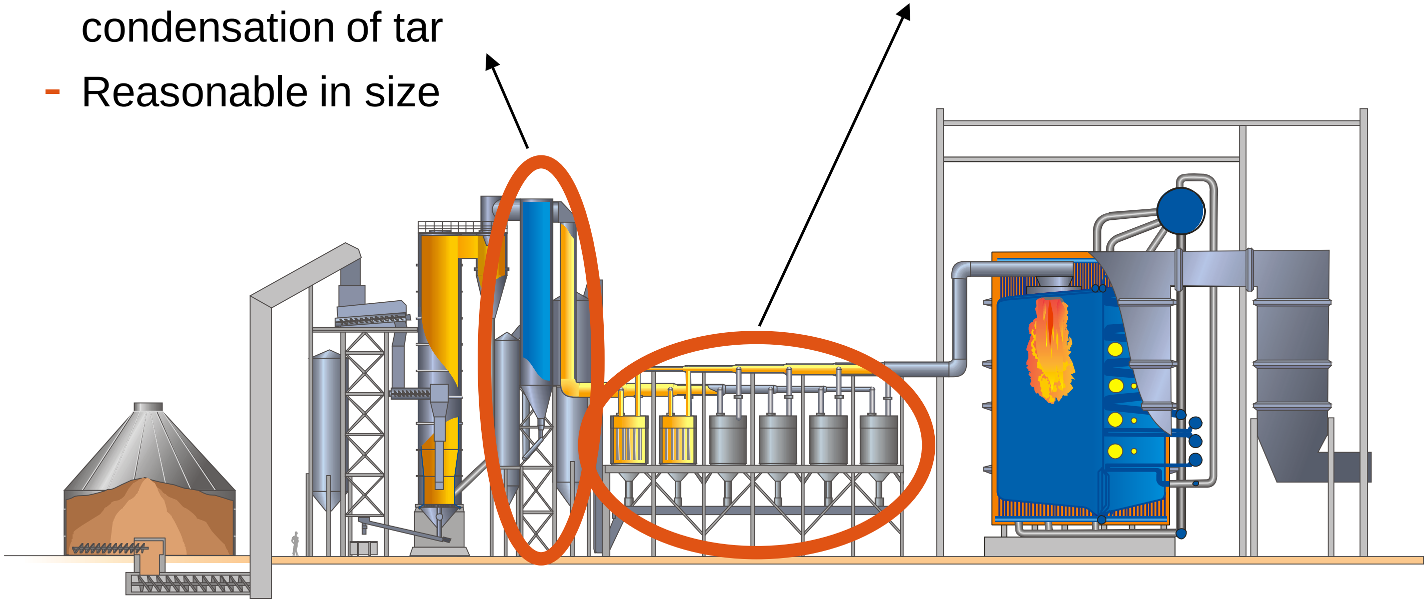
Temperature window for gas cleaning

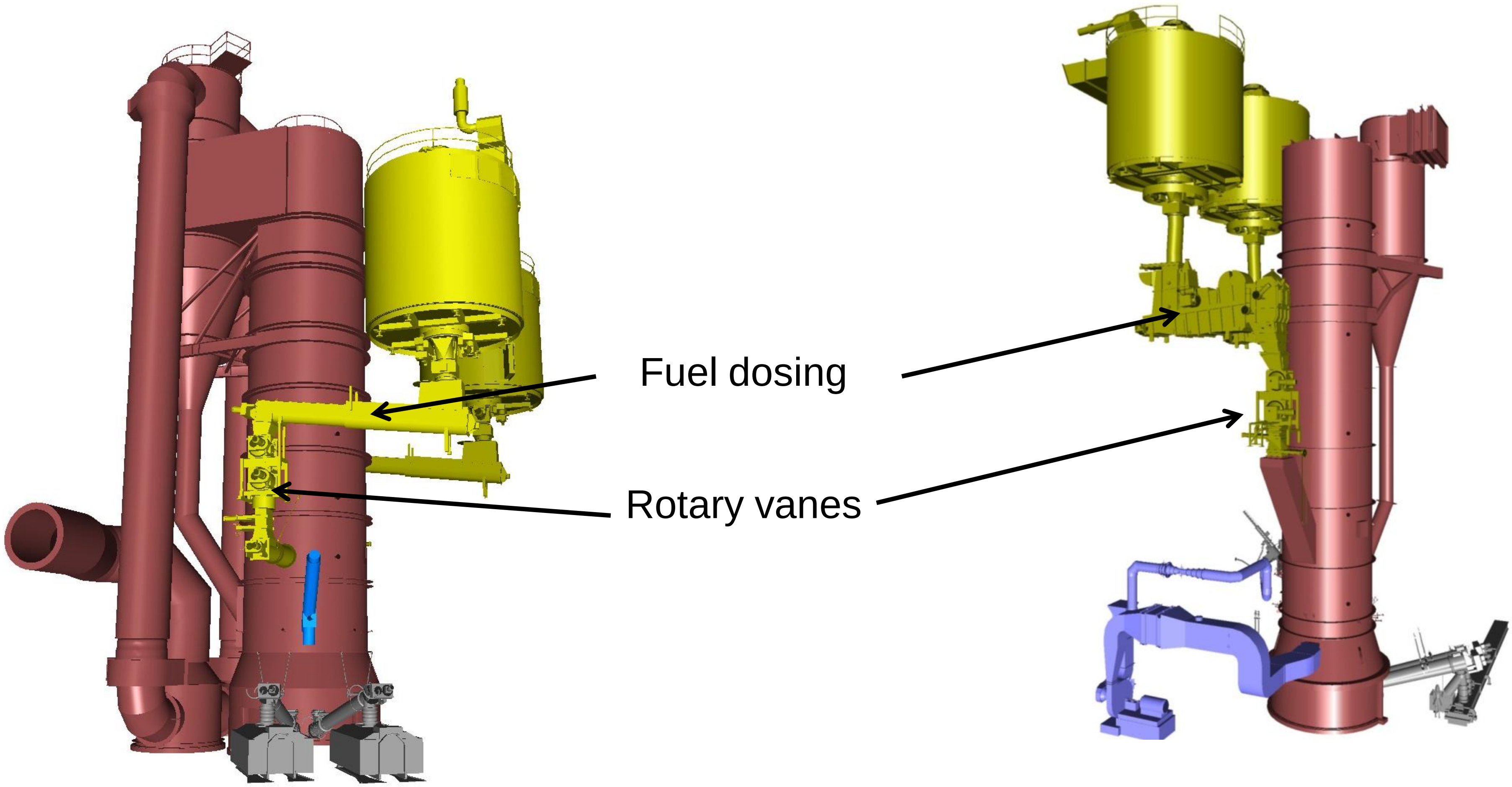
- **Design of gas cooler**
  - Low enough temperature to condense corrosive components
  - Low enough temperature to avoid corrosion in the cooler it self
  - Enough temperature to avoid condensation of tar
  - Reasonable in size
- **Ceramic high temperature filters**
  - The filters withstand high temperature
  - Condensation of tar has to be avoided



Solid Recovered Fuel (SRF)

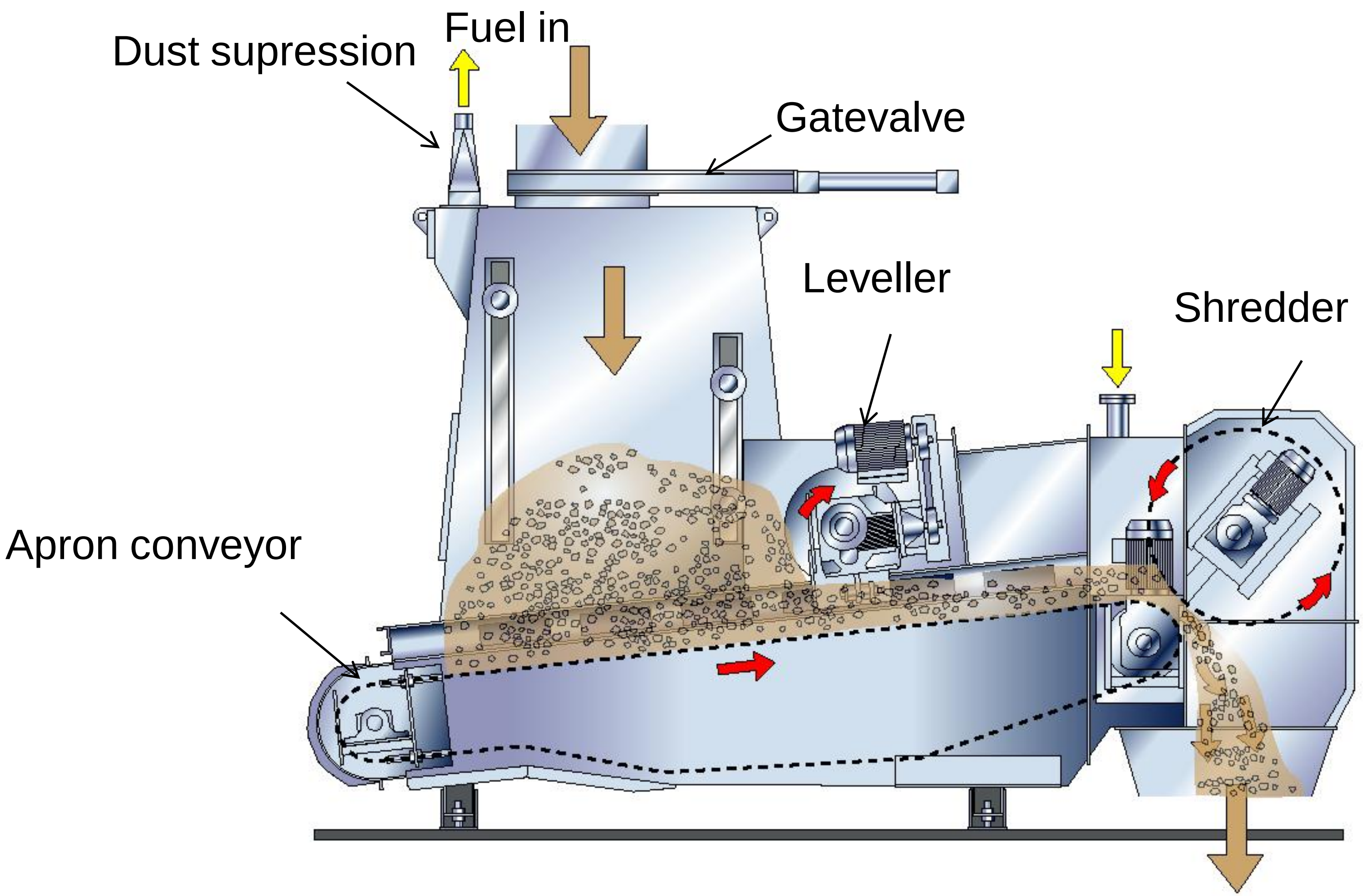
- Fuel fractions used in Lahti
  - Sorted houshold waste, industrial wate, demolition wood
- Demands on particle size: same as för CFB boilers
  - >90 % pass a 63 mm sieve
  - Max length 200 mm
- Fuel quality
  - Max moisture < 30..40 %. Normaly recommended 15-25 %
  - LHV 13-20 MJ/kg as received
  - Large non combustibel particles lowers the availabillity

Adjustment to handle SRF



Feeding Master

Fuel feeding for demanding fuels



Stable operation in varying conditions

- Stable flame
  - No need for support fuel
  - Over 35% moisture content
- Excellent combustion
  - 2s, 850°C
  - Very low CO, with low O_2
- Process recovers from interruptions
  - Load changes
  - Fuel feeding blockages
- Reliable fluidization
  - No problems with sintering

Basic idea works - No corrosion detected

Gas cooler and boiler inspected

- Gas cooler walls
  - Smooth steel surface below fouling layer
  - Manufacturing tracks are still visible
  - Thicknesses measured after 4500h are the same than original ones
- Gas boiler
  - Smooth pipe surfaces
  - Manufacturing tracks are still visible
  - No visible marks of corrosion anywhere
  - Next measurement in spring

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Expect results