Improved analysis of post-consumer scrap to further push a circular steel industry

ESTEP 2024
Annual Event

Johannes Rieger

2024-10-30

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European Steel Technology Platform
20 years together

H2 FOR GREEN STEEL
3rd INTERNATIONAL CONFERENCE
meets
A CIRCULAR ECONOMY DRIVEN BY THE EUROPEAN STEEL

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ONE STEP AHEAD.

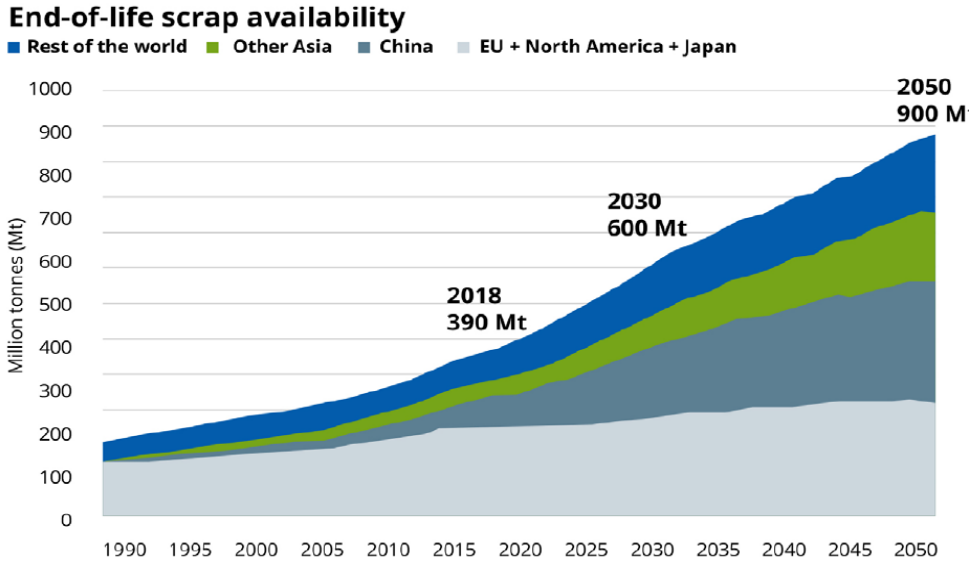
PRIMETALS TECHNOLOGIES

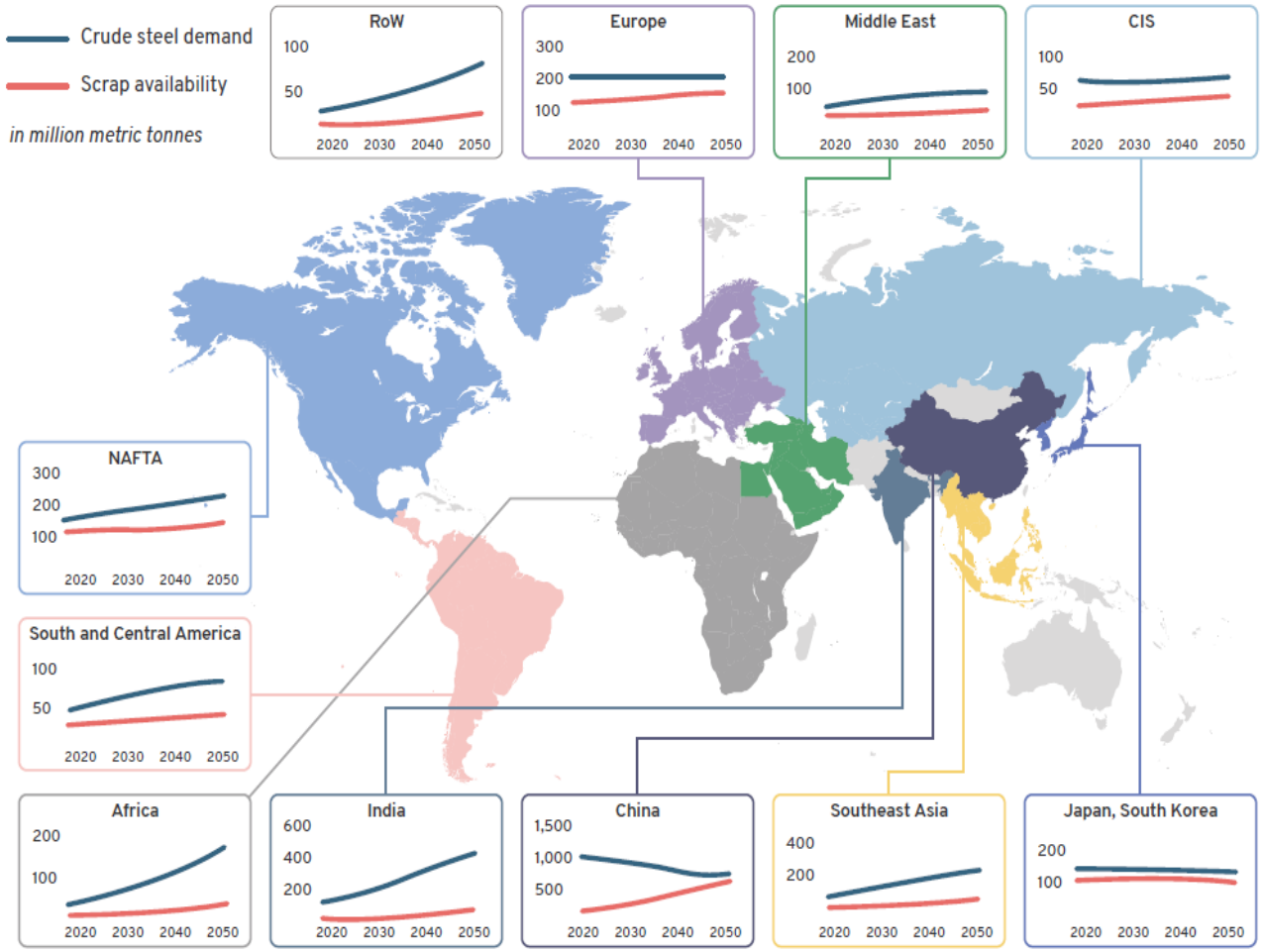
SCRAP QUALITY

A challenge for future steel production

metallurgical competence center

- Crude steel demand will be 30% higher in 2050 than it is today
  - Contribution of scrap in total steel charge will likely grow to 40% in 2050 from currently ~30%
  - 79.3 Mt of scrap used in EU (2022)
- Increasing share of post-consumer scrap will not allow 100% recycling for all high-quality steel grades





Sources: Mission Possible Partnership, Net-zero steel sector transition strategy (2021)
Worldsteel Association, Scrap use in the steel industry, fact sheet, 2021

SCRAP TRADING

EU as net scrap exporter

- Metallic tramp elements (e.g., Cu, Sn, Cr, Ni, Mo) prevent reuse of post-consumer scrap for some steel grades
- Surplus of low-quality scrap within the EU generates large scrap exports (EU as worldwide largest scrap exporter)
- 17.6 Mt scrap exported from EU-2027 in 2022 (19.2 Mt in 2023)
  - NED as main scrap exporter (3.9 Mt in 2022)
  - TUR and EGY as main buyers
- Higher quality scrap is imported into the EU to be used for steelmaking
  - 3.9 Mt in 2022

Motivation for R&D&I → Enable increased use of post-consumer scrap in steel industry

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Source: Bureau of International Recycling (BIR), World Steel recycling in figures, 14th edition (2023)

PURESCRAP PROJECT

Partners and main roles

The Clean Steel Partnership

SWERIM

REDWAVE

Sensor technology
Process control
Data analysis

LULEÅ UNIVERSITY OF TECHNOLOGY

SPECTRAL INDUSTRIES

DANIELI AUTOMATION

Tech partners

Sant'Anna
Scuola Universitaria Superiore Pisa

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Societal aspects

K1 MET
metallurgical competence center

Dissemination
Exploitation & IPR

PURE SCRAP

Scrap recycler

STENA RECYCLING

Steel producers

SSAB

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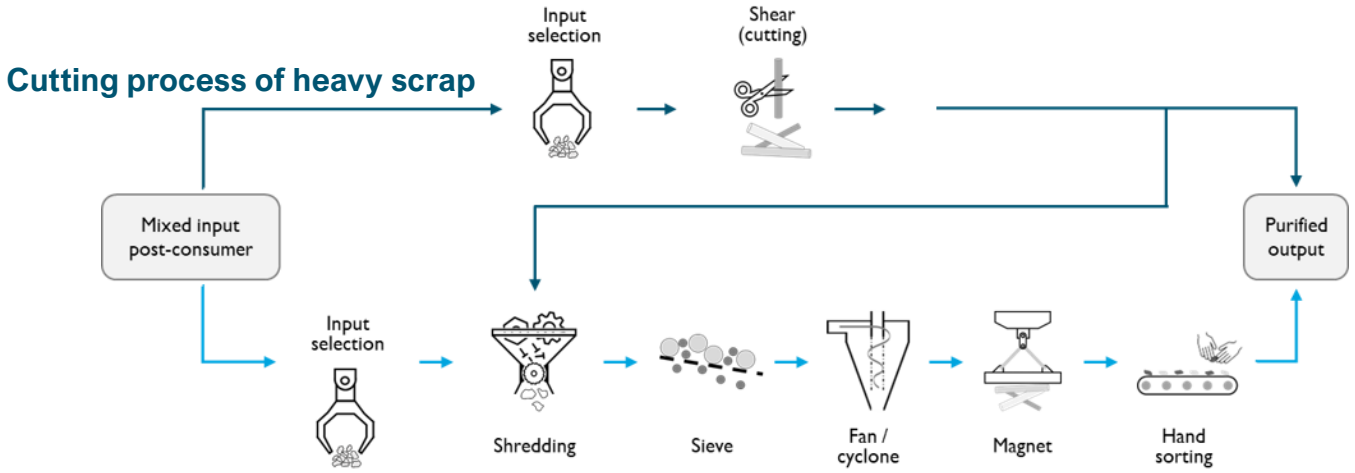
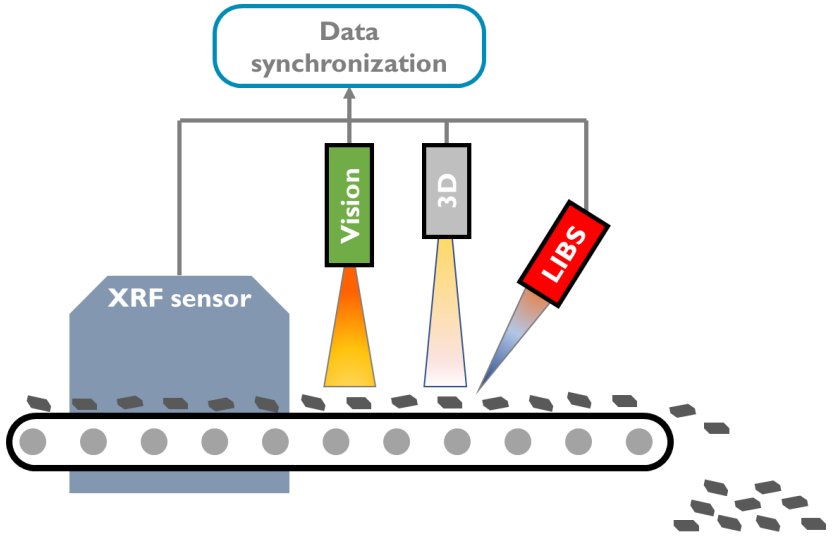
PURESCRAP APPROACH

Sensors for size, volume, and composition

Integration of PURESCRAP sensors into scrap processing chain



More detailed sensor application (example for shredded scrap shown below)



- Sensor stations to analyse heavy and shredded scrap
- Heavy scrap: Vision (camera + LiDAR) – Robot unit (for LIBS positioning) – LIBS – ICT network
- Shredded scrap: Camera – LiDAR + RGB-D camera – LIBS – XRF – ICT network

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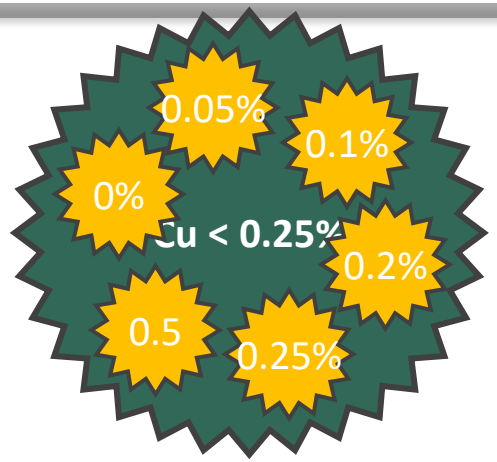
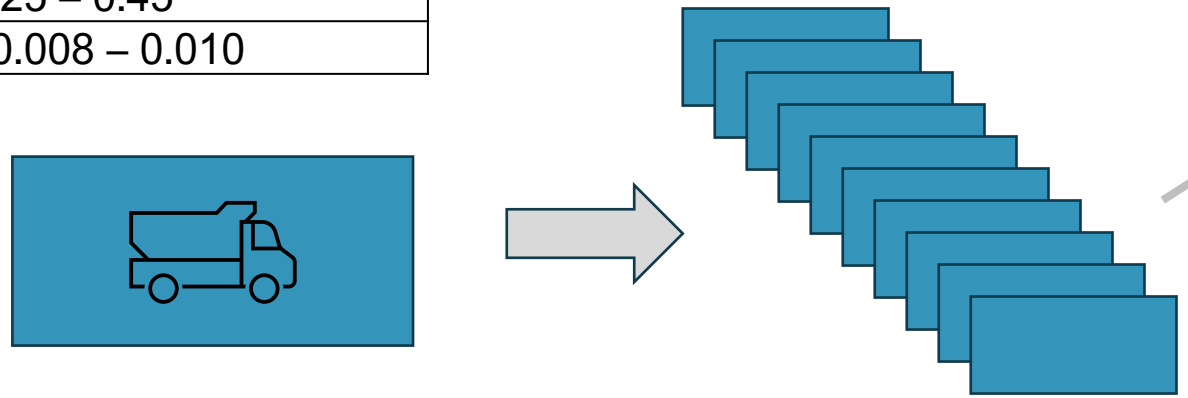
PURESCRAP CONCEPT

Batchwise analyses of scrap



Important Key Performance Indicators (KPIs)

Element	Range (wt.%)
Cu	0.05 – 0.10 – 0.15 – 0.20 – 0.25
Ni	0.05 – 0.15 – 0.25 … 1
Mo	0.05 – 0.25 – 0.45
Sn	0.005 – 0.008 – 0.010



Recycler

Steelworks

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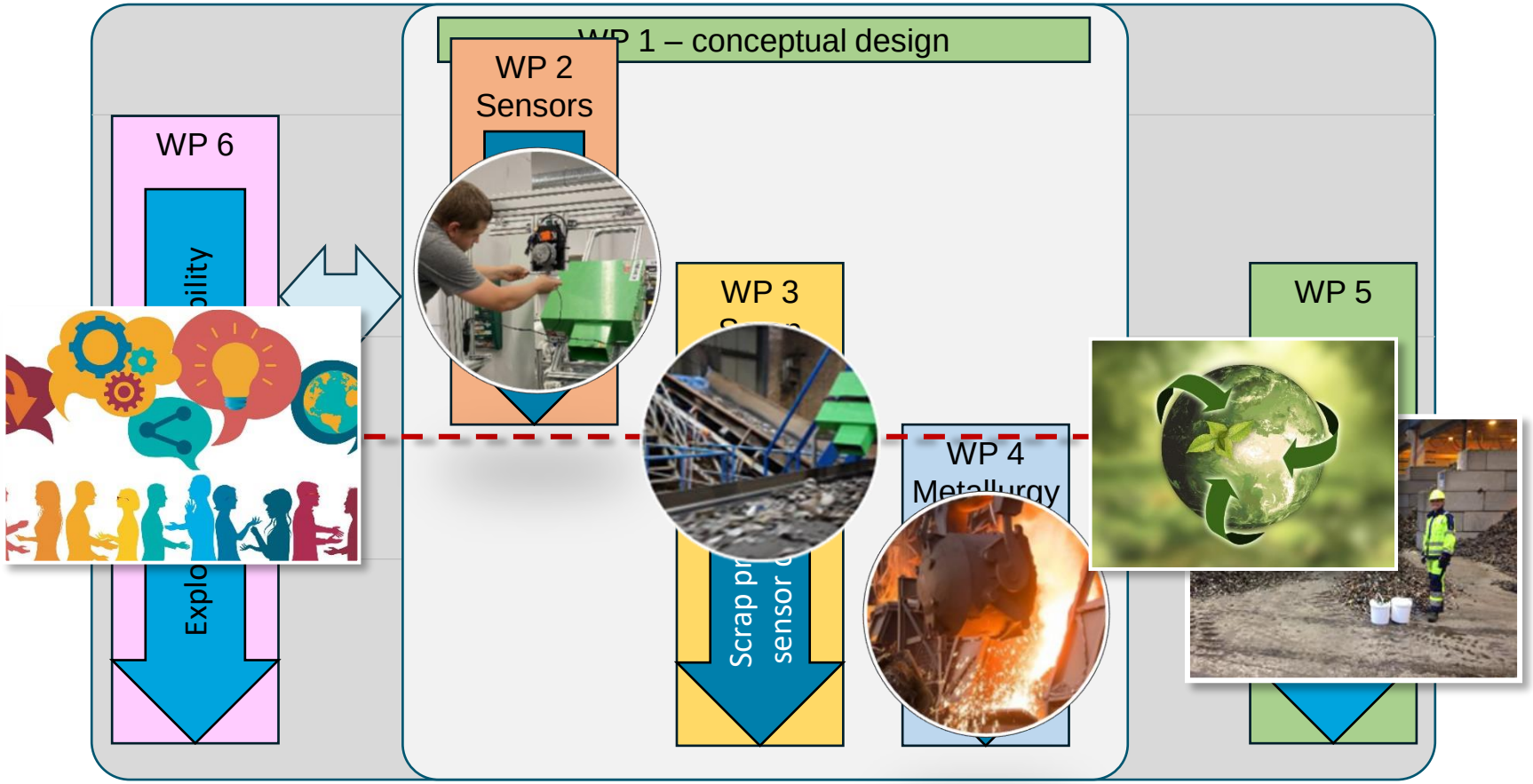
PROJECT STATUS



Month 1 of 42
(January 2023)

Month 22 of 42
(October 2024)

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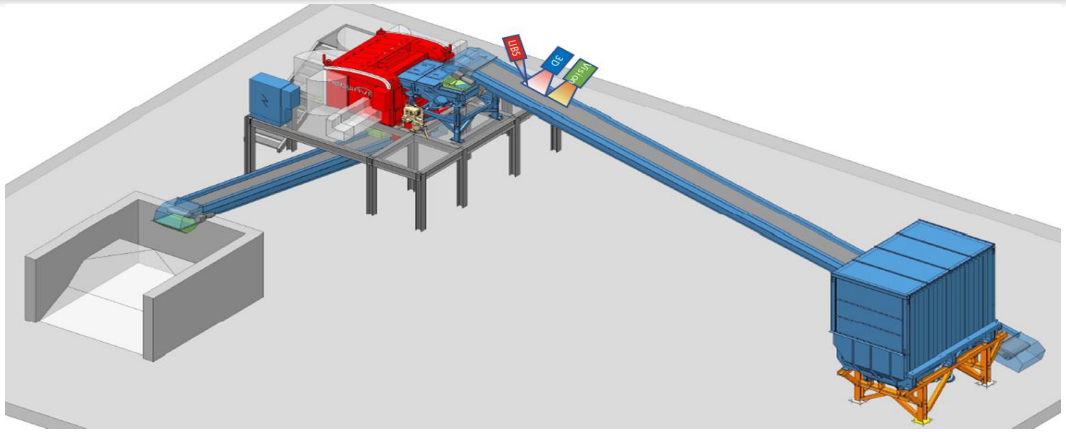
SENSORS COMBINED WITH SCRAP ANALYSIS

Test station for shredded scrap analysis

System	Status
Feeder and belt	✓ Ready
Belt control system (PLC)	✓ Electrical connections ☐ Interface with server (belt status)
Server	✓ Installed and ready (waiting for PLC connection)
XRF	✓ Machine installed
LIBS	✓ Mounted and connected ☐ Finetuning needed
Camera	✓ Mounted and connected ☐ Training for image analysis
3D	✓ Mounted and connected ☐ Training for volumetric analysis



The first batch of complex Fe scrap passed through the system

Testline for training and evaluation of sensor systems for shredded scrap

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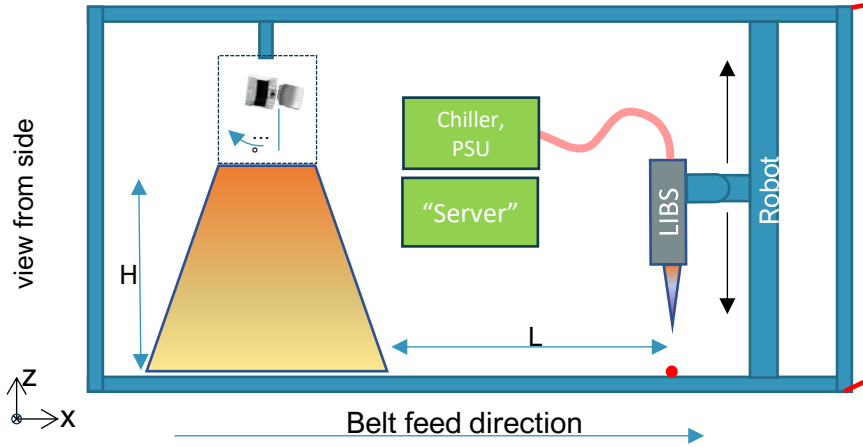
SENSORS COMBINED WITH SCRAP ANALYSIS

Sensor station for heavy scrap analysis

All devices and initial test activities are started.

Material handling: **feeder, conveyor**

Sensors: **3D, LIBS (on robot)**



Arrangement of 3D sensor and LIBS sensor for heavy scrap analysis
LIBS-robot is guided by the 3D sensor

Planned real sensor station arrangement for heavy scrap

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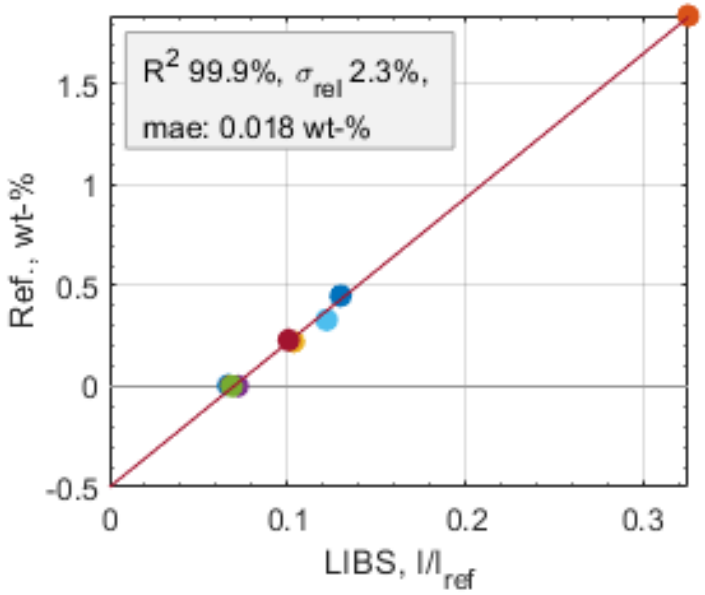
SENSORS COMBINED WITH SCRAP ANALYSIS

Sensor station for heavy scrap analysis

Analysis station for heavy scrap - ongoing mounting of parts

Cleaning effect on rusted samples



Calibration for Mo, 180 ppm absolute error

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OUTLOOK ON SCRAP USE FOR STEELMAKING

Melting of the sorted scrap and steel quality analysis

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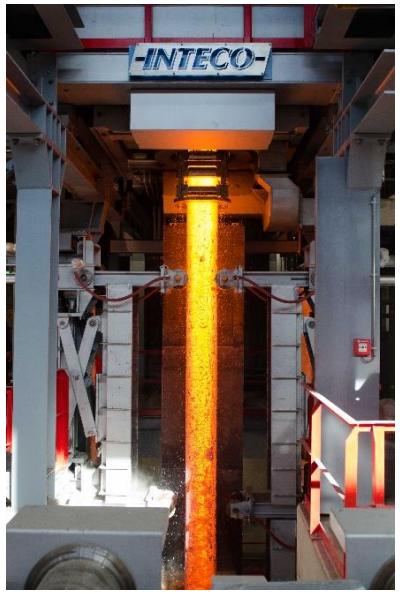
Induction Furnace (5t capacity)

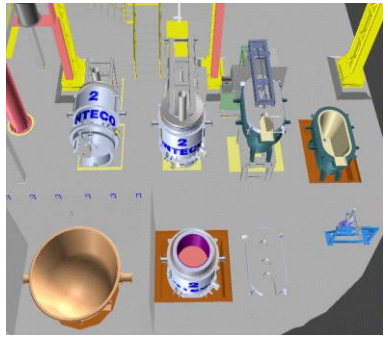
Ladle Treatment (Ladle Furnace + Vacuum Degassing)

Caster (Vertical continuous line)



Round casted material (Ø 230 mm) or ingots (270x360 mm)

Peripherals



Ladle and tundish management and firing, dust separation

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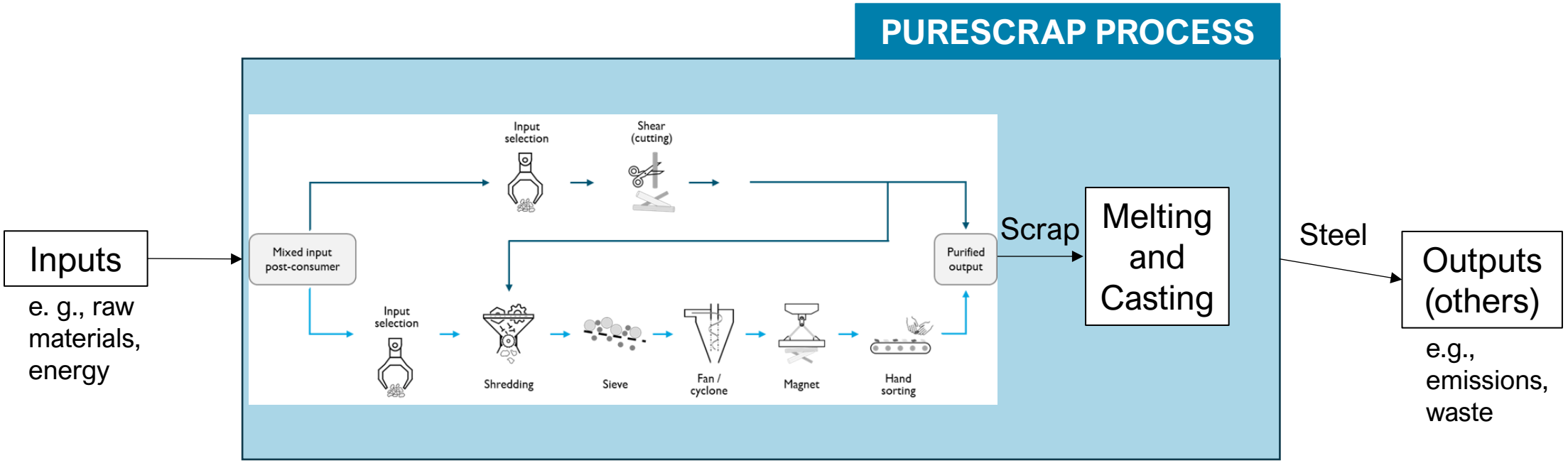
ENVIRONMENTAL IMPACT ASSESSMENT

Life Cycle Assessment (LCA) & Life Cycle Costing (LCC)

- Environmental and economic impact assessment for reuse of post-consumer scrap
- Definition of final goals and scope as 1st step (discussions currently ongoing)
  - Functional unit: production of 1 ton crude steel
  - System boundaries: cradle-to-gate



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Thank you! Questions?

K1-MET: Johannes Rieger*, Melanie Leitner (*johannes.rieger@k1-met.com; T: 0043 664 8832 2499)

SWERIM: Jonas Petersson

Scuola Superiore Sant'Anna: Valentina Colla, Alice Petrucciani

Luleå University of Technology: Anton Koval, Jan Niemi

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