CAESAR HEU project

CirculArity Enhancements by Low quality Scrap Analysis and Refinement

ESTEP annual event

A Circular Economy driven by the European Steel

04/10/2023, Barcelona, Spain

Funded by the European Union

Grant N°: 101058520

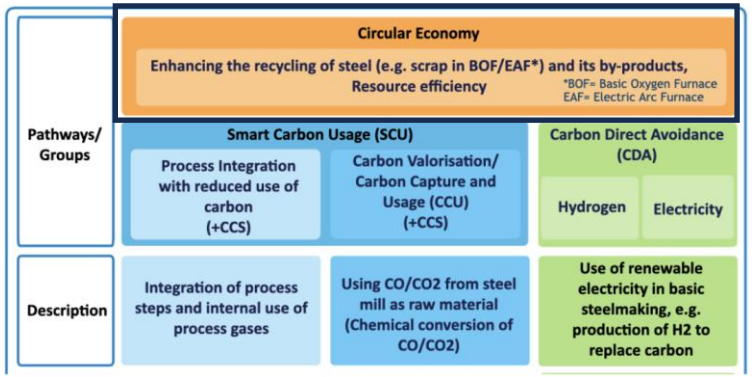
CAESAR

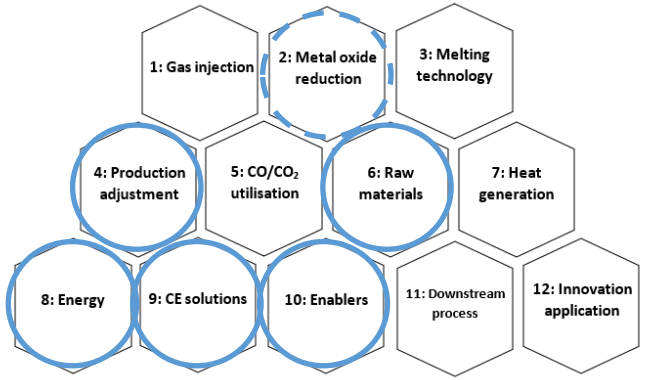
European project (Horizon Europe – Clean Steel Partnership)

Challenges to keep the EU steel sector competitive at global level and climate-neutral, in line with the European Green Deal and the CleanSteel Partnership.

Stakes :

- EU Steel industry has to drastically reduce CO_2 emissions
- Producing steel from iron ore consumes ~4 x more energy and produces 4 times more CO_2 than from metallic iron
- Pre-consumer scrap represents ~45% of the scrap used worldwide
- ~55% comes from other processes and contains various type of pollutant (inert materials, other metals, plastics, etc.) → post-consumer scrap
- Current trend: decrease in the pre-consumer scrap and an increase in the short- and long-term of the post-consumer scrap stream.
- Nowadays, “low-quality” scrap not suitable for most steelmaking applications.





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CAESAR

European project (Horizon Europe – Clean Steel Partnership)

Consortium
CRM (B) - Coordinator
AMMR (F)
AMBCRC (S)
AMBD (L)
AMBe (B)
AMF (F)
AM Sestao (S)
Rolanfer (F)
Reydesa (S)
Inatec (S)
Azterlan (S)
Tomra Sorting (G)
KUL (B)

Duration
48 months
Starting in June 2022

CRM Contact
JC.Pierret

Total budget = 8029 k€
Maximum Grant = 6295 k€

Title : CirculArity Enhancements by Low quality Scrap Analysis and Refinement

Objectives :

- ✓ to identify new opportunities to use and reuse lower-quality scrap through a better comprehension of the scrap market and the opportunities provided by advanced characterization, sorting and cleaning technologies;
- ✓ to support the production of high-quality steel products in the **EAF** and the increase of scrap rate at the **converter**;
- ✓ to develop and implement an industrial demonstrator of scrap sorting/cleaning based on innovative combination of best available technologies.

This project deals with enhancement of post-consumer scrap and addresses in particular:

- Mapping of scrap market and assessment of grades being exported out of EU;
- Characterization of these scrap grades;
- Optimization of primary treatment (shredding, cleaning, magnetic separation, shearing);
- Validation of advanced multi-step upgrading;
- Advanced sorting ;
- On-line characterization (XRF, hyperspectral technics);
- Valorisation of residues: non-ferrous metals, carbonaceous material and mineral fraction;
- Industrial validation of quality improvement.

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Consortium

- 3 steelmaking sites: 2 BOF, 1 EAF
- 6 R&D centers/university
- 2 metal recyclers (with shredding/shearing and sorting equipment)
- 2 technology developers with specific cleaning technologies

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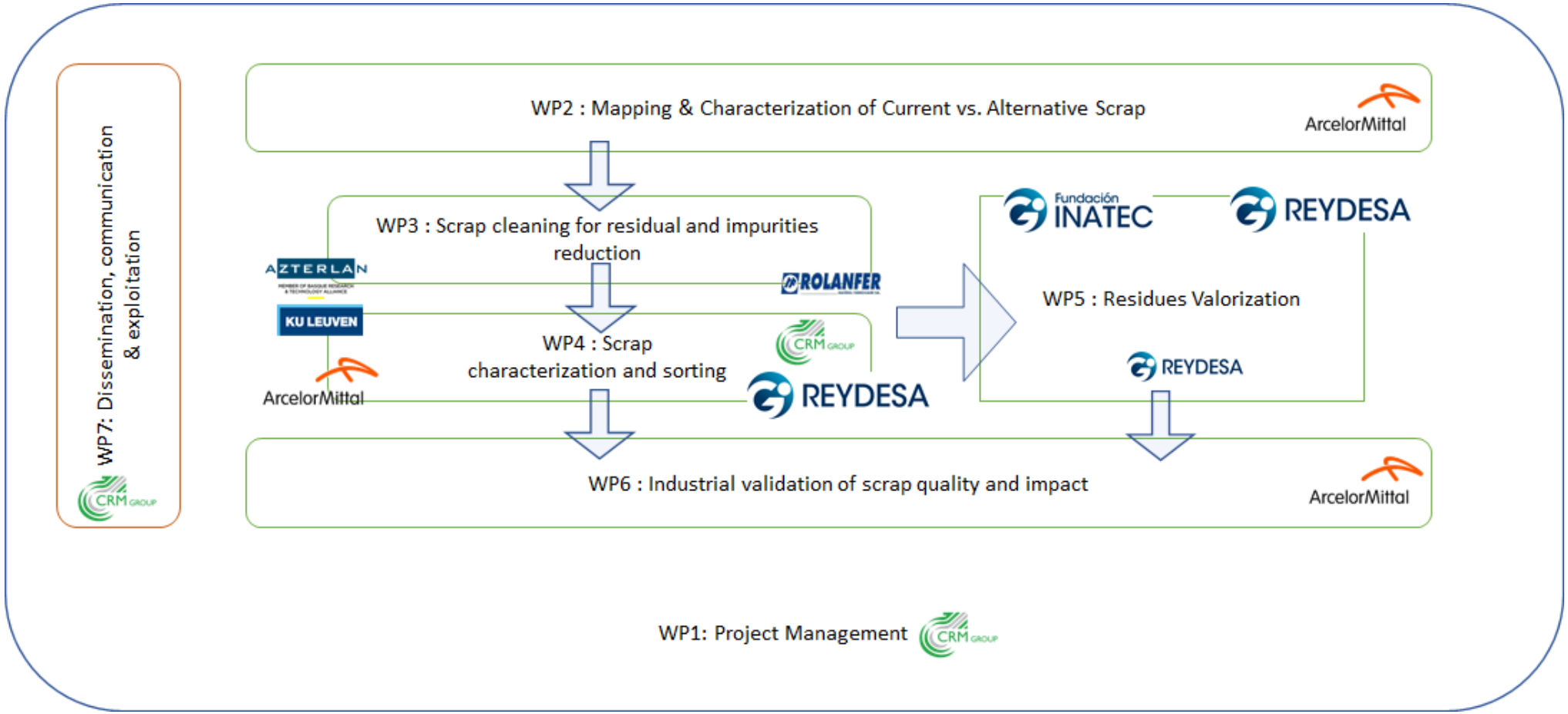
Work program



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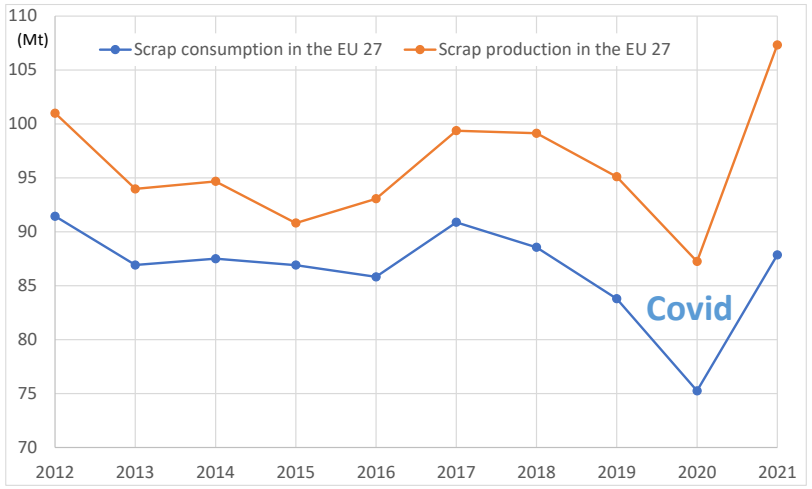
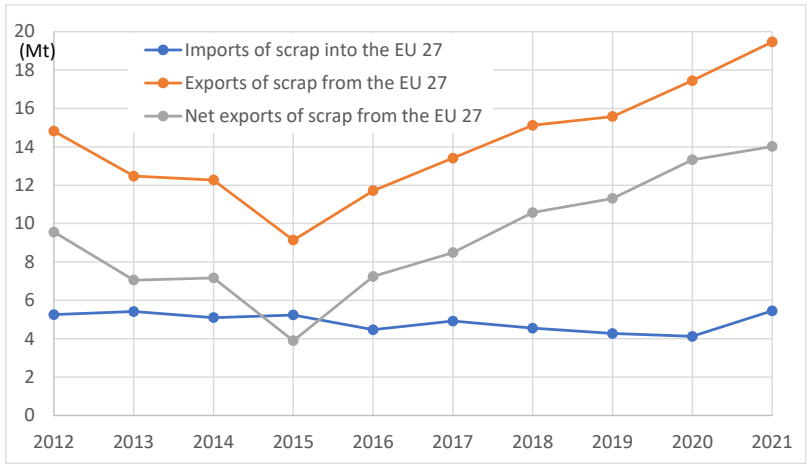
Mapping and characterization of current and alternative scrap



- EU produces lot of scrap
- Variations agree with the global economy of Europe
- Gap between scrap produced and consumed in EU 27
- This gap widens since 2015



Scrap production higher than consumption → Europe is exporting scrap
Scrap imports in Europe remains at low level → EU 27 is net exporter
Phenomenon is increasing with time

Ferrous scrap is by far the first “waste” exported from the EU27.

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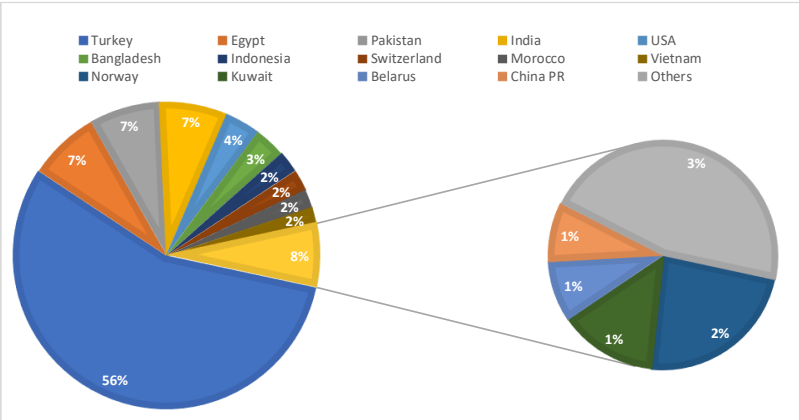
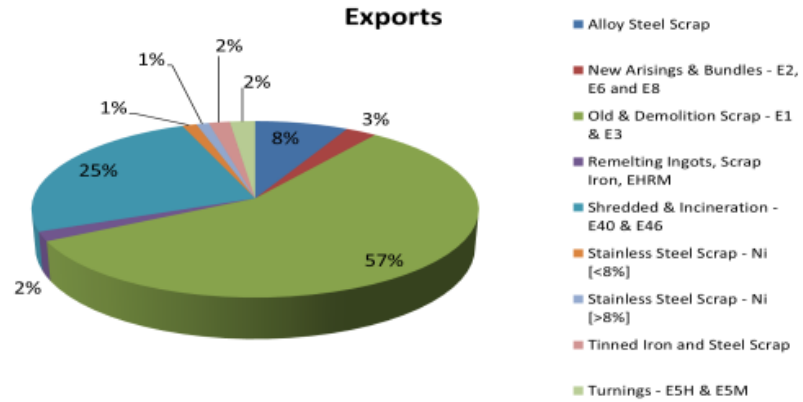


2021:

- Turkey imported 2/3 of ferrous scrap leaving Europe
- Then came Egypt, Pakistan, the USA, Switzerland, India and Moldova.

Almost same ranking in 2018

China, (1st world scrap user) takes only 1% of EU exportations.



~20Mt scrap could be used in EU industry without import but:

- < 10% of the scrap exported outside Europe is new scrap.
- > 90% are post-consumer scrap of rather poor quality (E1 & E3 are major grades exported).

➔ To be able to use such scrap grades to produce steel sheets, need to find technical solutions to upgrade them.

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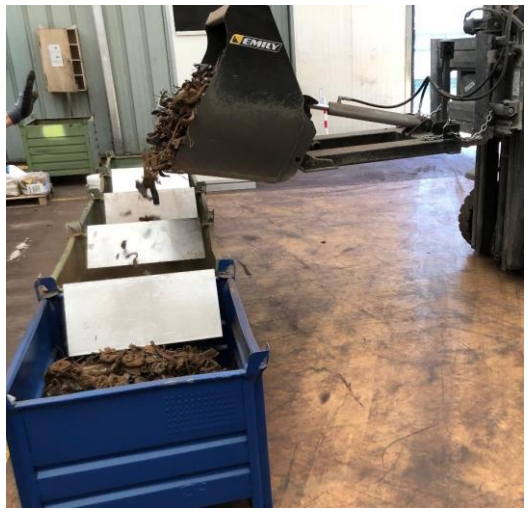
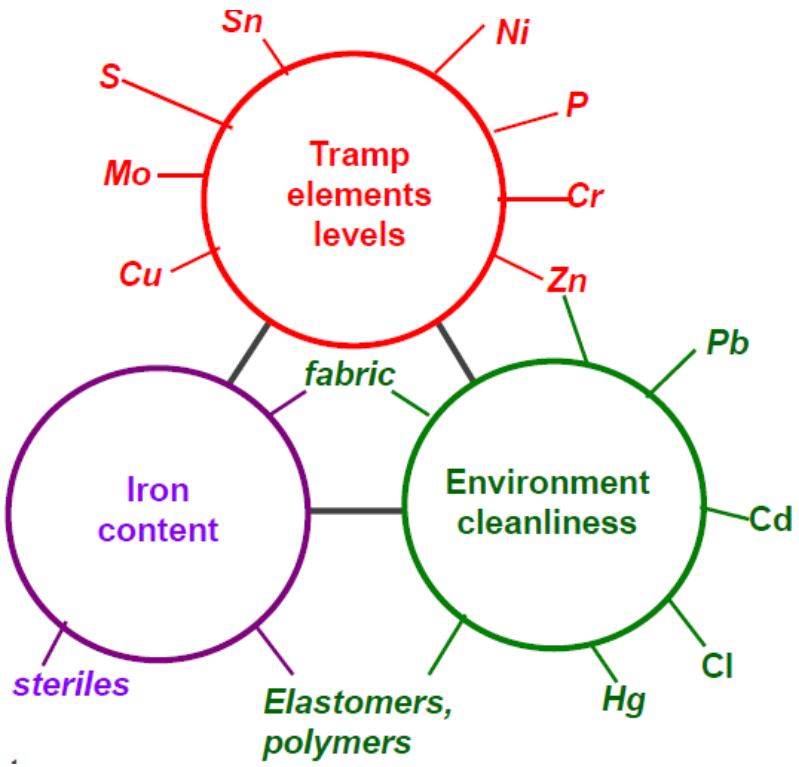
Mapping and characterization of current and alternative scrap

Scrap sampling is complex:

- Sampling is essential to make characterizations and calculate ViU
- Scrap fragments are for some grades rather large (> 1 m for E1, E3, E2, E8),
- Old collected scrap (E1, E3) are very heterogeneous
- scrap cannot be grinded in fine powder.



Sampling on site



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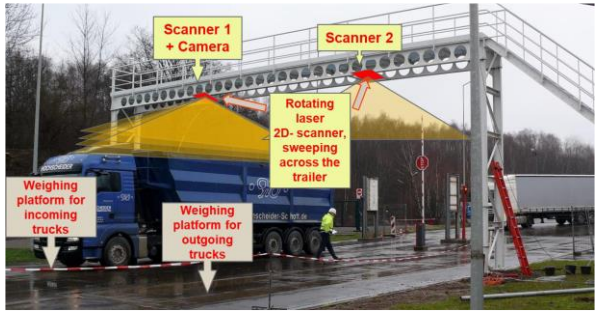
Mapping and characterization of current and alternative scrap

Scrap Characterization :

- Scrap piles bulk density
- Scrap density/volume in truck or wagon
- Scrap true density
- Size distribution
- Chemical content:
  - Hand sorting
  - Portable analyzer
  - Magnetic separation
  - Shredding
  - Lab melting tests
  - Industrial melting tests



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- Chemical content:
  - Hand sorting
  - Portable analyzer
  - Magnetic separation
  - Shredding
  - Lab melting tests
    - 100 – 350kg induction furnaces
    - CRM 1t plasma/EAF/SAF furnace
    - AMMR 6t pilot EAF
  - Industrial melting tests
    - AM Sestao plant

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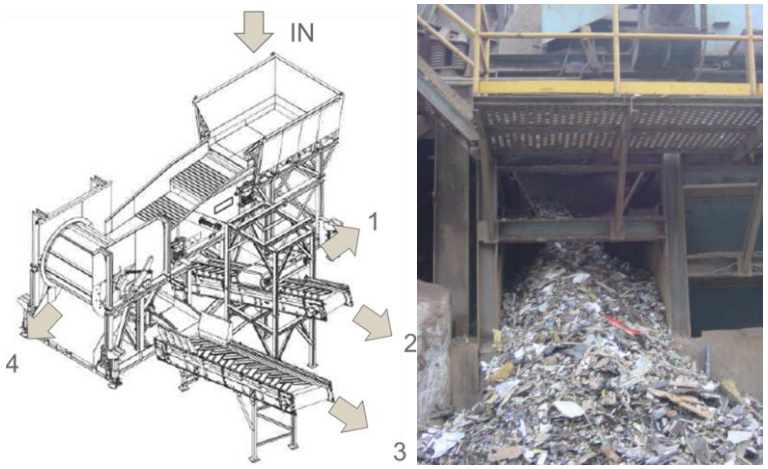
Scrap cleaning for residuals and impurities reduction

Primary treatment optimization on E1, E3, HMS and E40
combination of shearing, shredding, magnetic separation and screening processes at partners premises (Rolanfer and Reydesa) as well as on steel plants (cleaning machines).



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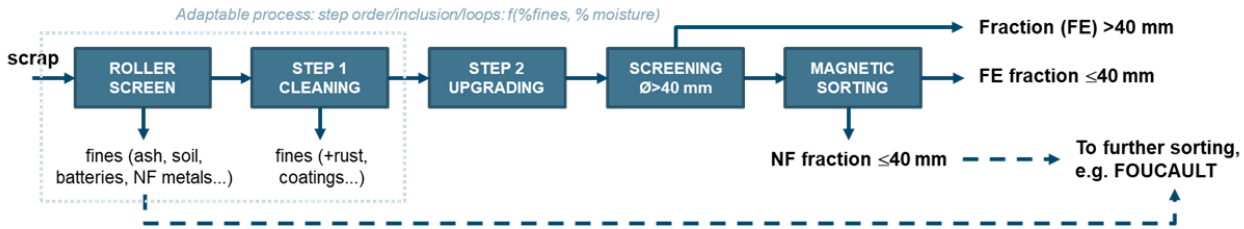
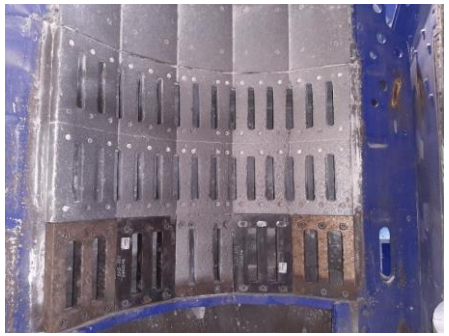
Scrap cleaning for residuals and impurities reduction

Advanced scrap cleaning

- Aspartel technology (E46 and E40)



- BHS Rotoshredder (E40)



- Kubota vertical shredder

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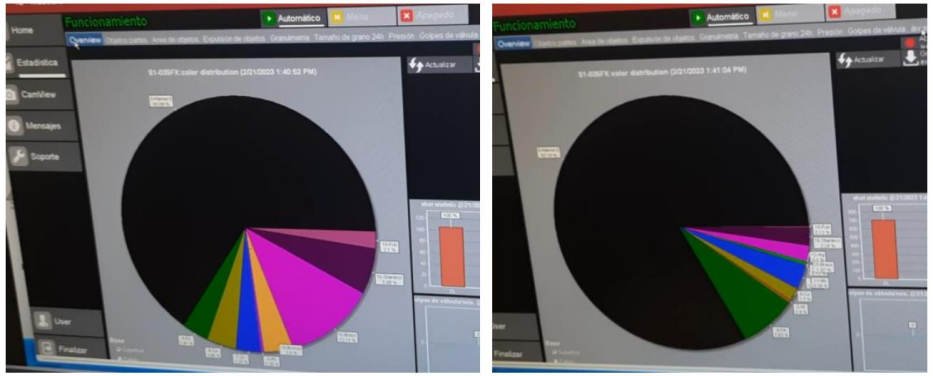
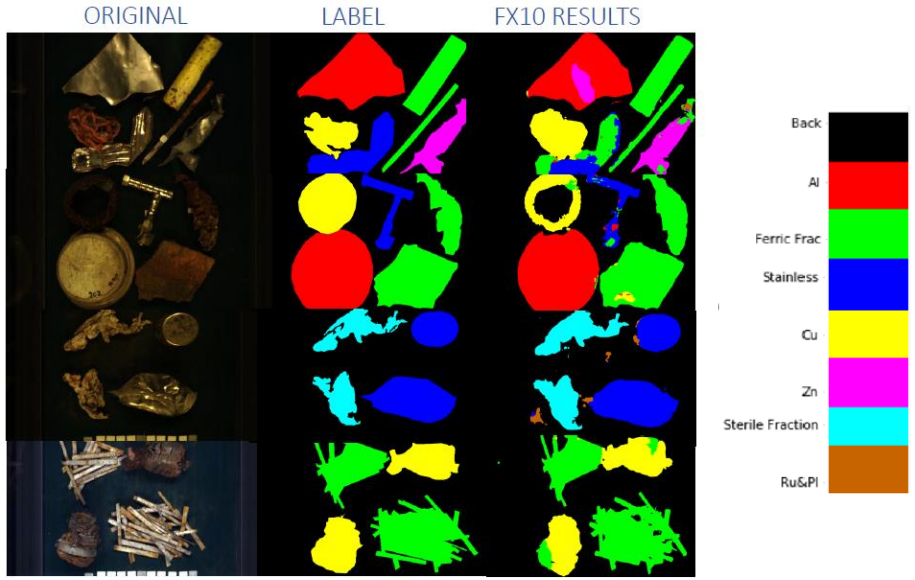
Scrap characterisation and sorting

Characterization/sorting means:

- XRF technology
  - On-line (piece by piece) characterization



- Vision and hyperspectral technologies
- Libs technology
- A.I. (neural network) to sort or detect steel scrap
- Density
- Magnetic…



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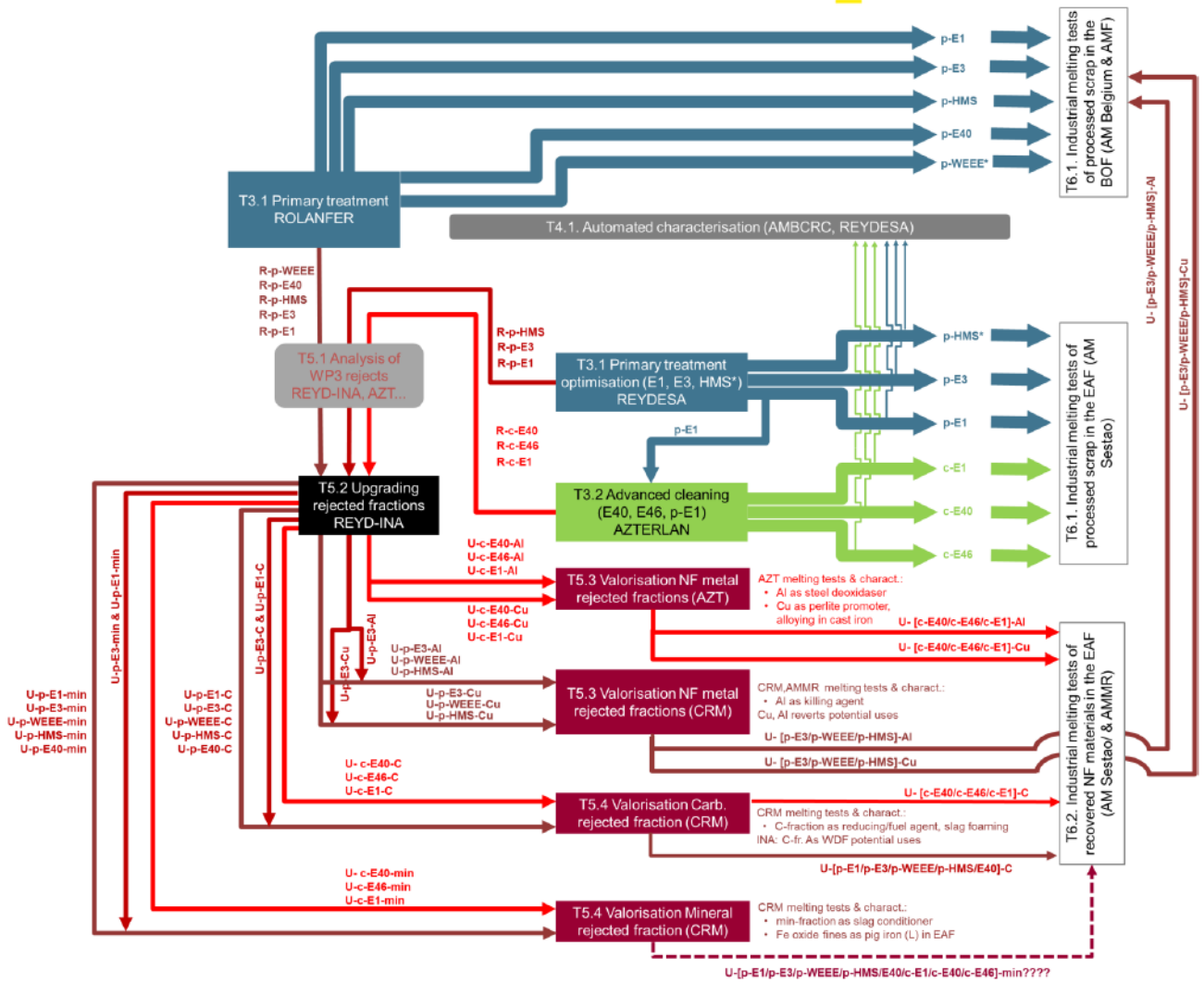
Residues' valorisation

Project aims to valorize all the treatment by-products:

- Non-ferrous metals
- Carbon bearing materials (plastics, wood…)
- Mineral fraction

Work on the optimization of separation steps



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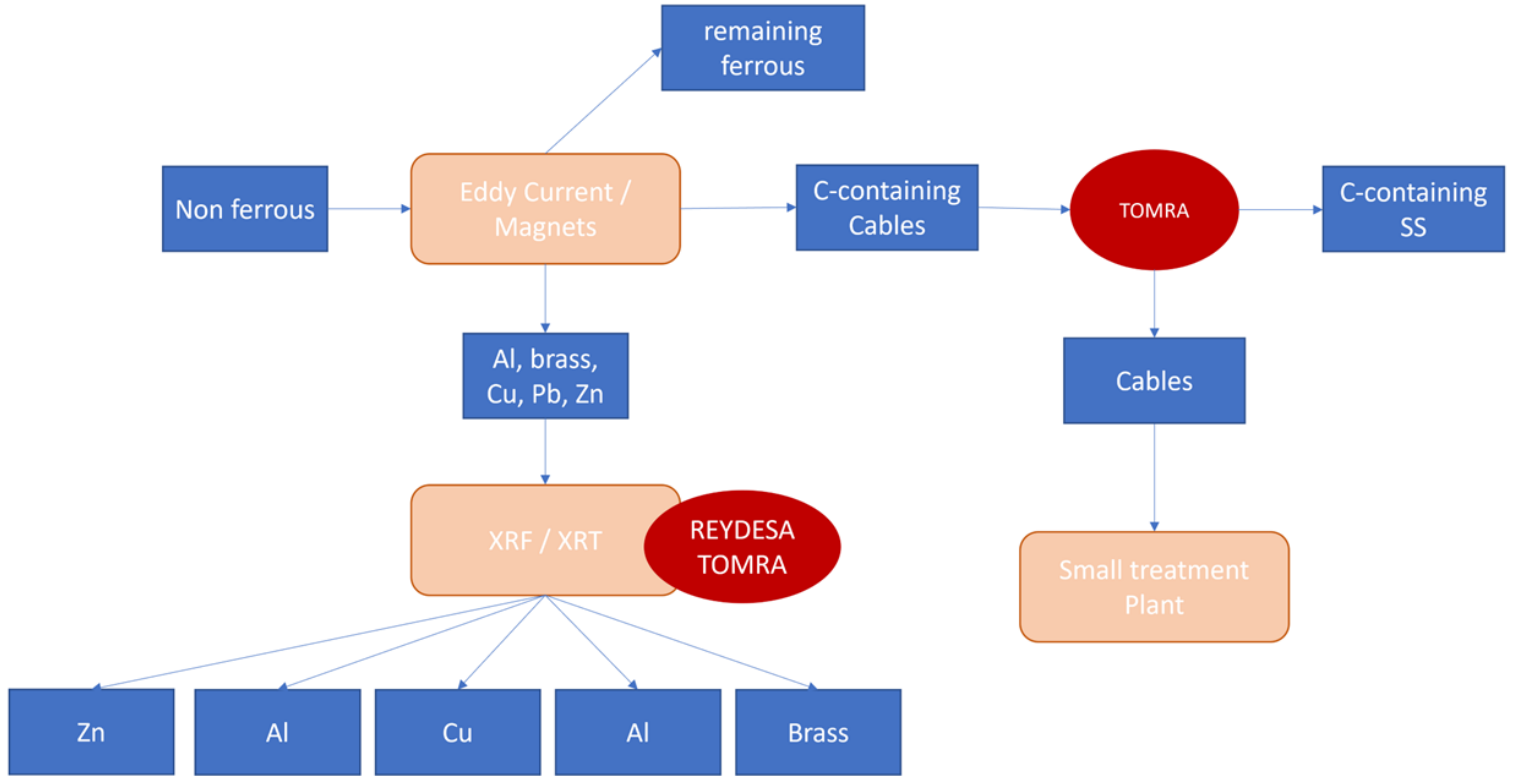
Residues' valorisation

Non-ferrous metal fraction separation:

- Stainless steel
- Aluminum
- Copper
- Brass
- Zinc
- Lead



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Residues' valorisation

Carbon-bearing material to be recovered as coal replacement or as waste derived fuel depending on specifications

Mineral fraction :

- Applicability in steelmaking processes (slag conditioner…)
- External valorization
- Recovery of metals by smelting reduction (alternative ore)

Example, shredding filter dust

C-bearer material

Alternative ore

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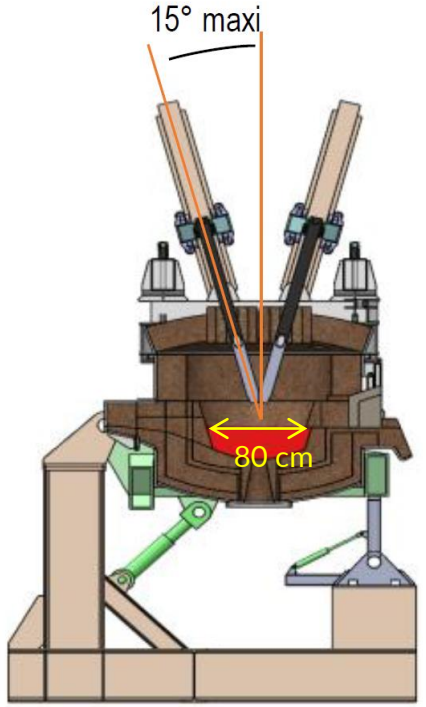

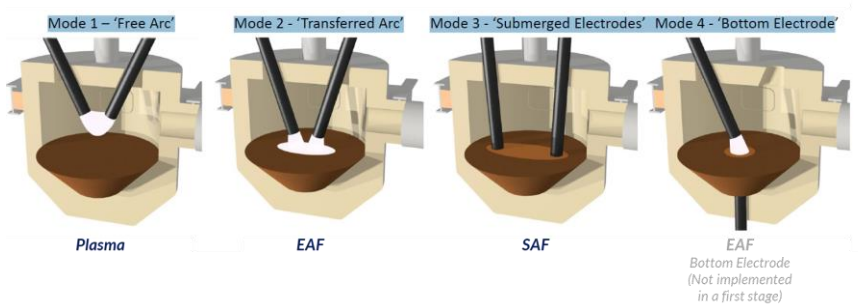

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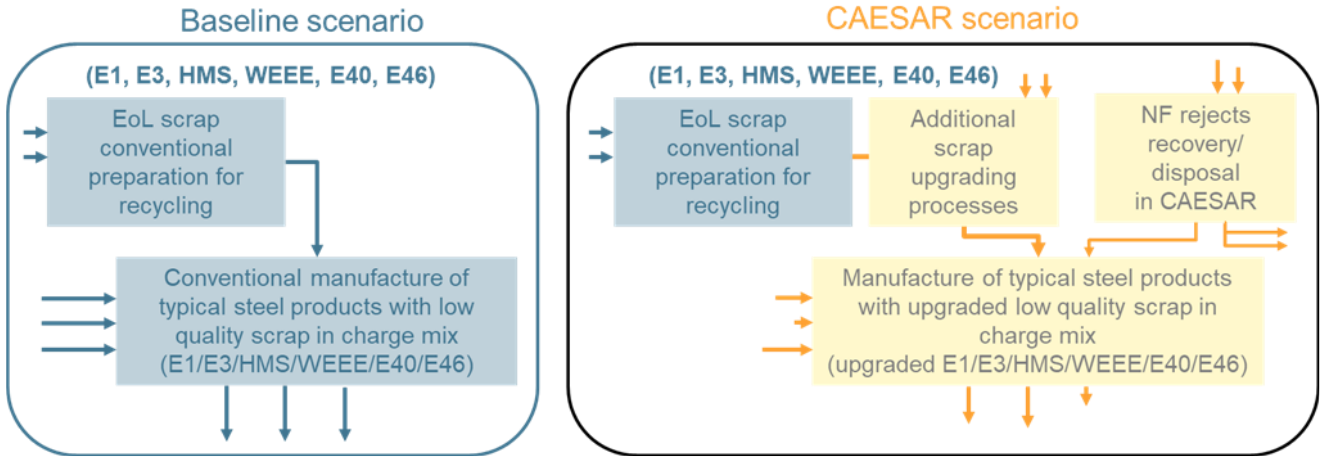
Industrial validation of scrap quality and impact

Industrial melting trials performed at AM Sestao, Fos and Gent plant on raw low-quality scrap.

Optimized treatment scheme will be validated at real-size on bot EAF and BOF

LCA analysis



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CAESAR HEU project

The research leading to these results has been performed within the CAESAR project (website address) and received funding from the European Community's Horizon 2020 Programme (RFCS) under grant agreement n° 101058520

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