



Development of Recovery Boiler Technology – Present View

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Agenda

1

Sustainability through the entire value chain

2

Safe and reliable solutions

3

**Towards autonomous operation with
advanced process controls, smart sensors
and digital solutions**

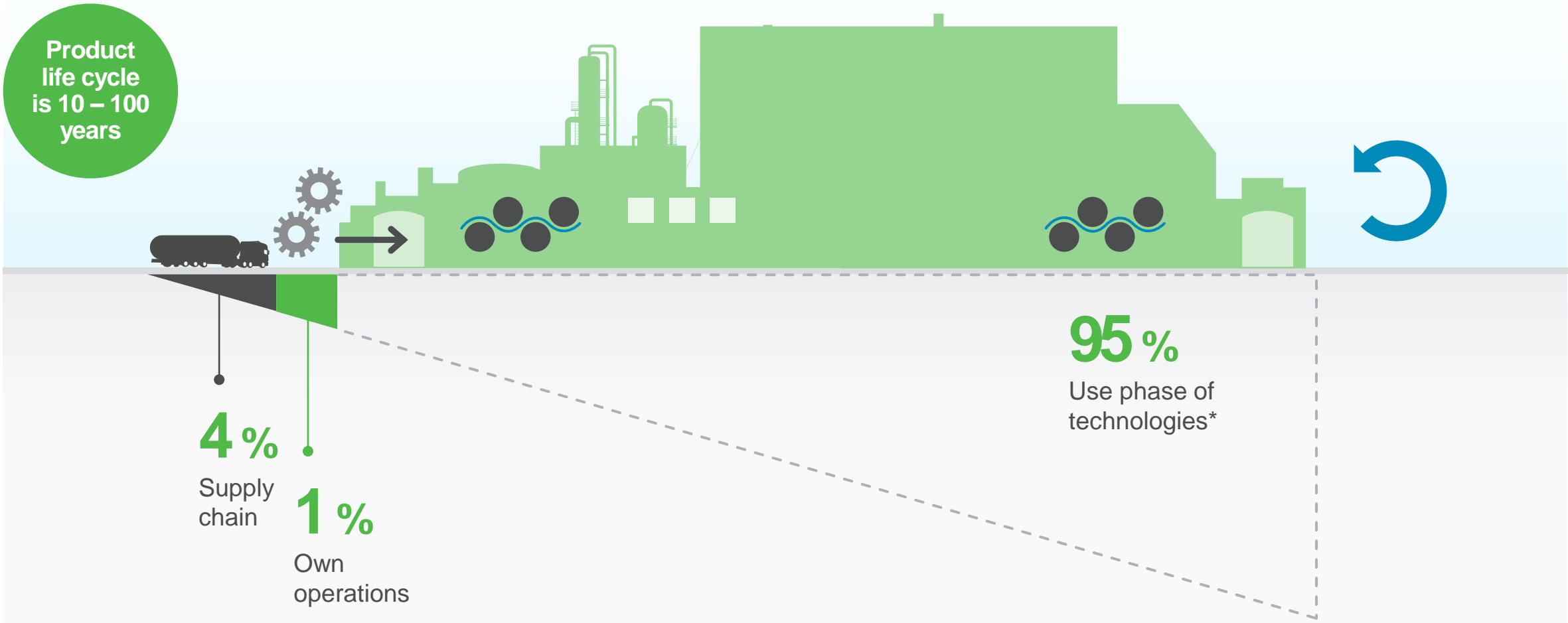




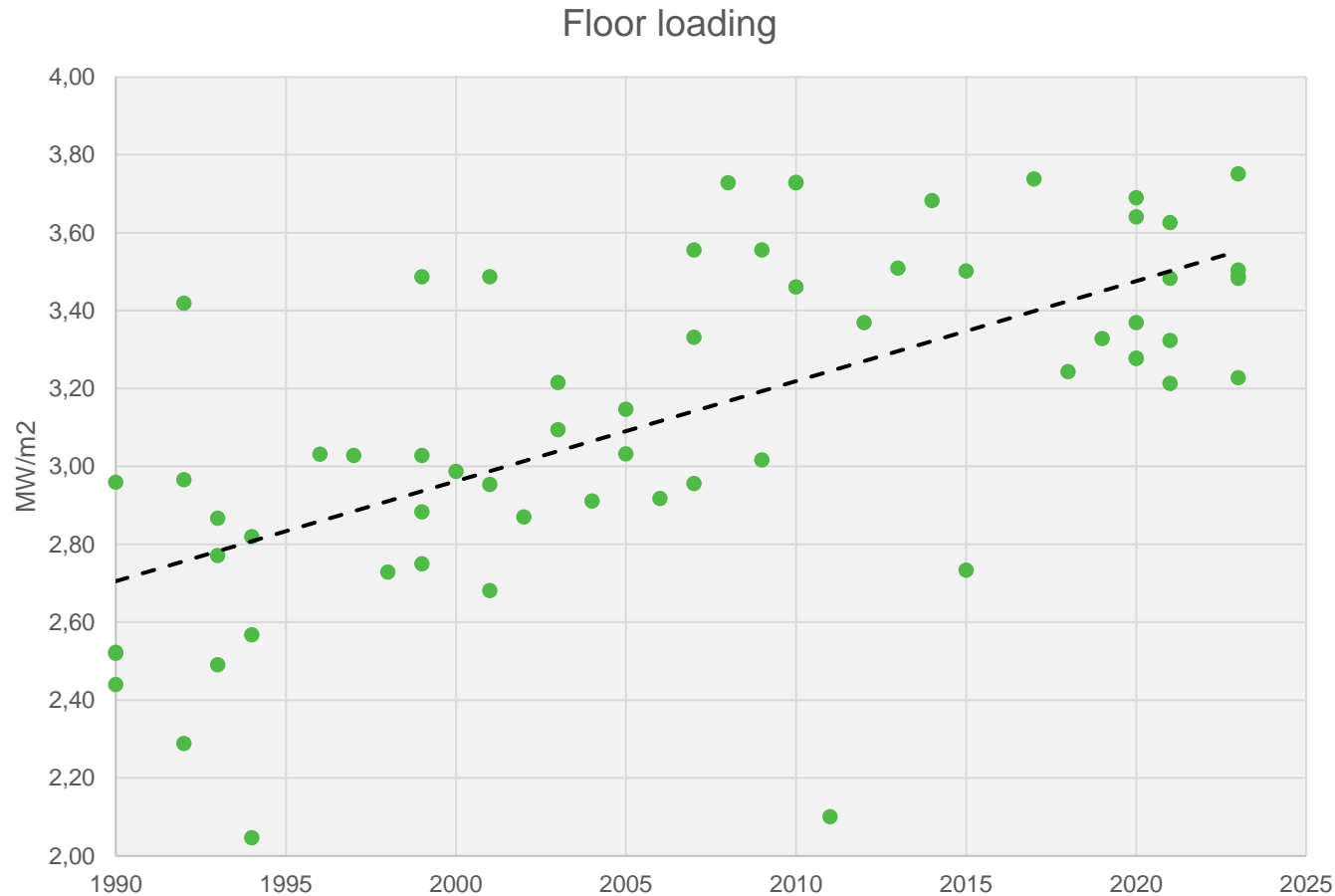
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**Sustainability through
the entire value chain**

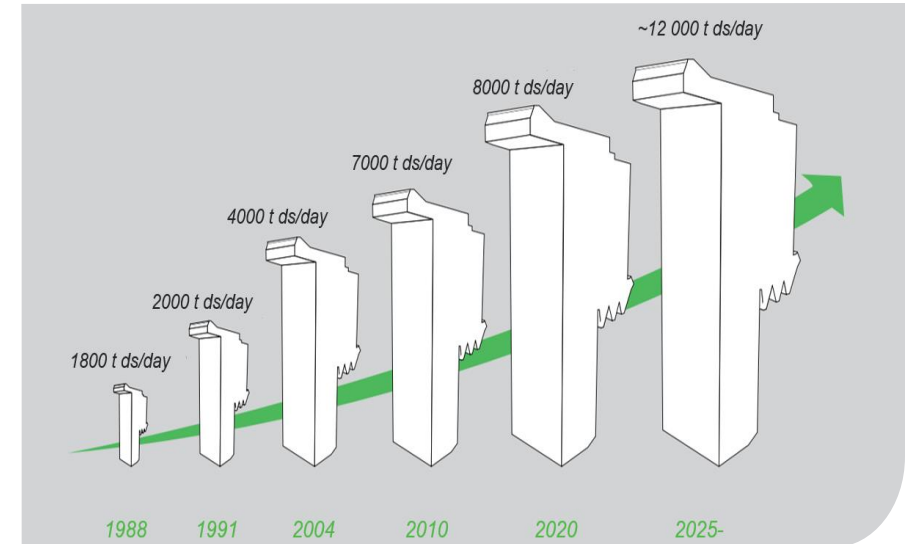
The distribution of environmental impacts in Valmet's value chain



Development of Floor loading and boiler size

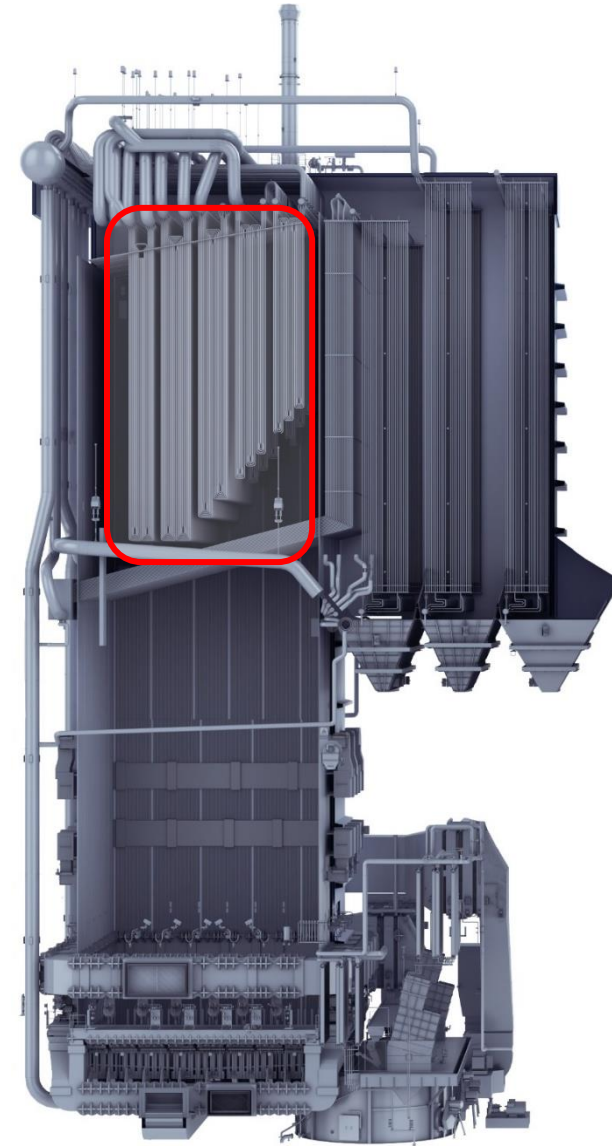
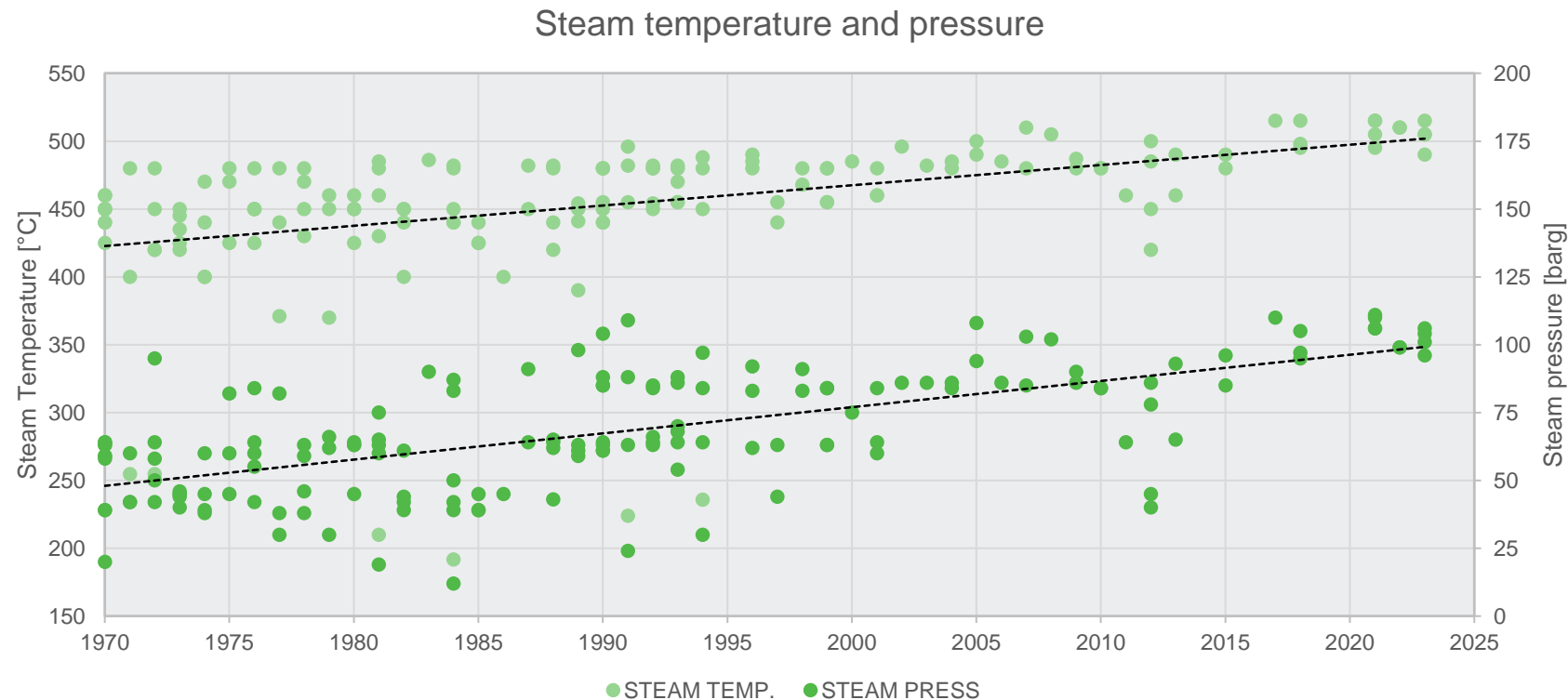


- Higher floor loadings and bigger unit sizes are both promoting sustainability
- Higher production per utilized steel kg

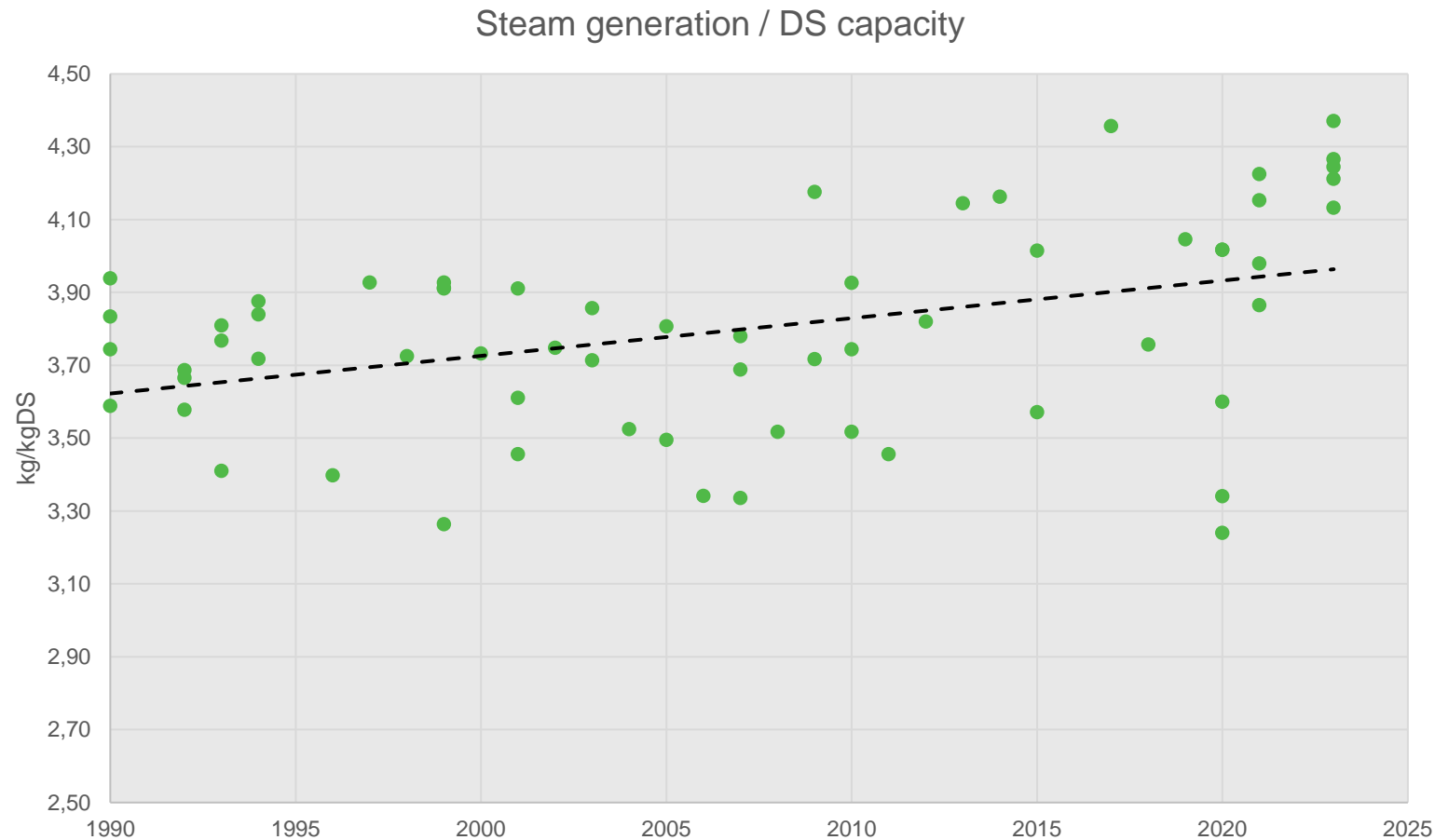


Development of main steam parameters

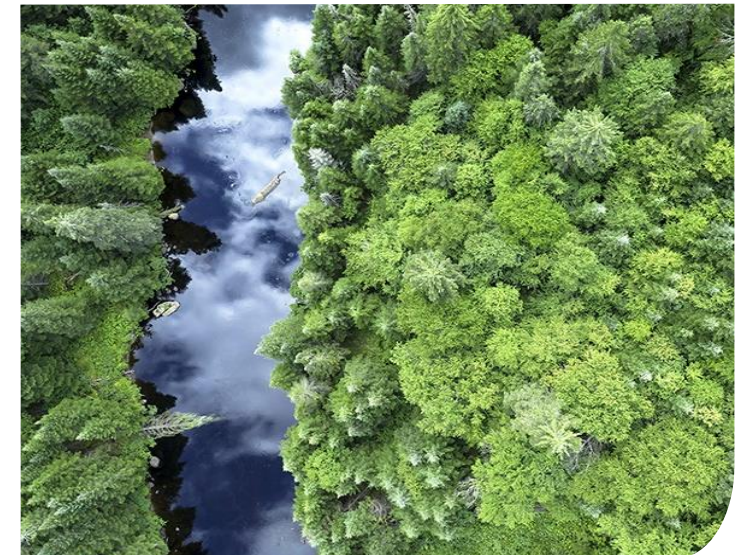
- Up to 2000 -> 480°C / 80 - 85 bar
- 2000 to 2015 -> 485°C – 495°C / 85 – 95
- Nowadays 500°C – 515°C / 100 – 110 bar
- Higher steam parameters mean higher electricity production from same raw material amount



Development of steam generation



- Even though steam parameters have increased over the past years, steam generation per burned BL kg has increased
 - Even more electricity
 - Less emissions per produced MW



Ash treatment

Sustainability targets : zero solid waste and zero liquid effluent

Modern mills are closed systems leading to higher Cl and K concentrations

- The role of ash treatment becomes vital

Environmental savings

- Less discharge of chemicals to recipient

Saves money

- Reduced chemical consumption
- Fewer and shorter maintenance outages

Increased pulp production

- Improved recovery boiler availability

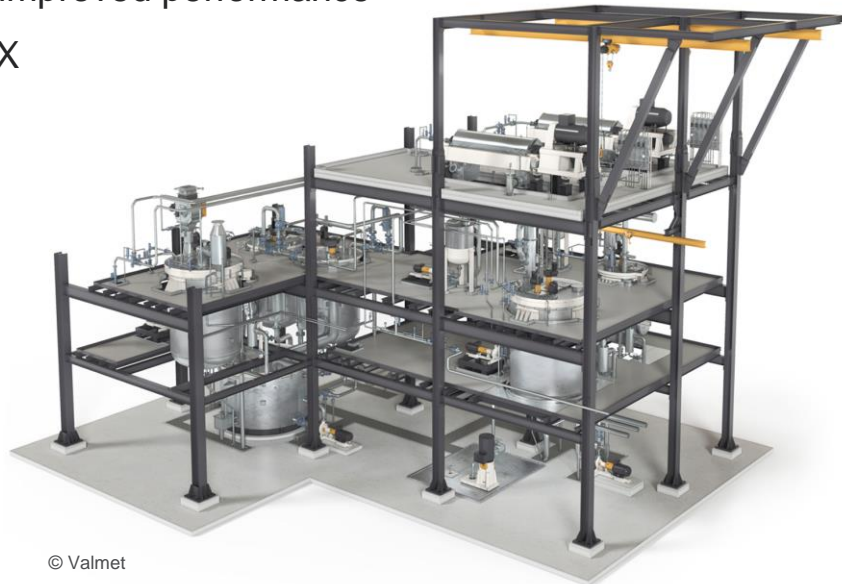


Valmet Ash Treatment Solutions

Improved recovery boiler availability by removing chlorine & potassium from the ESP ash

Ash Leaching (25-400 t ash /d)

- Excellent performance at both low and high carbonate concentrations
- Stable, robust process
 - Few components
 - No steam needed
- Single or Duo technology
- Sulphuric acid can be dozed for improved performance
- Lower CAPEX



Ash Crystallization (> 80 t ash /d)

- Superior protection of recovery boiler by removal of non process elements (K, Cl)
- Superior recovery of cooking chemicals (Na, S)
- More sensitive to impurities and high carbonate ash
- Independent, or with process integration with evaporation for improved steam consumption
- Lower effluent
- Higher CAPEX



Nox emissions

- In addition to primary methods, there are secondary means to reduce NO_x emissions even further: SNCR / SCR / scrubber

Table 8.4: BAT-associated emission levels for NO_x emissions from a recovery boiler

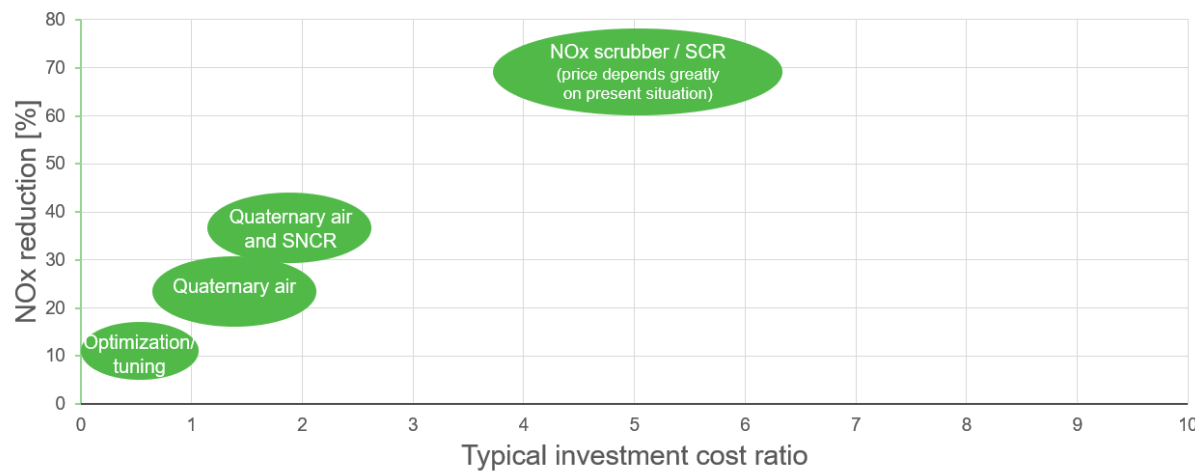
Parameter		Yearly average ⁽¹⁾ mg/Nm ³ at 6 % O ₂	Yearly average ⁽¹⁾ kg NO _x /ADt
NO _x	Softwood	120 – 200 ⁽²⁾	DS <75 %: 0.8 – 1.4 DS 75 – 83 % ⁽³⁾ : 1.0 – 1.6
	Hardwood	120 – 200 ⁽²⁾	DS <75 %: 0.8 – 1.4 DS 75 – 83 % ⁽³⁾ : 1.0 – 1.7

⁽¹⁾ Increasing the DS content of the black liquor results in lower SO₂ emissions and higher NO_x emissions. Due to this, a recovery boiler with low emission levels for SO₂, may be on the higher end of the range for NO_x and vice versa.

⁽²⁾ The actual NO_x emission level of an individual mill depends on the DS content and the nitrogen content of the black liquor, and the amount and combination of NCG and other nitrogen containing flows (e.g. dissolving tank vent gas, methanol separated from the condensate, biosludge) burnt. The higher the DS content, the nitrogen content in the black liquor, and the amount of NCG and other nitrogen containing flows burnt, the closer the emissions will be to the upper end of the BAT-AEL range.

⁽³⁾ If a recovery boiler were to burn black liquor with a DS > 83%, then NO_x emission levels should be reconsidered on a case-by-case basis.

DS = dry solid content of black liquor.



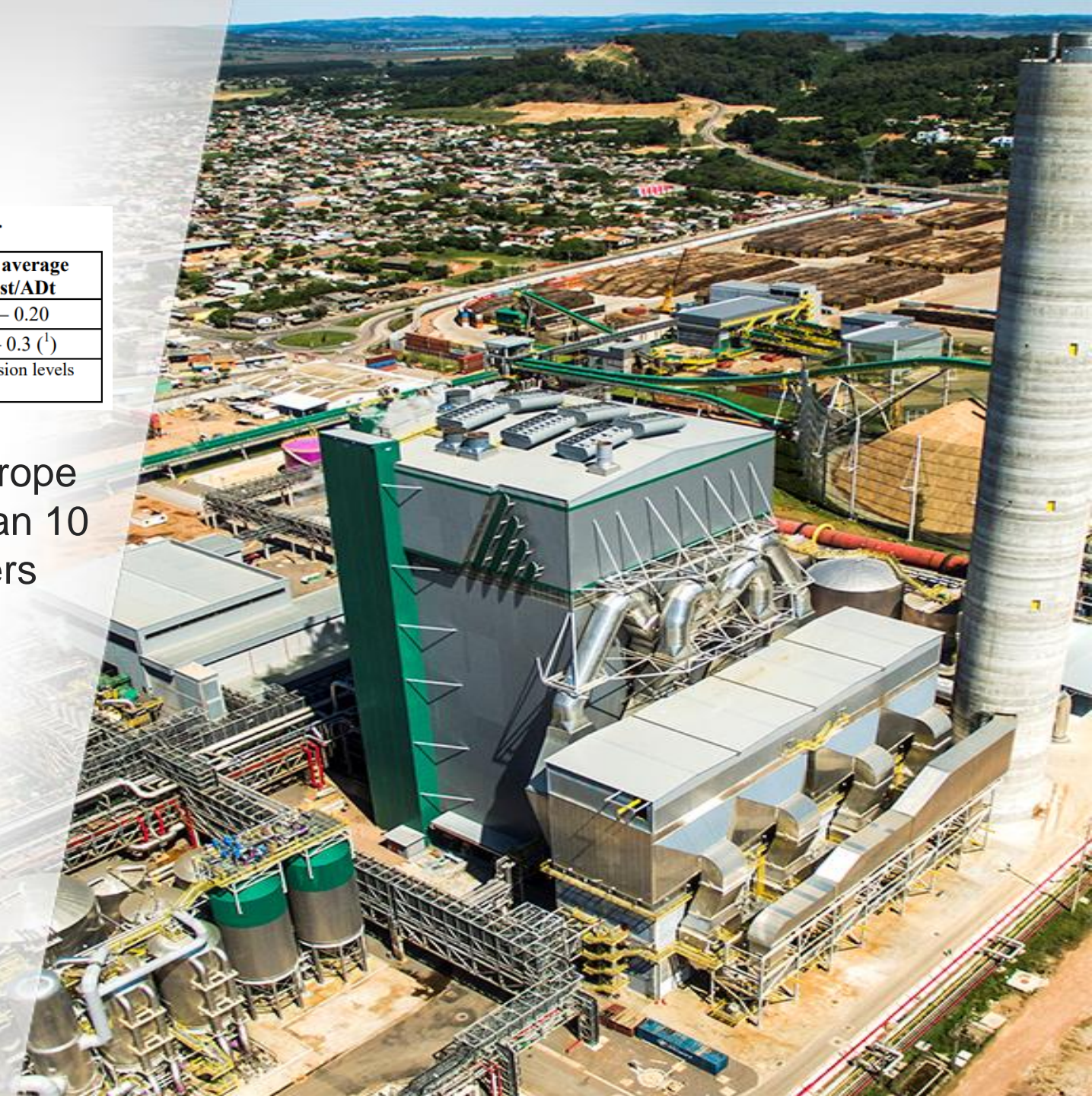
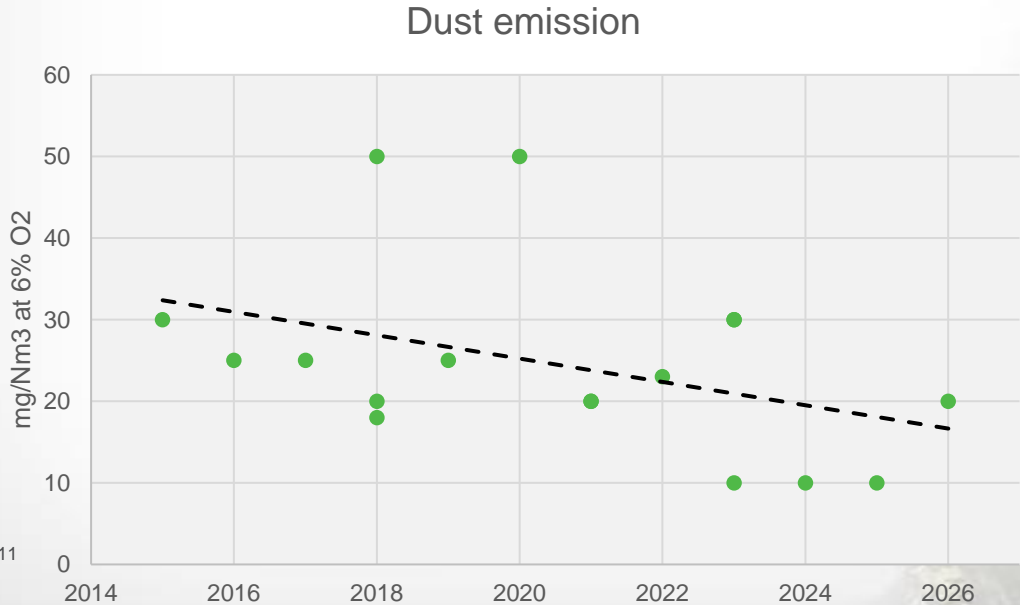
Dust emissions

Table 8.5: BAT-associated emission levels for dust emissions from a recovery boiler

Parameter	Dust abatement system	Yearly average mg/Nm ³ at 6 % O ₂	Yearly average kg dust/ADt
Dust	New or major refurbishment	10 – 25	0.02 – 0.20
	Existing	10 – 40 ⁽¹⁾	0.02 – 0.3 ⁽¹⁾

⁽¹⁾ For an existing recovery boiler equipped with an ESP approaching the end of its operational life, emission levels may increase over time up to 50 mg/Nm³ (corresponding to 0.4 kg/ADt).

- Today, many customers, especially in Europe and China, require dust emission less than 10 mg/Nm³ at 6% O₂ for new recovery boilers





2

Safe and reliable
solutions

Safety first

Operator safety is at the top of the priority

Operator safety

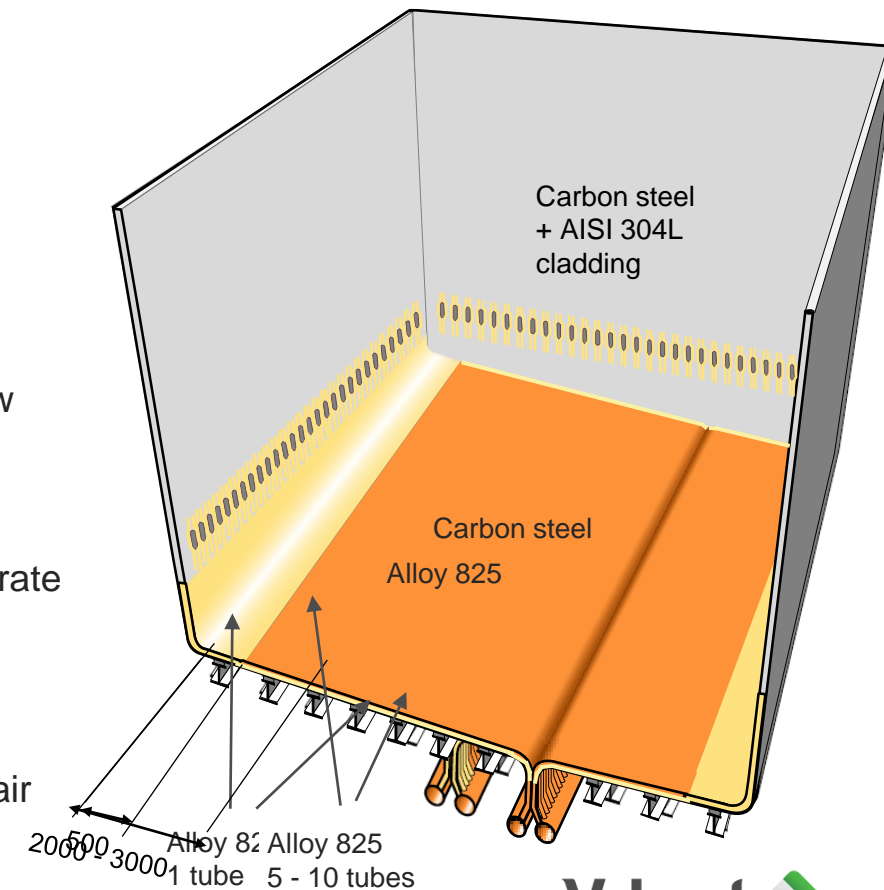
- Pressure part materials made to last for decades
- Smelt spout robot for operators' safety
- Online analyzer for reduction rate
- Ergonomic retractable liquor gun station with safety door
- Safe and reliable burner solutions for auxiliary fuel and odorous gases
- Advanced leak detection
- Fully integrated safety system with Valmet DCS
- Smelt protection gear



Pressure part materials made to last for decades

Lower furnace material selection

- Nowadays most typical materials used in floor are carbon steel and Alloy 825
- Many customer who have selected minimum Alloy 825 coverage have later extended Alloy 825 portion 2 – 3m due to observed corrosion
 - Upgrade cost of floor materials afterwards can be 10-times higher compared to capital investment
- In latest projects, many customers have selected whole floor with Alloy 825 or longer extension 2 – 3 m
 - Clearly, tendency is towards higher coverage of Alloy 825 to ensure long lifetime and low maintenance need
- Typical lower furnace opening materials are Alloy 825 and 304L
 - In high pressure and high loaded boilers, there has a been an increase in the corrosion rate and cracking of 304L opening tubes
 - This has been seen especially in big openings, such as SUB and manddoors
 - Experiences of upgrading to Alloy 825 material have been positive
 - Some customers have selected extending Alloy 825 material limit above secondary air level in new projects





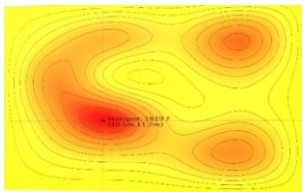
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**Towards autonomous
operation with advanced
process controls, smart
sensors and digital solutions**

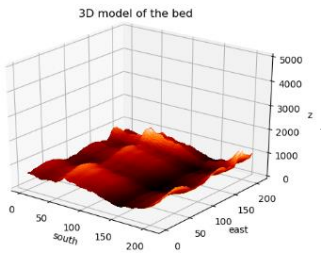
Recovery Boiler Optimization

Toward autonomous operation

Acoustic Pyrometer
Combustion
Symmetry& Carryover



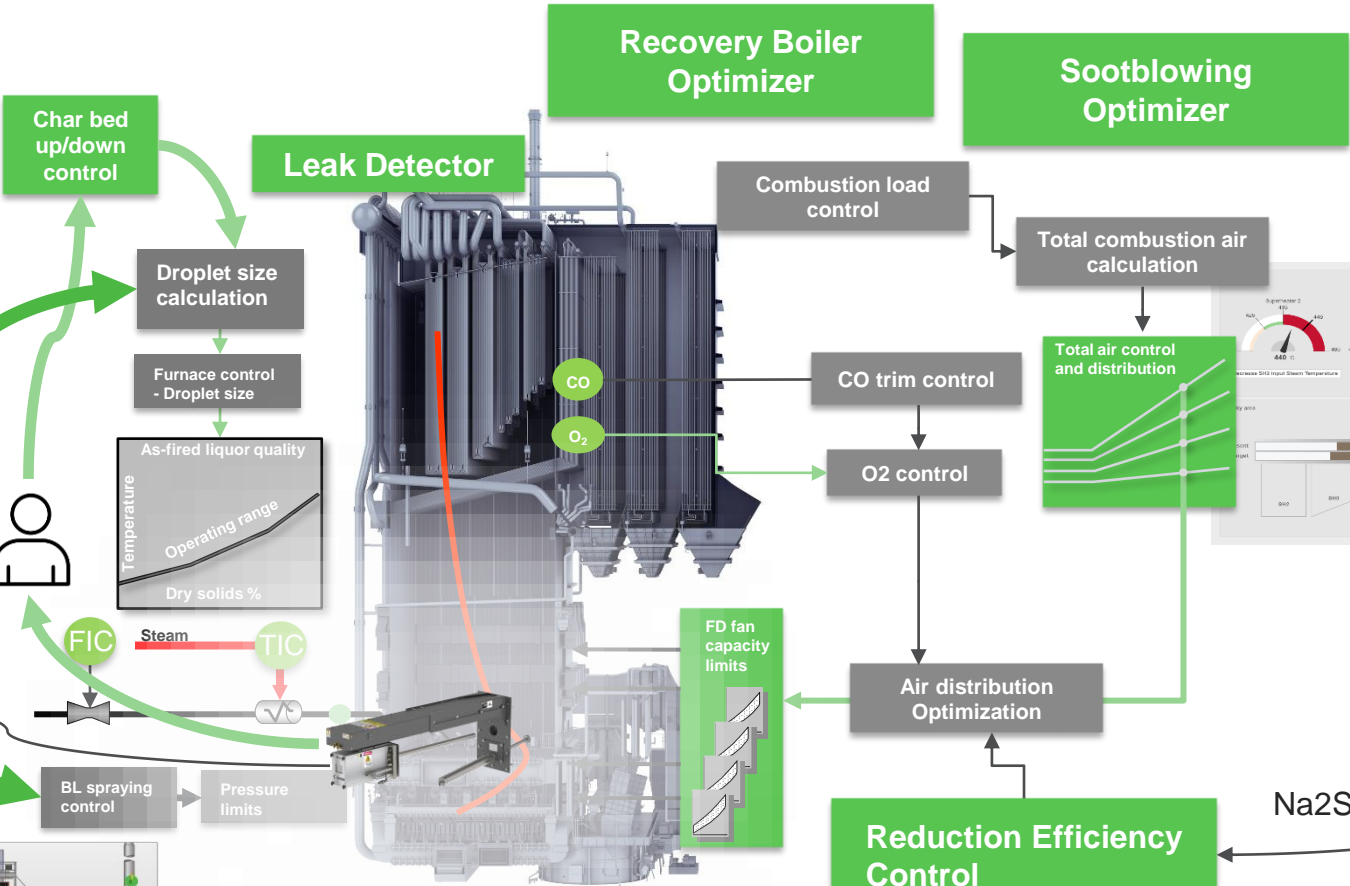
Carry over and
Combustion
symmetry



IR Cameras
3D Bed Size
Combustion
monitoring



RB Performance monitoring
© Valmet | Optimization solutions for recovery boiler



Ash Balance
Optimization

Valmet Recovery
Ash Analyzer



Valmet Recovery
Liquor Analyzer



Valmet 



One example of digital solutions

Online CFD solution to oversee combustion conditions in furnace

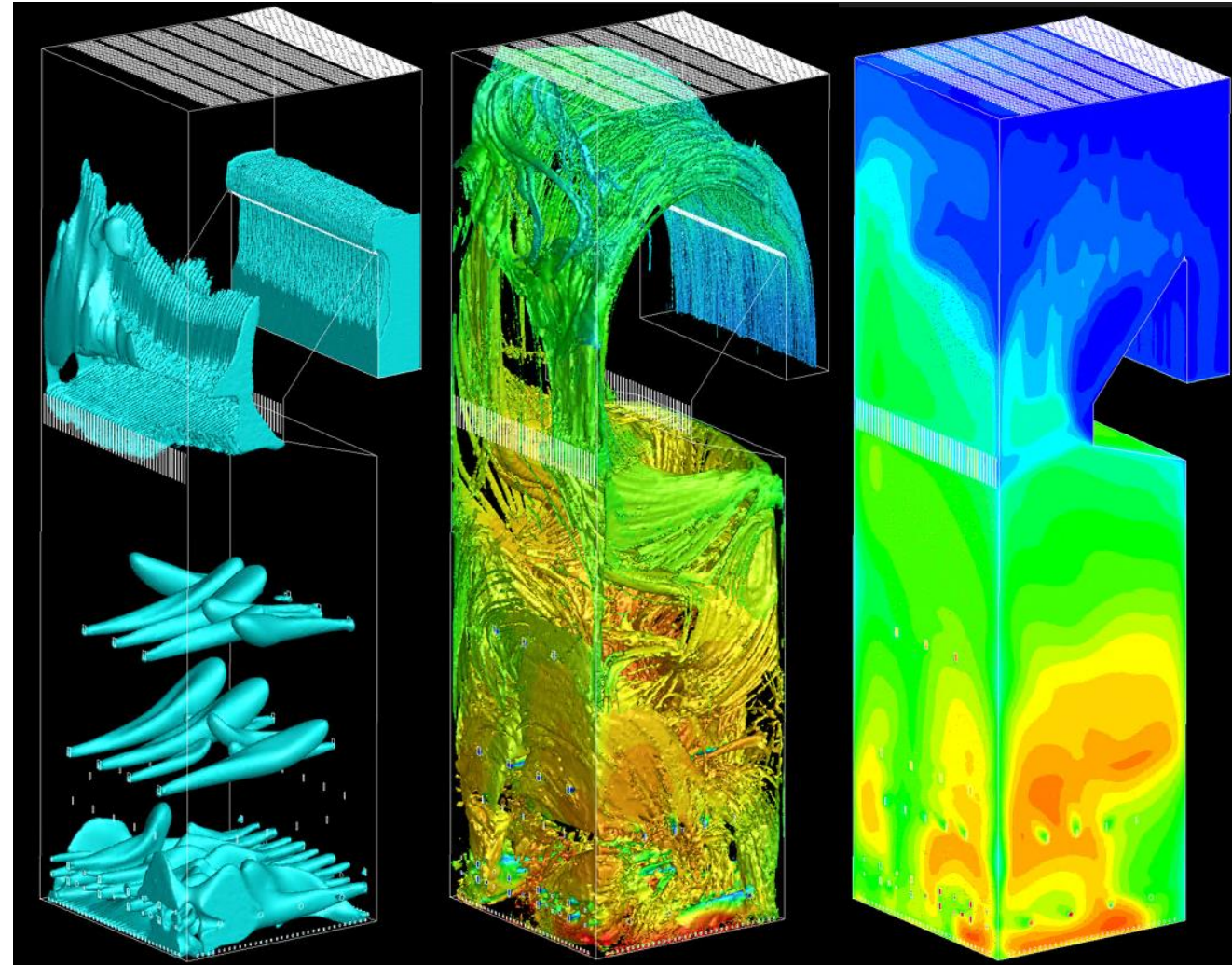
- Valmet Recovery Boiler Combustion Diagnostics is a tuning and troubleshooting tool for operators and process specialists which visually shows the state of the combustion inside the furnace
- With Computational Fluid Dynamics (CFD), the application provides a variety of process parameters which are not possible to measure
- Enables making conclusions how to improve the current situation and optimize performance, availability and emissions

Air system performance

- Input for air distribution optimization
- Optimized performance and emissions

BL droplet carryover

- input for air distribution and droplet size optimization
- Increased availability and safety



Summary

High power features

+20% power generation compared to conventional RB

MAXIMIZED STEAM GENERATION

Full pressure tank (LP)
Feedwater preheating (MP1)
Feedwater interheating (MP2)

Combustion air temperature
even up to 220 °C

Black liquor dry solids
concentration up to 85%



MAXIMIZED ELECTRICITY PRODUCTION

Steam parameters up to
515 °C and 105 bar(g)

Soot blowing steam from
turbine extraction



MINIMIZED STEAM CONSUMPTION

Heat recovery from vent gases
to make-up water

Heat recovery from flue gases
to deminwater/TG condensate



Support for optimized operation over time

		Before commissioning	Year 1 Start at take-over	Year 2
Connectivity	Set-up for remote connection to your DNA and connectivity to Valmet cloud	Before commissioning Smooth start-up Improving plant performance Access to Valmet experts		
Customer Portal	Place to access the applications, information and get in contact			
Operations panel	Dashboards to visualize Key Performance Indicators (KPIs) and Trending Tool			
Applications	Monitoring and optimizing the process (Centerline advisor, RB performance monitoring, RB combustion diagnostics)			
On demand expert remote support	Remote support provided through Valmet Performance Center			

