Metso Outotec Webinar
21 June, 2021

Metallurgy, key challenges and technical solutions in e-scrap smelting

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Metso:Outotec

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Agenda

21 June, 2021

Practicalities

Introduction and recap

Flowsheet development

eScrap solutions and challenges in e-scrap smelting

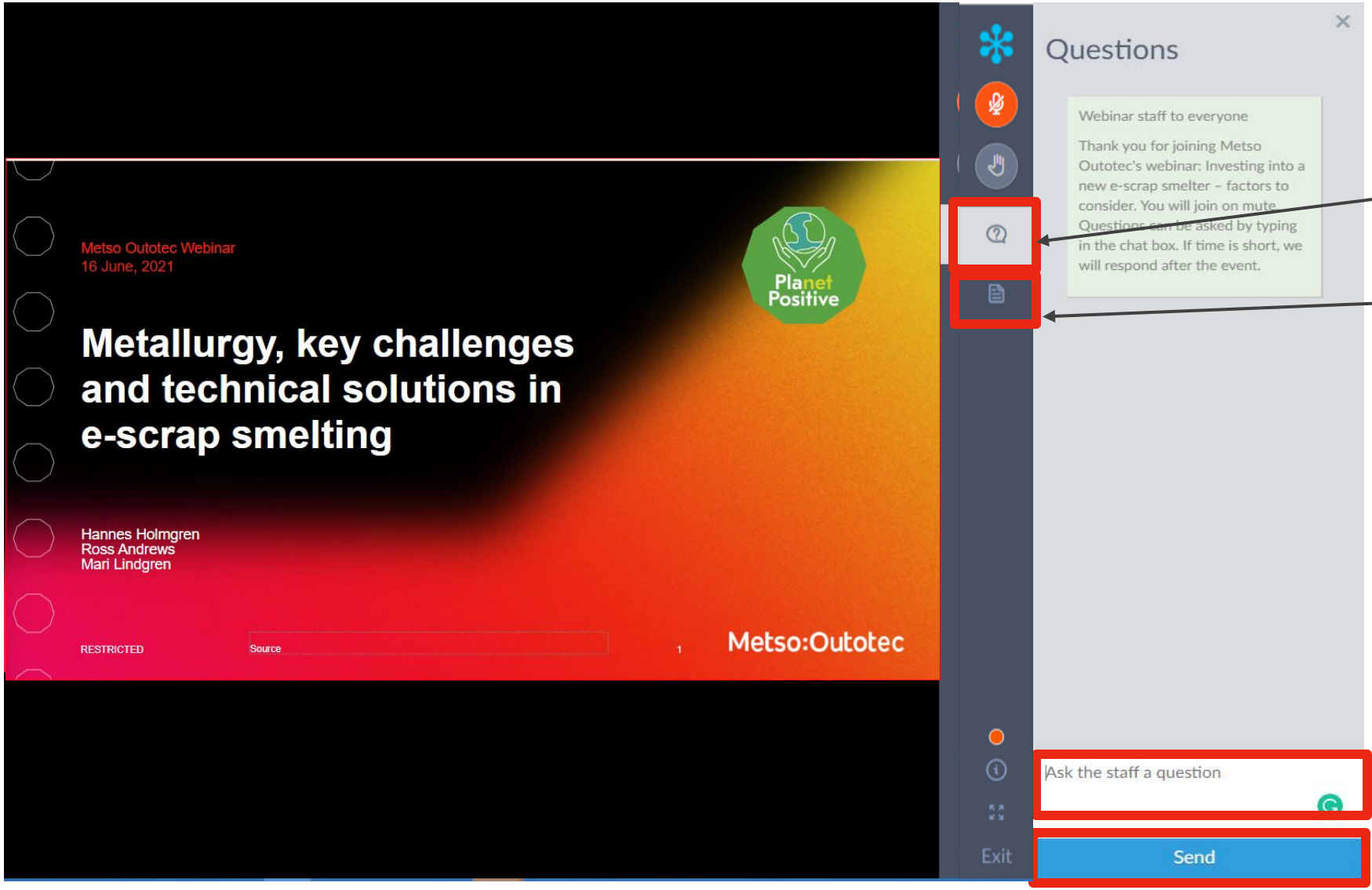
Summary

Q&A

Practicalities

- Our info session runs for one hour
  - 40 minutes of presentation
  - 20 minutes of Q&A
- Questions can be asked by typing in the chatbox
- All questions will be answered at the end of the presentation in the Q&A session
- If we run out of time during Q&A, we will answer any questions post-event by mail.
- A link to the meeting recording and presentation will be available on https://www.mogroup.com/events/
- Slides of the presentation are available for download

How to ask questions?



Open the chat box

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Type your questions here

Submit your questions

Presenters

Hannes Homgren, Technology Manager Precious Metals & Kaldo

- 10 years copper smelter experience with primary and secondary operations
- 3 years with Metso Outotec in process engineering

Ross Andrews, Process Design Manager, TSL Smelting

- 17 years with Ausmelt/Metso Outotec in process engineering
- Extensive experience in theoretical studies, pilot plant testing, and design and commissioning of smelters including secondary copper processes.

Mari Lindgren, Director of R&D, Smelting

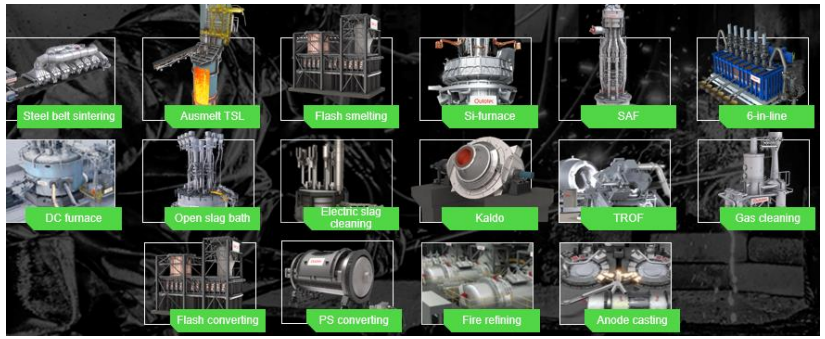
- Mari has Ph. D in Materials Engineering.
- She has 20+ years in research in various roles. 45+ peer-reviewed articles and 25+ conference papers.

Introduction and recap

Metso:Outotec

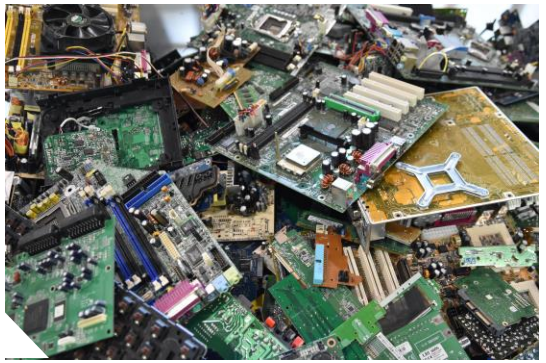
Introduction

- Metso Outotec is the frontrunner in sustainable technologies and e-scrap is a good example
- E-scrap generation grows and provides an interesting raw material source
- Metso Outotec eScrap solution:
  - Full product portfolio
  - R&D facilities for optimization
  - Based on references and experience



Recap: Investing into a new eScrap smelter – factors to consider

- Factors to consider
  - Raw material quality and quantity
  - Impurity elements
  - Environmental protection
- Definitions
  - WEEE and e-waste
  - e-scrap
  - eScrap solutions



Section 1

How do we develop flowsheets?- modelling and testing

eScrap flowsheet building

- Characterise the feed
  - Elemental Analysis -> Component Analysis
  - What's missing?
  - Feed rates
- Group Feeds
  - High grade feeds can go further 'down' the flowsheet
  - Any feeds require pretreatment?
- Understand Product requirements
  - Black Copper/Raw Copper/Refined Copper

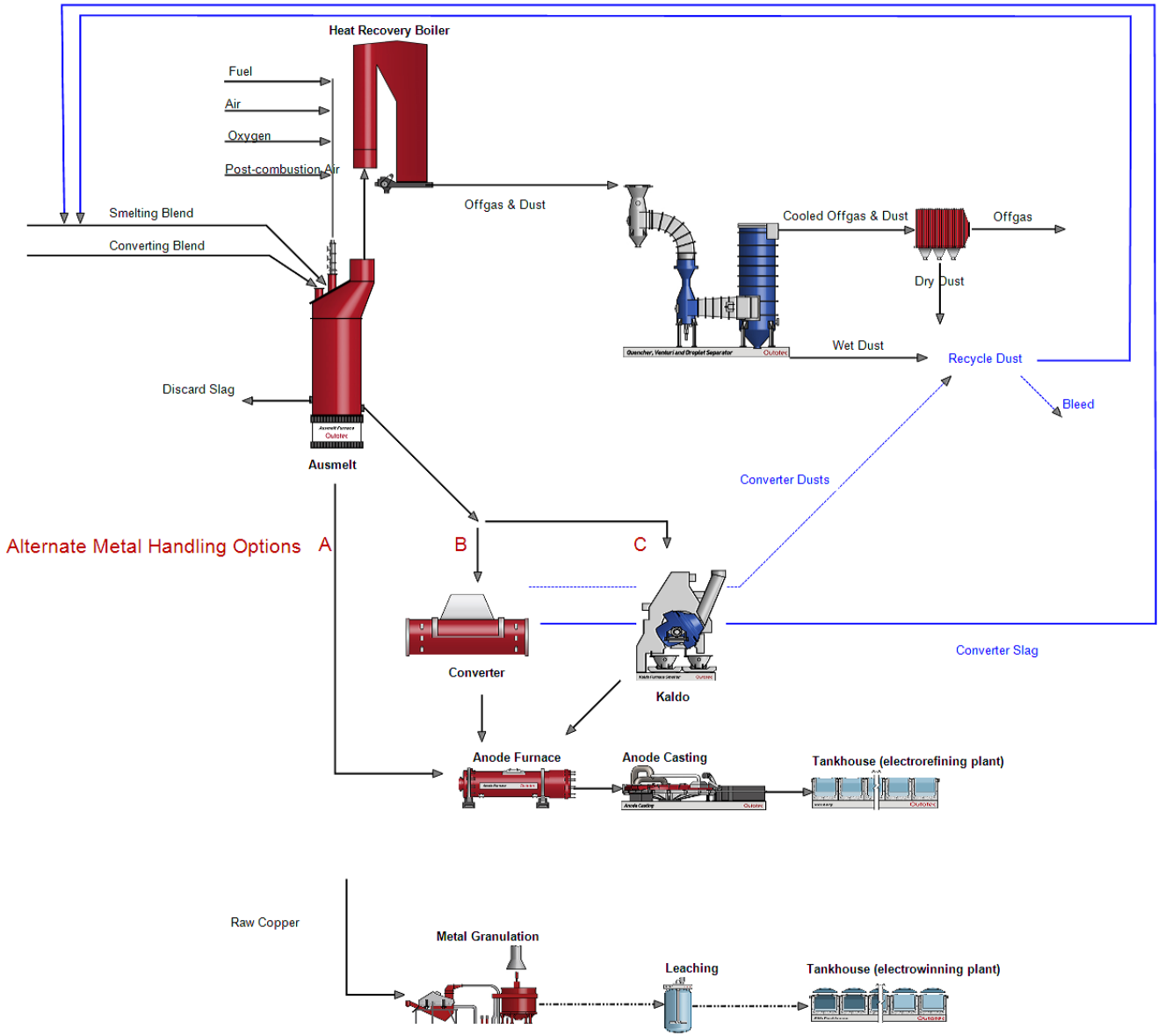
Sample	Cu	Fe	Ni	Co	Zn	Cr	Sn	Pb	Ag	Sb	SiO_2	CaO	Al_2O_3	MgO	MnO	TiO_2	S	'Organics'
MB #1	23.3	0.16	0.02	0.01	0.19	0.01	0.02	0.11	0.01	0.01	38.44	7.28	7.05	0.19	0.01	1.25	0.46	24.8
eTag #1	16.9	11.2	1.49	0.02	0.47	0.7	0.1	0.36	0.7	0.7	39.02	5.26	5.31	0.18	0.7	0.73	0.18	20.2
eTag #2	16.3	7.79	1.51	0.02	0.5	0.38	0.1	0.05	0.38	0.38	42.04	5.78	5.56	1.48	0.38	0.74	0.52	19.1
RAM #1	12.5	5.97	4.24	0.01	0.09	0.02	0.17	0.32	0.02	0.02	53.13	3.67	4.23	0.1	0.02	0.45	0.12	16.2
RAM #2	17.4	3.39	2.41	0.01	0.23	0.01	0.02	0.11	0.01	0.01	47.04	3.92	3.84	0.38	0.01	1.25	0.05	21.8
CPU	19.5	10.4	7.06	2.49	0.23	0.01	0.6	0.08	0.01	0.01	33.8	3.76	3.4	0.15	0.01	2.45	0.43	16.6

Sample	Cl	Br
MB #1	0.07	11.08
MB #2	0.05	7.4
eTag #1	0.03	9.44

Sample	GCV (MJ/kg)
eTag #1	8.32
MB* #1	8.74
MB #2	8.25
MB #3	9.18
eTag #2	6.44

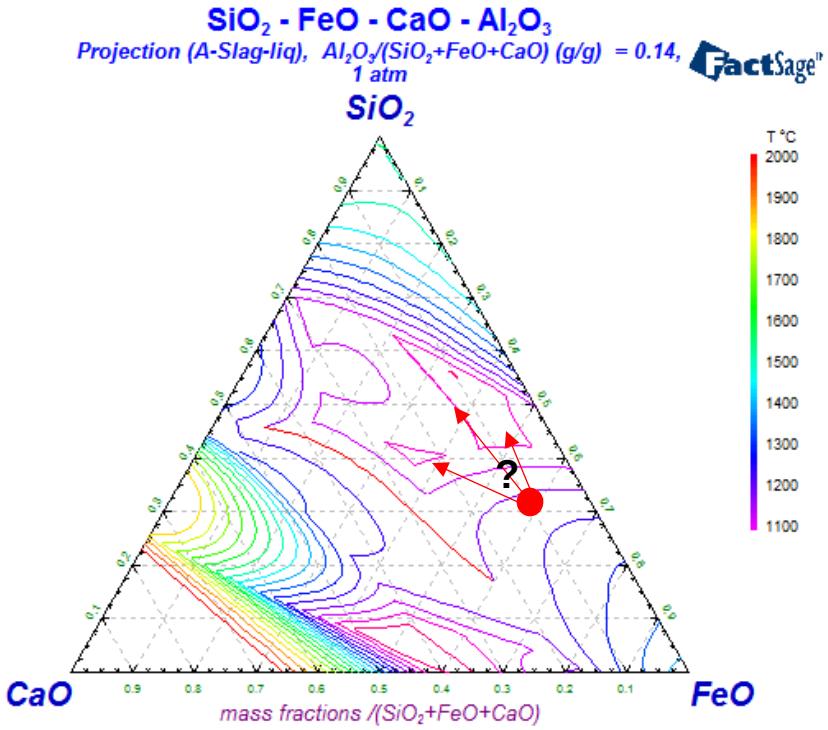
Steps in flowsheet building (cont.)

- Set up flowsheet
  - Generally, number of feeds and product quality will dictate complexity
- Use HSC SIM (or similar)
  - Need to consider recycle streams and bleeds
- Set process conditions to influence element distributions
  - Temperature, pO_2, slag chemistry
- Optimized recoveries



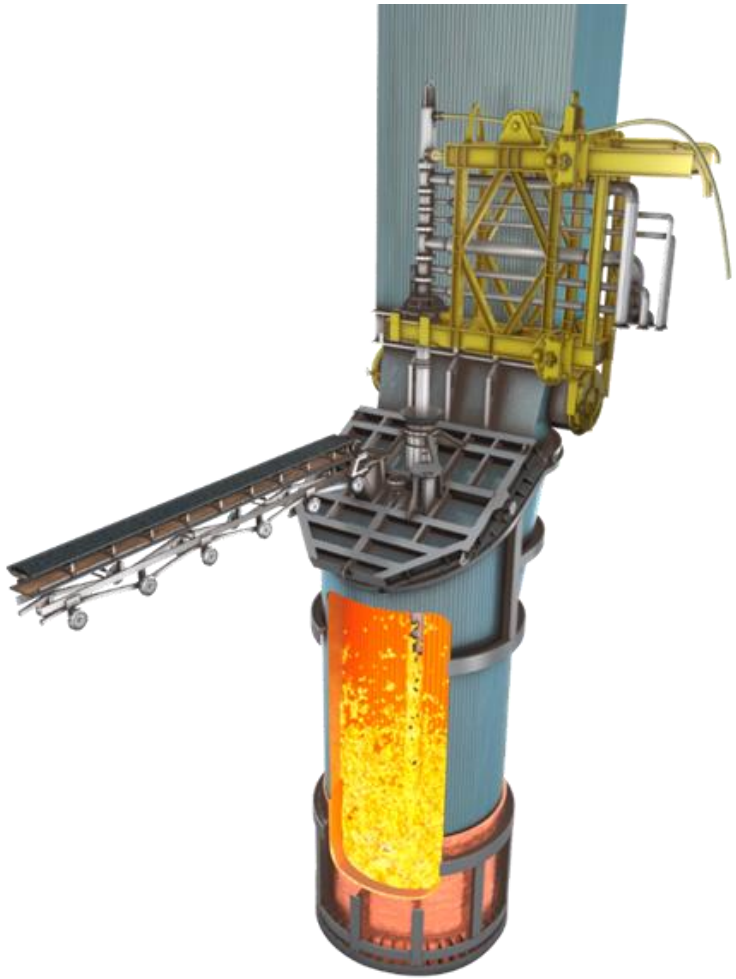
Process modelling

- Slag Chemistry requirements – feed blend will result in a natural slag chemistry that will need adjustment to achieve suitable properties (typically melting point and viscosity)
  - Keep fluxing to a minimum. More slag, potentially more metal loss to slag, increased energy cost
- Modelling using HSC Chemistry, MTDATA, FactSage, Plant data, Pilot plant data, Laboratory data and literature.
- Important to understand differences in equipment and how it's modelled
  - Data interpretation is important, particularly around volatile components



Key challenges in process modelling

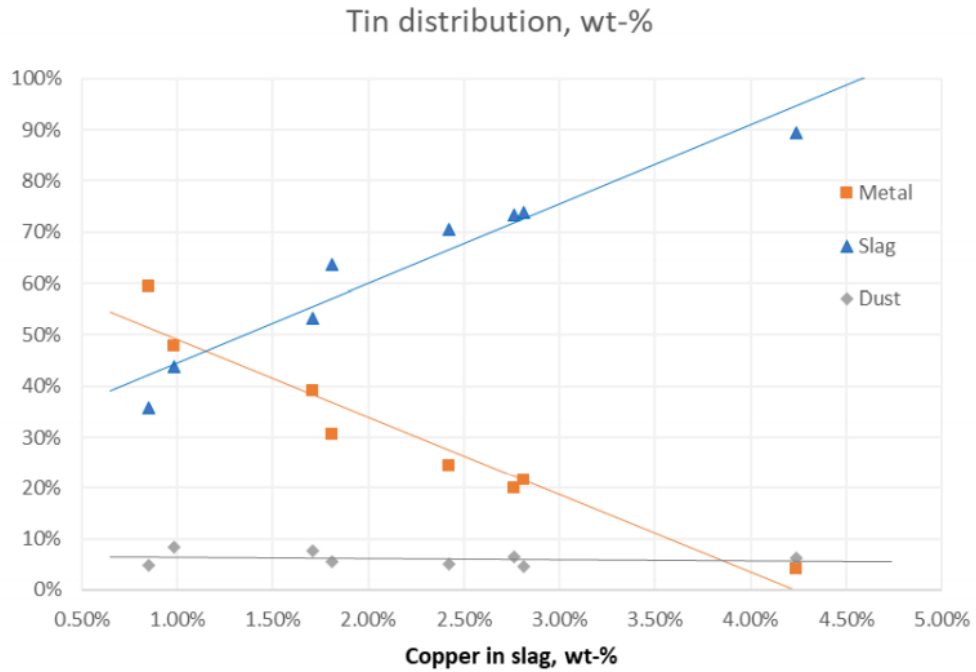
- Aluminium in feed. Will oxidize to Al_2O_3 which can make slag challenging.
  - Influence equipment choice and fluxing targets
- Plastics in WEEE– PVC, Epoxy, HIPS, ABS, PP, other plastics
  - Energy source
    - Primary utilization – bath temperature
    - Secondary utilization – steam from heat recovery boiler
    - A source of halides, dioxins and furans
- Critical to:
  - Understand the feed
  - Understand the thermodynamics
  - Understand the equipment

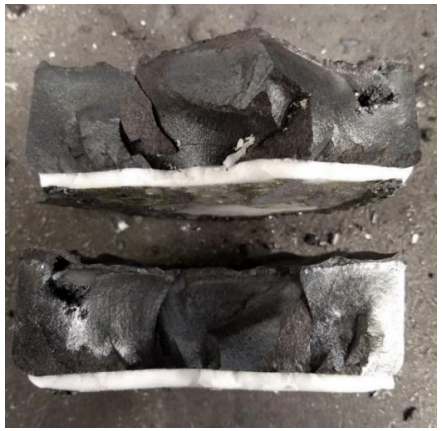


Characterisation and testwork

Metallurgical tests

- Experimental testing
  - When thermodynamical databases incomplete
  - For sizing and up-scaling
  - Process guarantees
- Laboratory scale
  - Distribution coefficients
  - Synthetic or doped slags can be used
- Pilot scale
  - Needs more feed material
  - Distribution coefficients
  - Estimation of energy balance





How do we develop flowsheets?

1. We aim to optimized solution
2. Combination of modelling and experimental work
3. Requires deep metallurgical knowledge
4. We have all the capabilities to support the customers

Section 2

eScrap solutions and challenges in e-scrap smelting

Slag challenge

- **Slag system in Ausmelt TSL and Kaldo**
  - Same base for slag system for TSL and Kaldo
  - Ausmelt requires fluid slag (Kaldo can handle high viscosity)
  - FeO-SiO2-CaO-Al2O3 smelting
  - FeO-SiO2 converting
- **Goals:**
  - Impurities to slag, one target Al2O3 15-20 % (today, tomorrow?)
  - Slag amount controlling element can vary
  - Low levels of Cu and PMs
- **Challenges:**
  - Unknown and varying feed –solved by mixing and e-scrap quality control
  - Melting point and slag viscosity, PM-losses, enclosures-> poor combustion

Making a good slag is key – as in all pyro processes

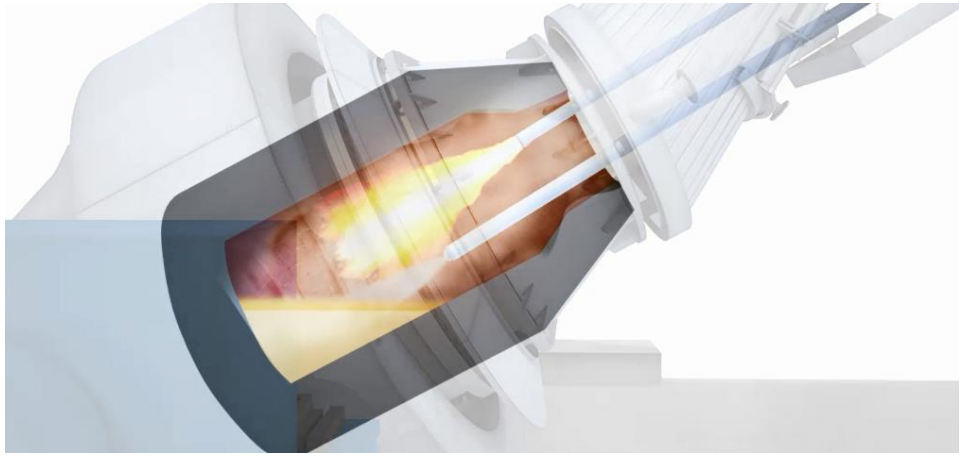
Impurities challenge

The behavior of main impurities in e-scrap smelting categories

- **Working environment**
  - Be, Hg, Li-batteries and Radioactive elements
  - Monitoring and rejecting at the smelting gate
- **Circulating and by-products**
  - Pb, Sn, Zn, Ni
  - By products or dilution

Impurities challange cont.

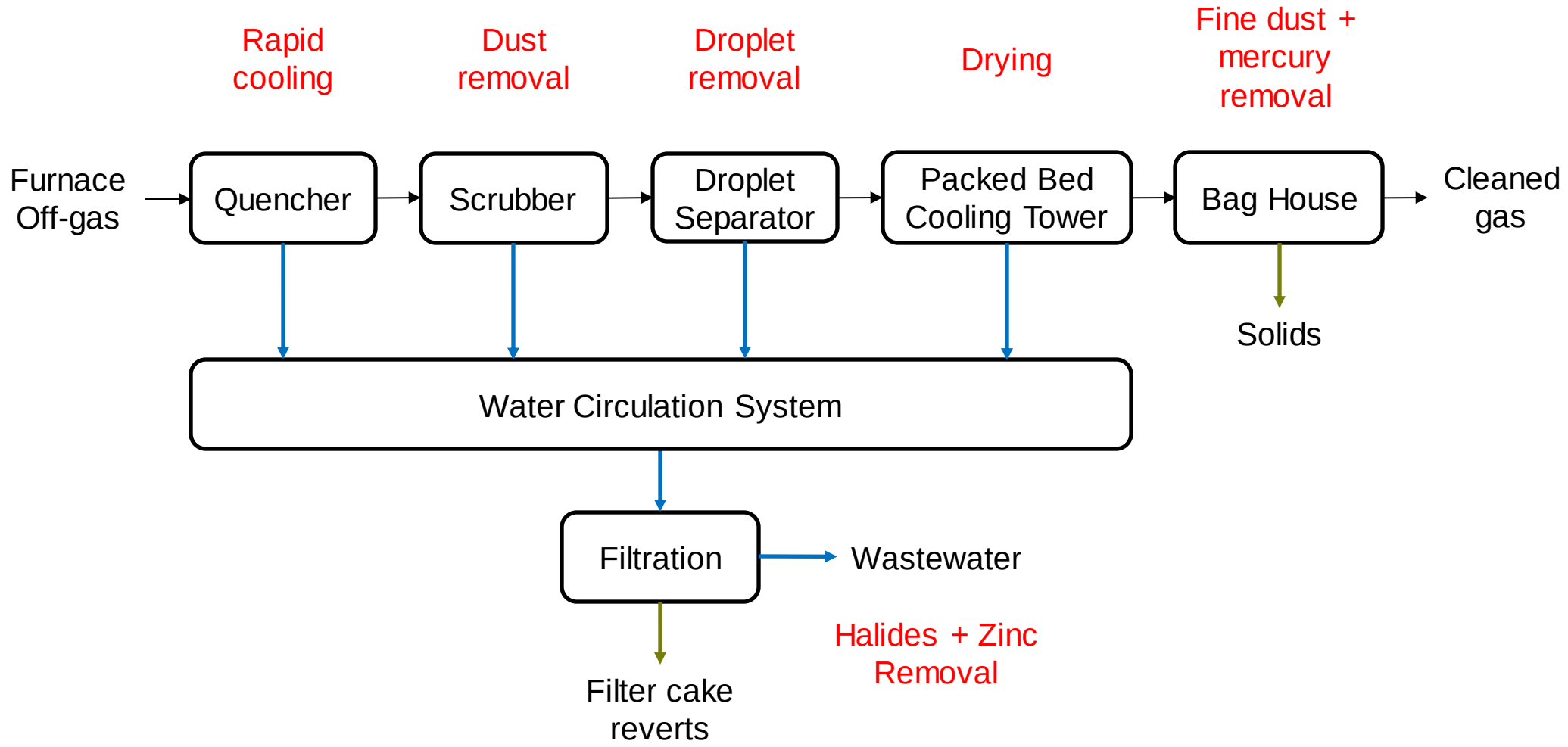
- **Slag elements**
  - Si, Cr, Al, Mg, Fe
  - Slag composition
- **Cu impurities**
  - Bi, Sb – Cu impurities
  - not as high today as past 20 years
  - Dilution
- **Environmental challenges**
  - Cl, Br, Hg



Gas cleaning flowsheet development

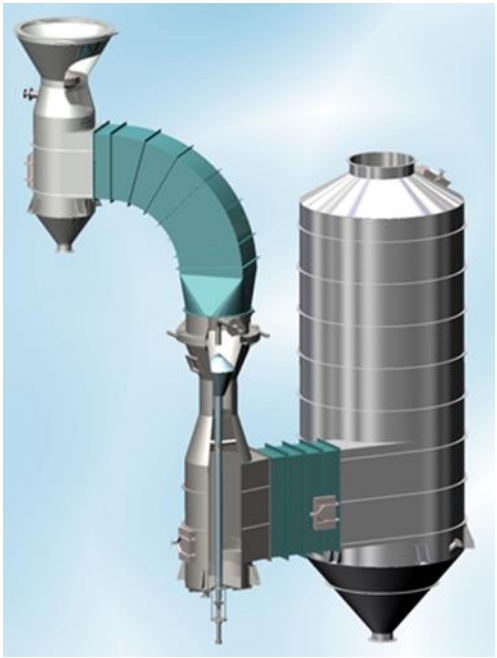
- Step 1, Furnace off-gas design basis
- Step 2, Client requirements (by-products and waste)
- Step 3, Process modelling; water, mass and heat balance
- Step 4, Equipment sizing, based on process model

Gas cleaning main process steps



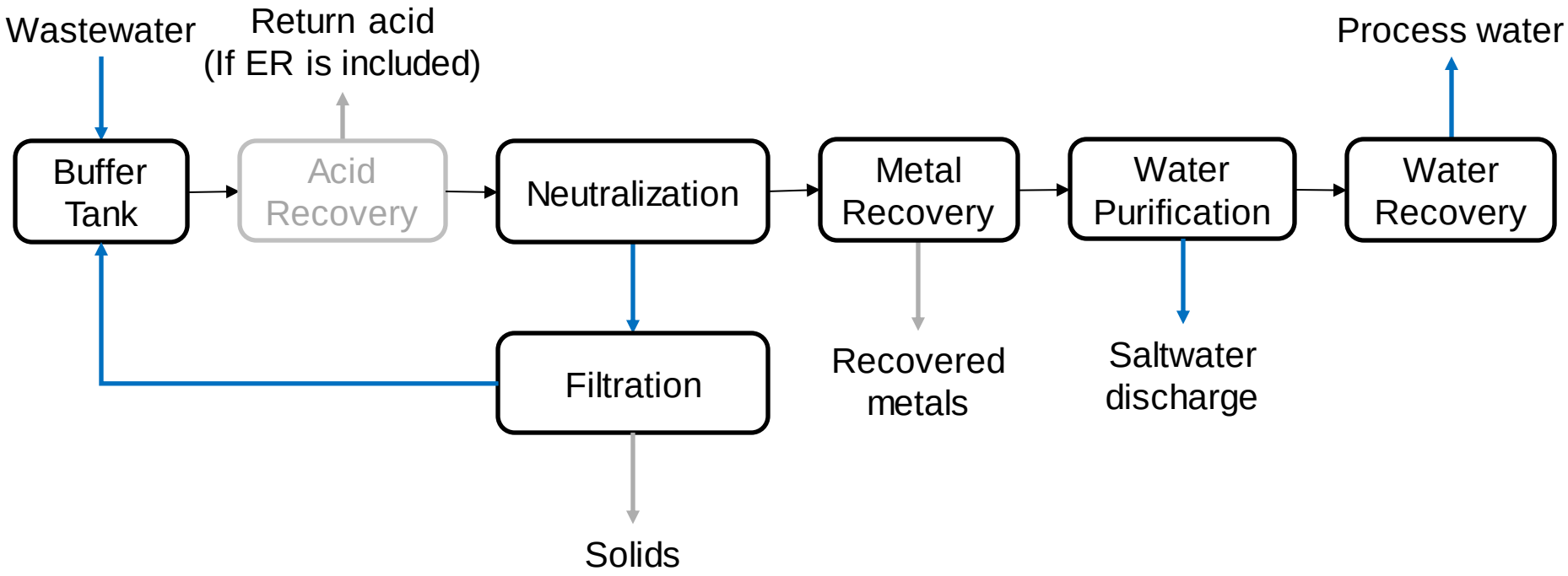
Gas cleaning options

- Kaldo furnace ventilation
- Heat recovery boiler
- Precipitation in water circulation system
- Filter cake treatment (hydrometallurgy, drying etc.)
- NOx removal by oxidation and scrubbing
- NOx removal by SCR (selective catalytic reduction)



Wastewater treatment overview

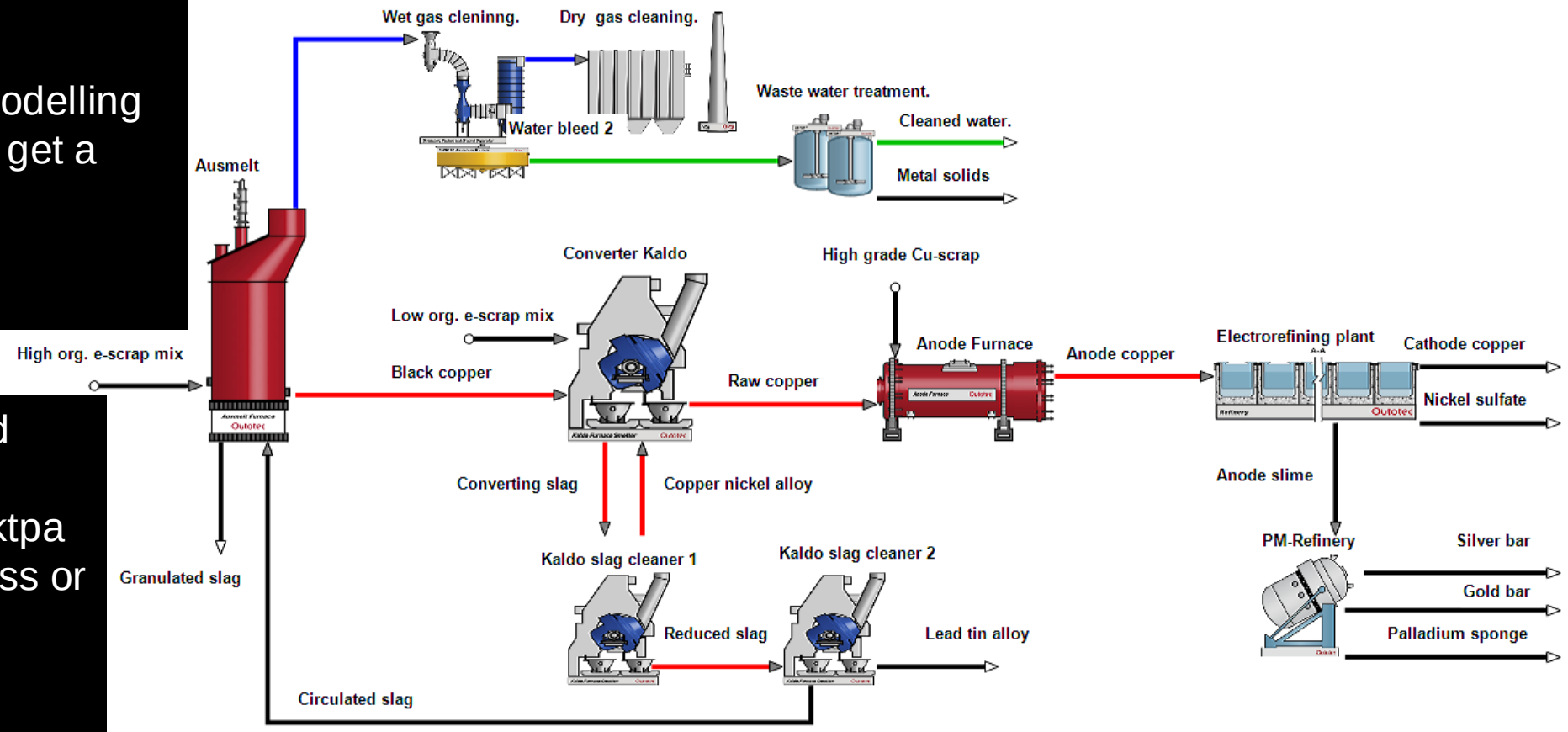
Saltwater discharge
or
zero liquid discharge



Example of large scale eScrap flowsheet

- Modular thinking
- Optimized solution for each case
- Result of flowsheet modelling and testing a basis to get a flowsheet
- Process guarantees

- Low and high Cu-feed
- Capacity up to >100 ktpa
- Electro-refining process or leaching SX-EW



Summary

1	Deep metallurgical knowledge – modelling and testing
2	Complete eScrap solutions built of proven technologies
3	Metso Outotec has the knowhow and capabilties to support the whole lifecycle of a plant

Q&A ?

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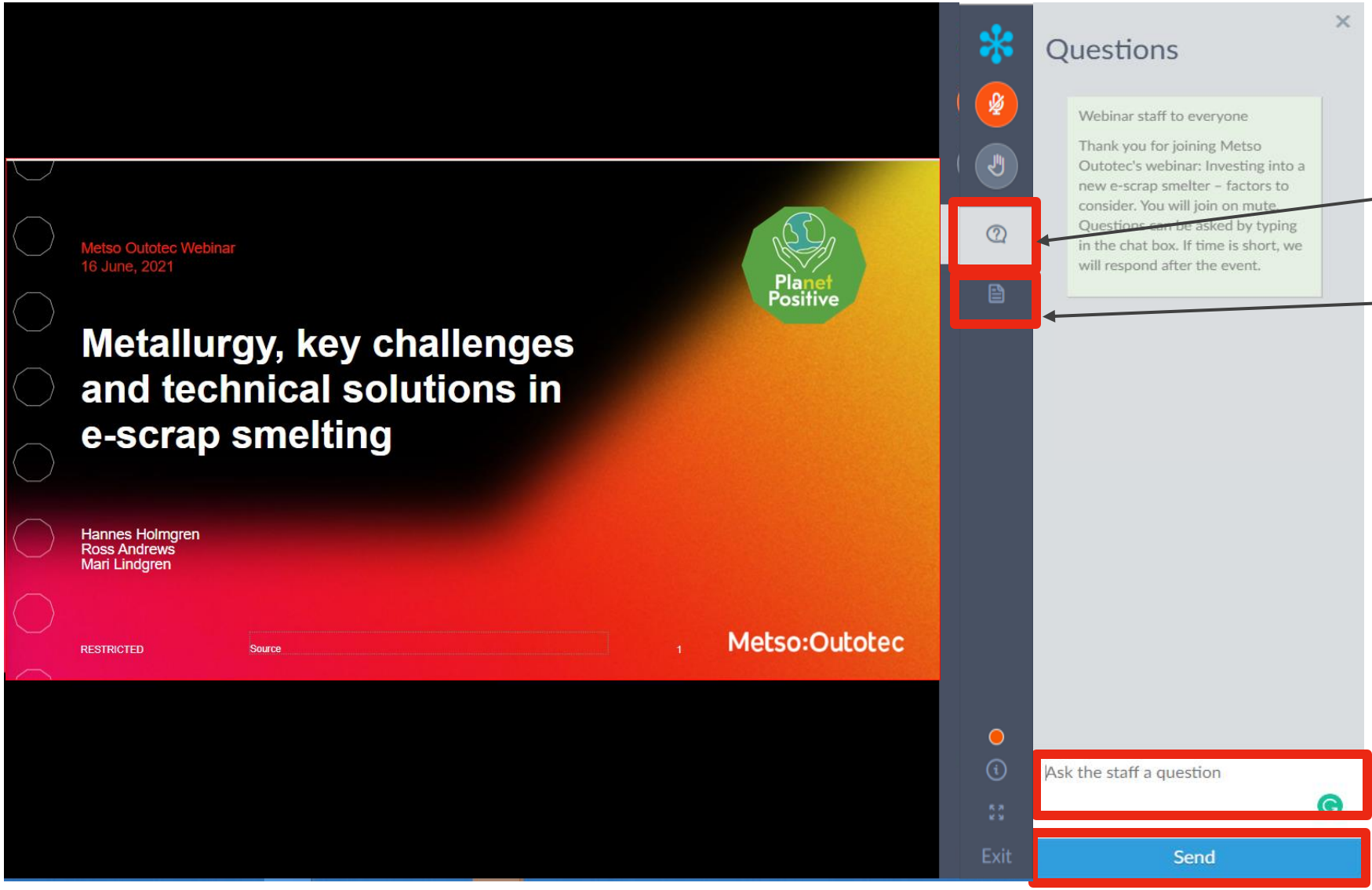
How to ask questions?



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