Life Cycle Assessment methodologies for multi-functionality in the steel sector through HIsarna and ReclaMet examples

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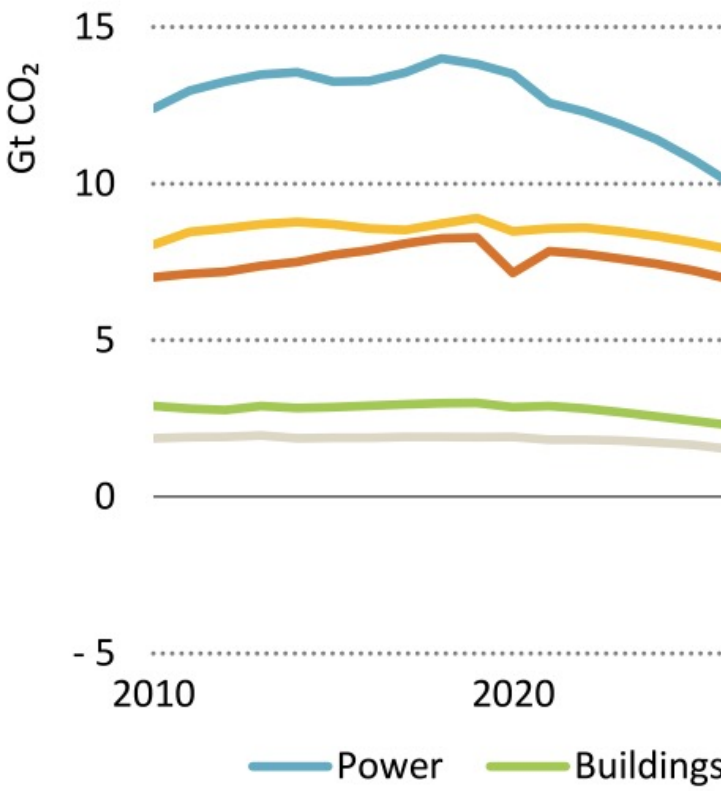
AGENDA

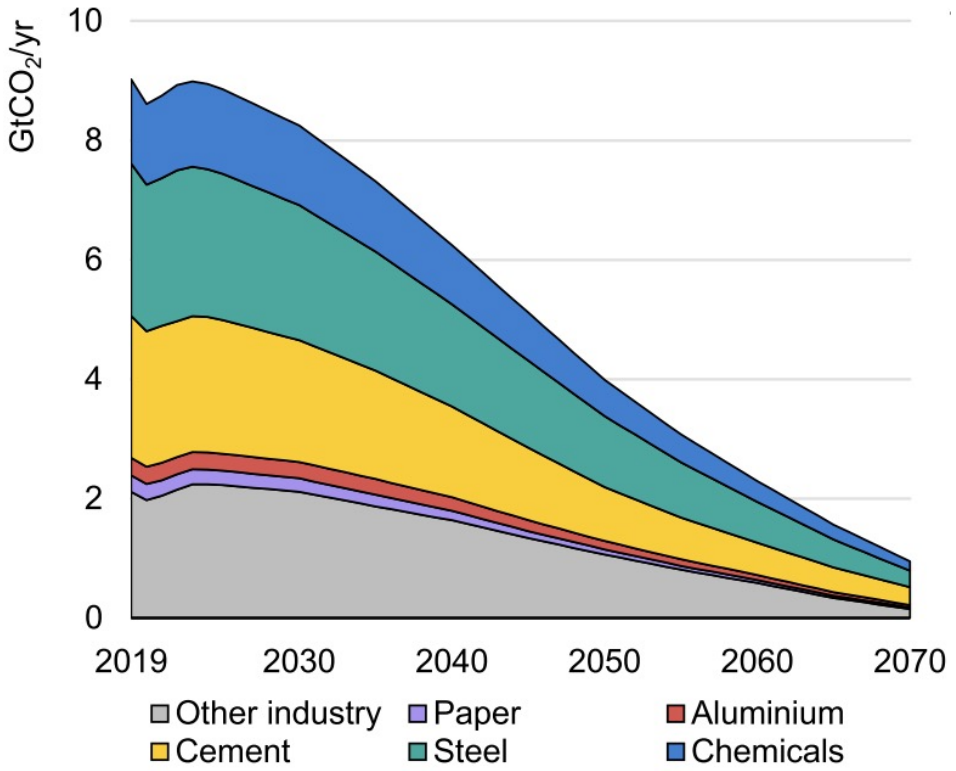
1. Introduction
2. LCA and multi-functionality
3. ReclaMet Project

Introduction

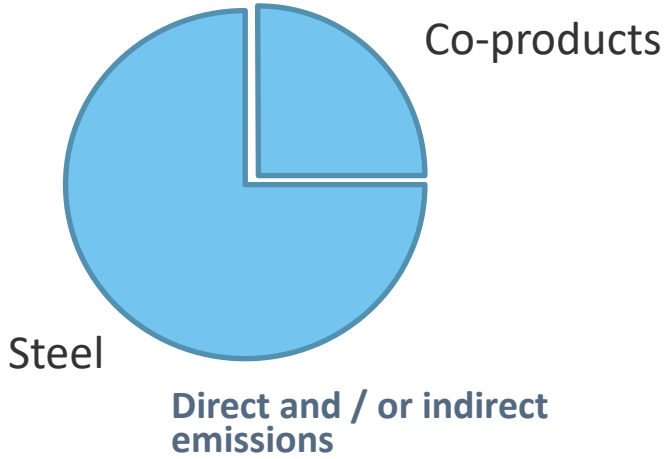
ACCOUNTING FOR STEEL INDUSTRY CO-PRODUCTS

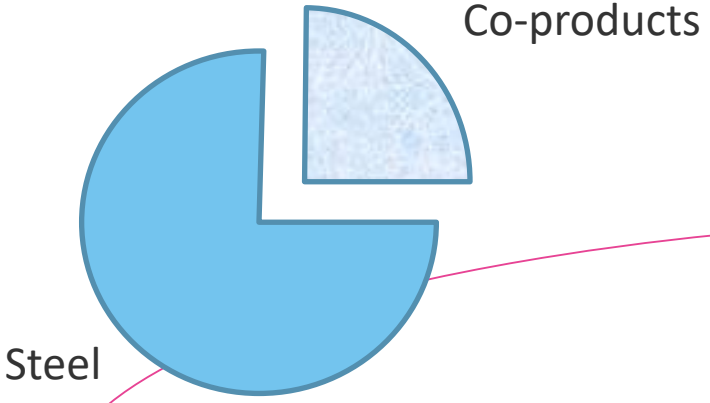


CO2 emissions by sector in the NZE (Net Zero Emissions)
IEA. (2021). *Net Zero by 2050 - A Roadmap for the Global Energy Sector*.

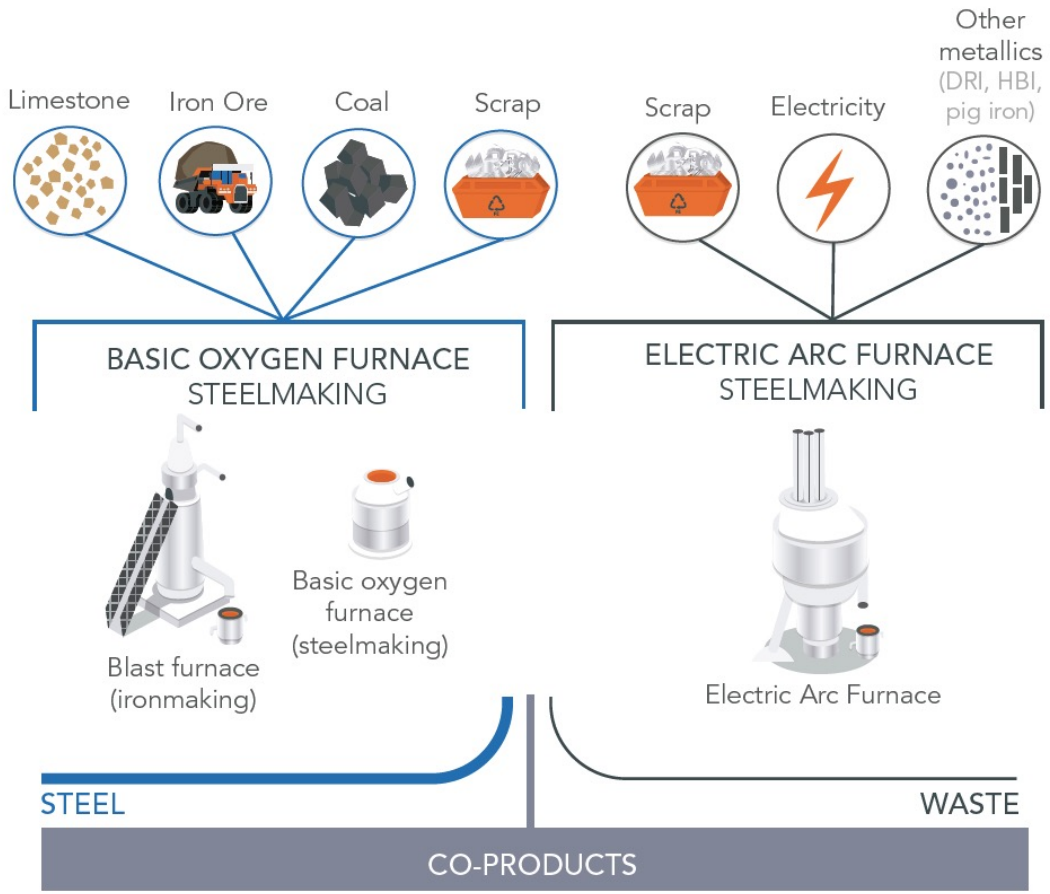


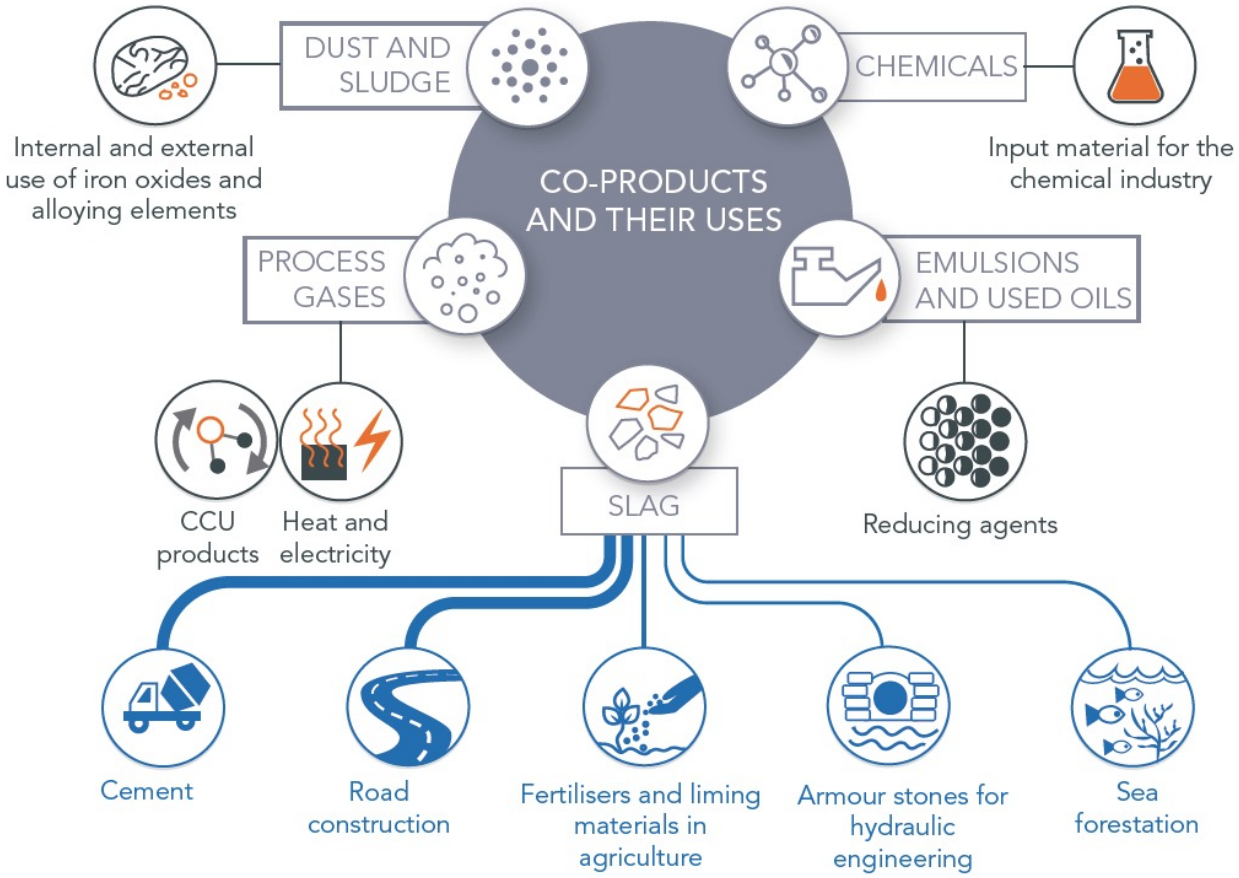
Global direct CO2 emissions in industry by sub-sector and region in the Sustainable Development Scenario, 2019-70
IEA. (2020). *Energy Technology Perspectives 2020*.





STEEL INDUSTRY CO-PRODUCTS





Net Zero Steel Pathway Methodology Project report (2021)

eit RawMaterials Connecting matters

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LCA and multi-functionality

MULTI-FUNCTIONALITY

Most systems are multi-functional. A steelmaking site produces steel and co-products like slag and process gases.

When we need to know the environmental impact of one of those co-products, like the process dust, the total emissions of the system need to be split between the main product and the co-product/s.

How can they be split?

STANDARDS APPROACHES FOR CO-PRODUCTS

Subdivision

System expansion/ substitution

Allocation

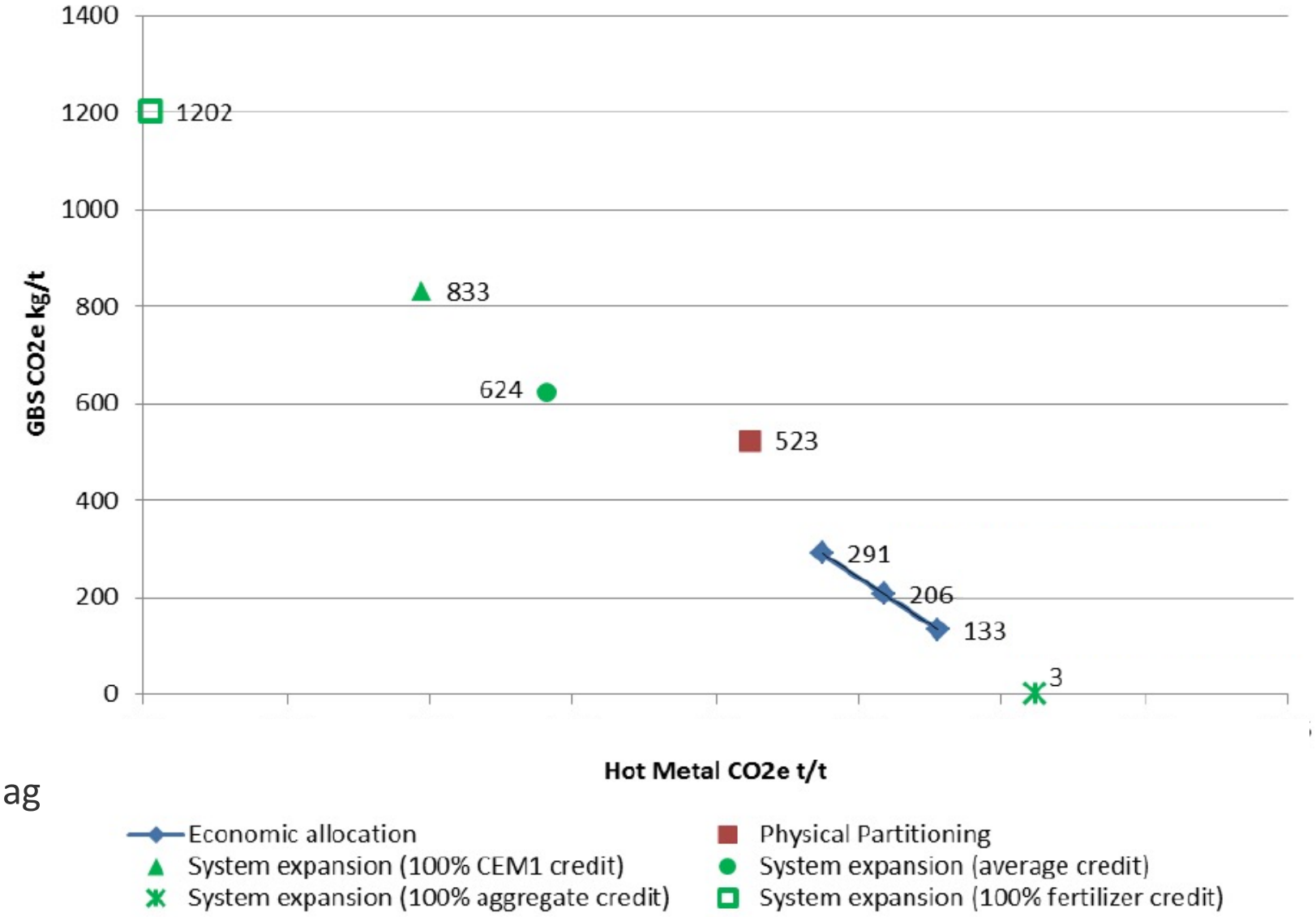
- mass allocation
- economic allocation

	ISO 14044	ISO 20915	ISO 21930	PEF	EN 15804
System expansion	1st	1st	1st (when the LCI of co-product is not needed)	1st	Not mentioned but upstream data 'out of your control' can follow ISO 14044
Physical partitioning /sub division	2nd	2nd	2nd	2nd	1st
Economic allocation	3rd	3rd	3rd	3rd	2nd

LIFE CYCLE INVENTORY CALCULATION METHODOLOGY: ISO 20915

Steel co-product	Co-product function	Avoided production
Blast furnace slag, basic oxygen furnace slag, electric arc furnace slag	Cement or clinker production	0,9 tonne per tonne of cement. Portland cement (CEM I)
	Aggregate or roadstone	Gravel production
	Fertiliser	Lime production
Process gas (coke oven, blast furnace, basic oxygen furnace, off gas)	Heat production for internal or external use	Coal, heavy fuel oil, light fuel oil or natural gas
	Electricity production	1MJ gas = 0,365 MJ electricity
Electric arc furnace dust	Zinc production	1 kg dust = 0,5 kg Zinc
Electricity from energy recovery	Electricity production	Electricity production
Steam from energy recovery	Heat generation	Steam production from natural gas 85 % efficiency
Hot water from energy recovery	Heat generation	Steam production from natural gas 85 % efficiency
Ammonia	Any ammonia application	Ammonia production
Ammonium sulfate	Any ammonium sulfate application	Ammonium sulfate production
Benzene	Any benzene application	Benzene production based on different technologies
BTX	Any BTX application	Benzene production based on different technologies
Scales	Metallurgical input to steel-making	Iron ore extraction
Sulphuric acid	Any sulphuric acid application	Sulphuric acid production
Tar	Any tar application	Bitumen production
Used oil	Heat generation	Coal, heavy fuel oil, light fuel oil or natural gas
Zinc	Any zinc application	Zinc production
Zinc dust	Any zinc application	Zinc production
Electrode	Electrode making	Electrode mix

STEEL SECTOR EXAMPLE



GBS: Granulated Blast furnace Slag
Indicative figures only

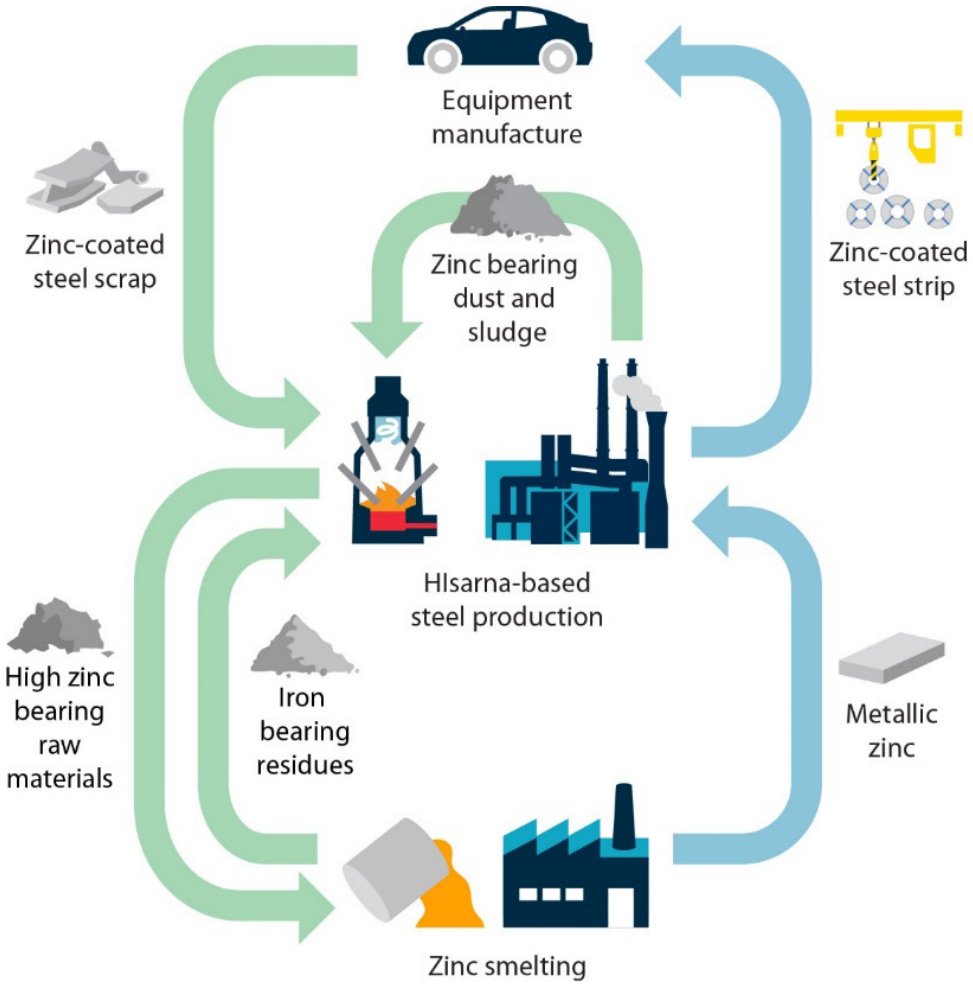
EUROFER

Analysis done by EUROFER

ReclaMet Project

RECLAMET

RECLAiming valuable METals from process residues with the HIsarna process



Project Partners

TATA STEEL (project leader)

CRM GROUP

nyrstar

TU Delft Delft University of Technology

LCA GOAL & SCOPE

Goal

Assess the potential environmental impacts of the ReclaMet system, considering a number of different Zn-rich feedstocks

By comparing to a 'baseline HIsarna' scenario

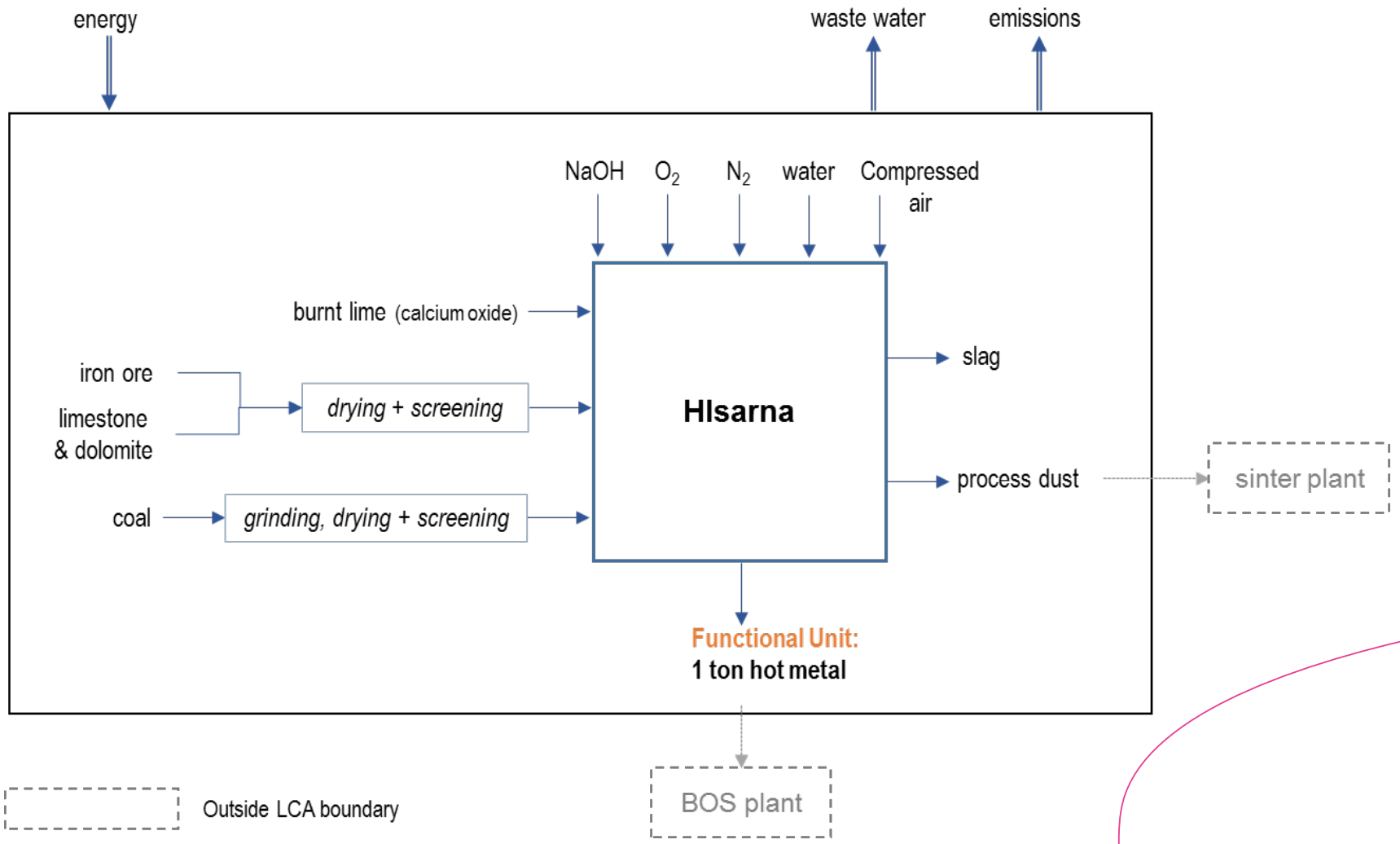
Scope

- Cradle-to-gate LCA study
- Scales: 60,000t/yr for the pilot plant and 1,500,000t/yr at full scale

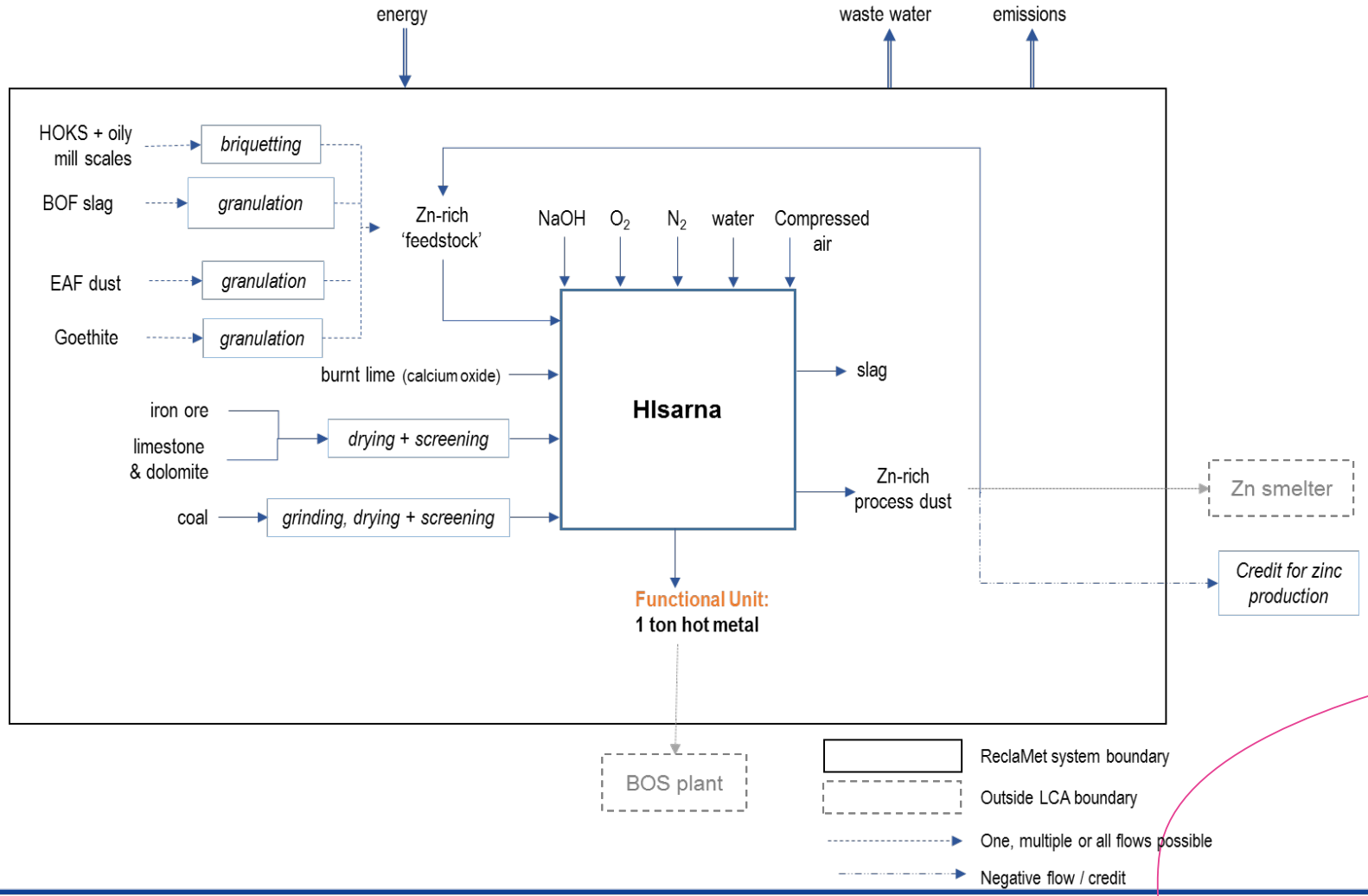
Functional Unit

- 1t hot metal

SYSTEM BOUNDARIES: BASELINE HISARNA

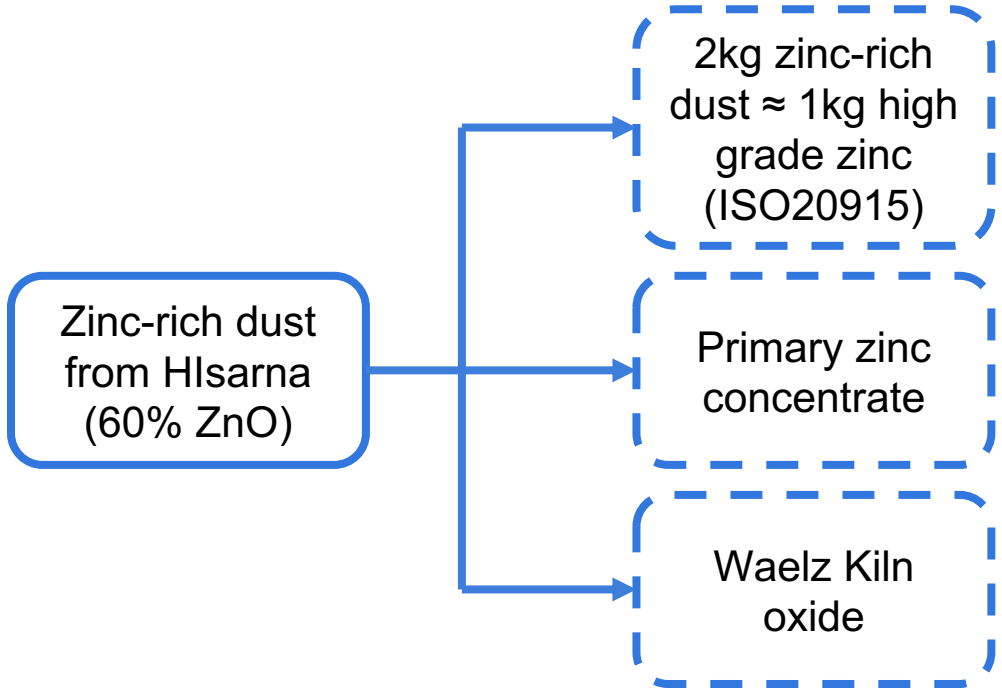


SYSTEM BOUNDARIES: RECLAMET SCENARIOS



OPTIONS TO DEAL WITH MULTI-FUNCTIONALITY IN RECLAMET

Substitution / system expansion



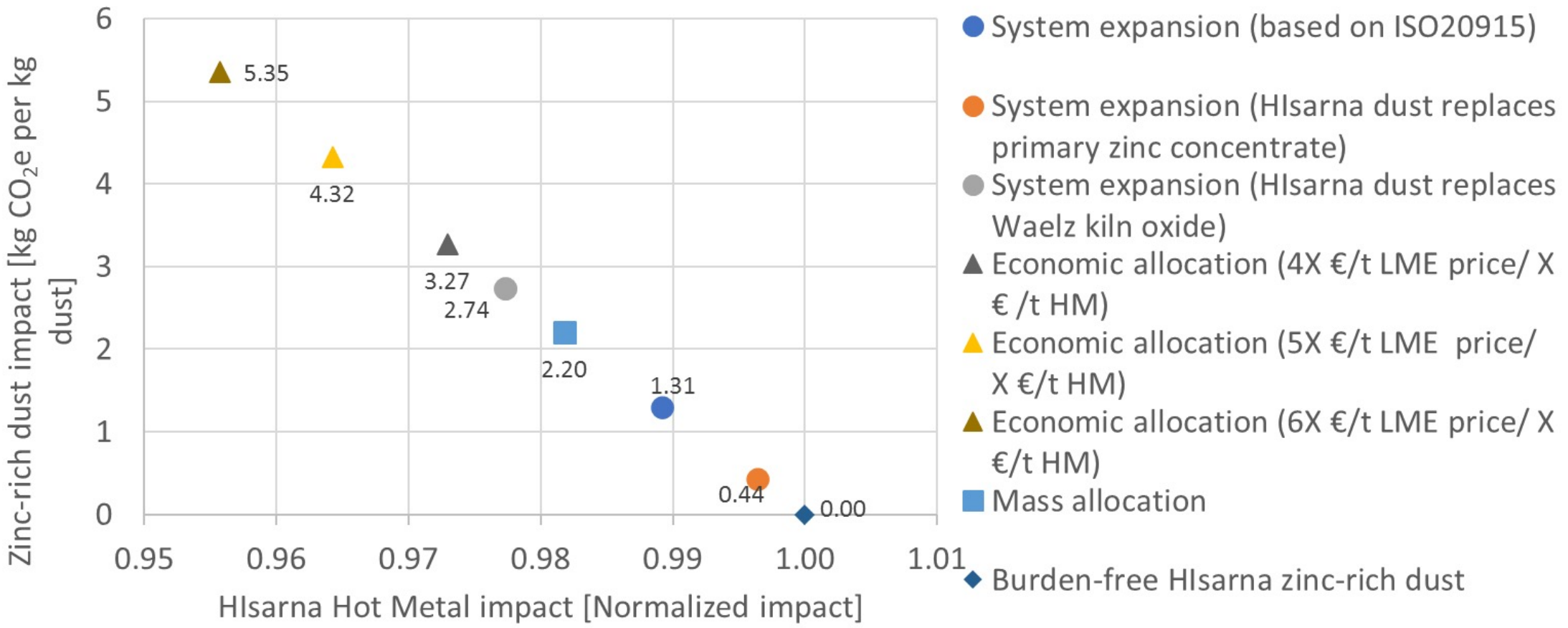
Other possible approaches include:

- economic allocation
- mass allocation

ENVIRONMENTAL IMPACT FOR ZINC-RICH DUST

Method	Zinc-rich dust [kg CO_2e per kg dust]	Notes
System expansion (based on ISO20915)	1.31	2 kg zinc-rich dust considered equivalent to 1kg high grade zinc. Reference: ISO20915. Dataset: Van Genderen, et al. (2016). A global life cycle assessment for primary zinc production.
System expansion (HIsarna dust replaces zinc concentrate)	0.44	Reference: Ecoinvent dataset ”Zinc concentrate"
System expansion (HIsarna dust replaces Waelz kiln oxide)	2.74	Reference: Waelz kiln GaBi model based on literature
Economic allocation	3.27	X €/t HM, 4X €/t LME price (illustrative figures, value of zinc dust based on London Metals Exchange prices)
Economic allocation	4.32	X €/t HM, 5X €/t LME price (illustrative figures, value of zinc dust based on London Metals Exchange prices)
Economic allocation	5.35	X €/t HM, 6X €/t LME price (illustrative figures, value of zinc dust based on London Metals Exchange prices)
Mass allocation	2.20	
Burden-free HIsarna zinc-rich dust	0.00	

ENVIRONMENTAL IMPACT FOR ZINC-RICH DUST



The reduction in GWP for Hot Metal from HIsarna is small, max 5%, due to the different output amounts of Hot Metal vs process dust

SUMMARY

- When attributing environmental emissions in a multifunctional system, there are different methodological LCA choices to be made.
- Each method can give a different GWP to the co-product. An example is presented for HIsarna and ReclaMet.
- The choice of allocation method is part of a discussion between companies/sectors.
- Collaboration between co-product user and co-product producer is essential to avoid emissions being “double-counted” or not accounted for.

ACKNOWLEDGMENTS

Fastsheet HIsarna

https://www.tatasteeleurope.com/ts/sites/default/files/TS%20Factsheet%20Hisarna%20ENG%20jan2020%20Vfinal03%204%20pag%20digital.pdf

EIT RawMaterials, ReclaMet project

EIT Project Agreement No:17209

https://eitrawmaterials.eu/project/reclamet/

TATA STEEL

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