



INTERDISCIPLINARY
CENTER

Sant'Anna
Scuola Universitaria Superiore Pisa



POLITECNICO
MILANO 1863

Giornata di studio

"Rifiuti e Life Cycle Thinking"

7^a edizione



Methodological discussion on the application of LCA to steel recycling

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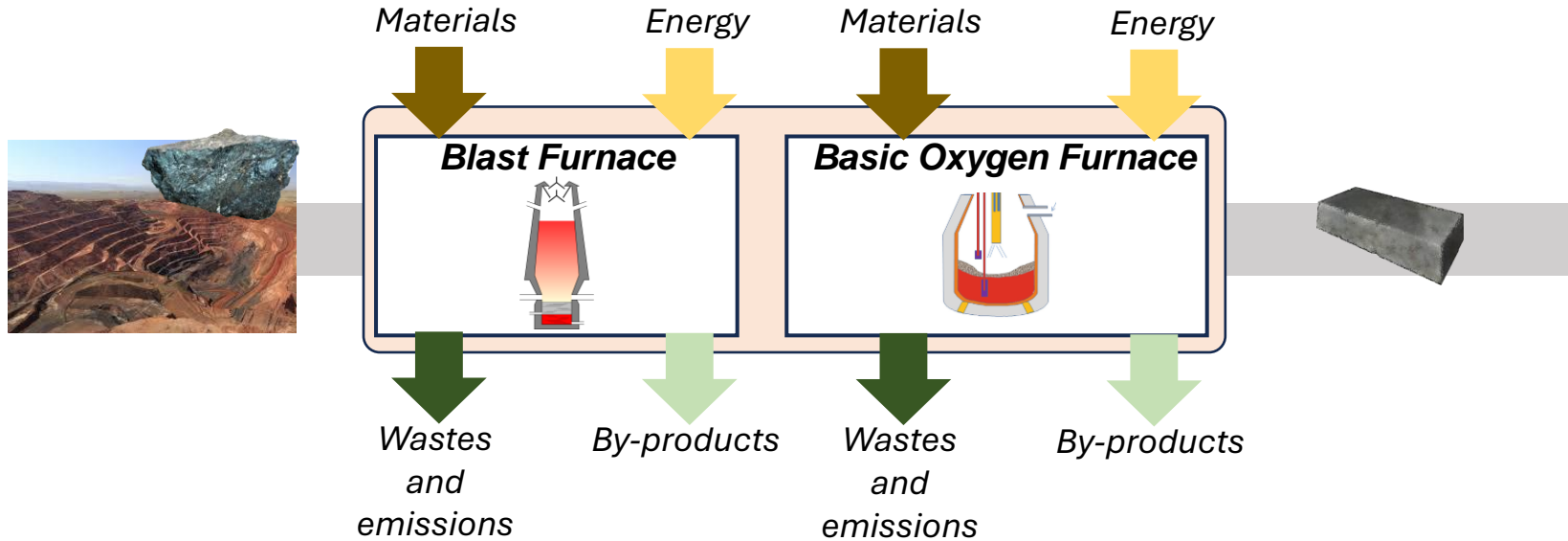
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January 28th 2025



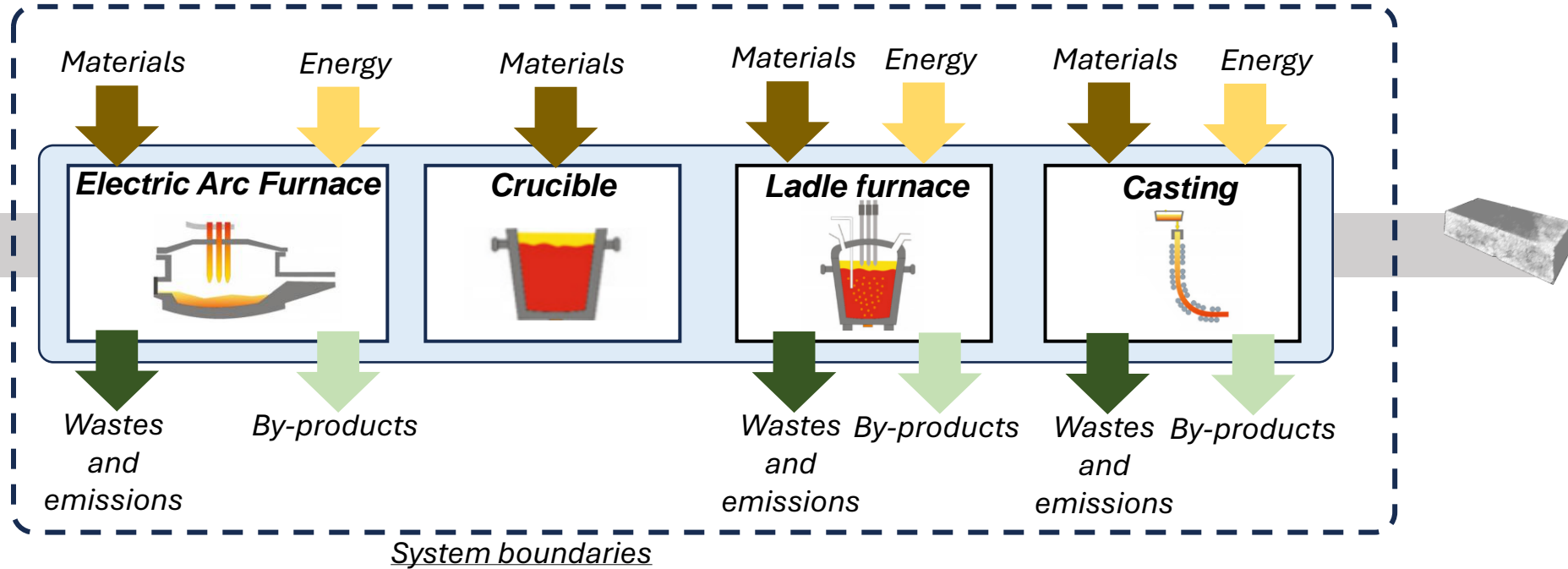
Production



Processing and use

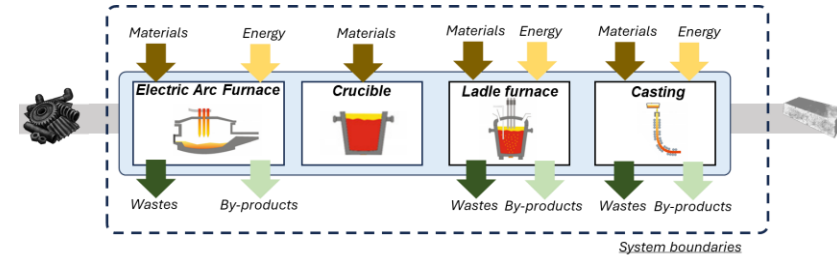


Recycling

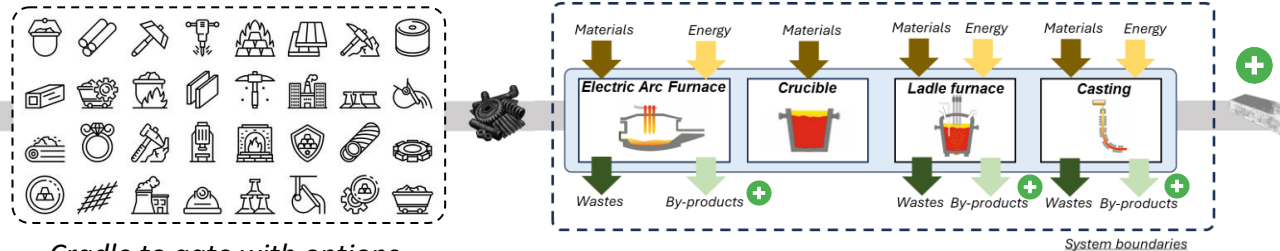


Steel Recycling - Modelling approaches

Cut-off  Valorizing the use of wastes as inputs since they are considered as burden free (van der Harst et al., 2016).



System expansion  Valorizing the recovery of output secondary materials (van der Harst et al., 2016).



Cradle to gate with options
(Santero and Hendry, 2016)

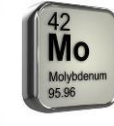
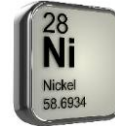
Santero, N., Hendry, J., 2016. Harmonization of LCA methodologies for the metal and mining industry. Int J Life Cycle Assess 21, 1543–1553. <https://doi.org/10.1007/s11367-015-1022-4>

van der Harst, E., Potting, J., Kroeze, C., 2016. Comparison of different methods to include recycling in LCAs of aluminium cans and disposable polystyrene cups. Waste Manag 48, 565–583. <https://doi.org/10.1016/j.wasman.2015.09.027>



The case study

ALCHIMIA aims at the development of an environmental optimization model that minimizes the environmental impact of every heat by adjusting the materials inputs depending on the scraps composition.

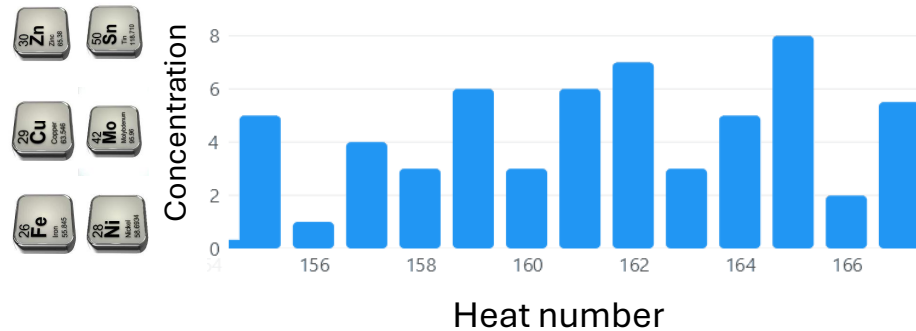


Research question



The LCI varies dynamically heat-by-heat. A dynamic LCA approach and a statistic evaluation of the impact categories allows to evaluate the variability of the results. The results depend on the LCA modelling approach.

Research Question: can the analysis of the results variability support us in deciding what is the most suitable recycling modelling approach for **ALCHIMIA**?

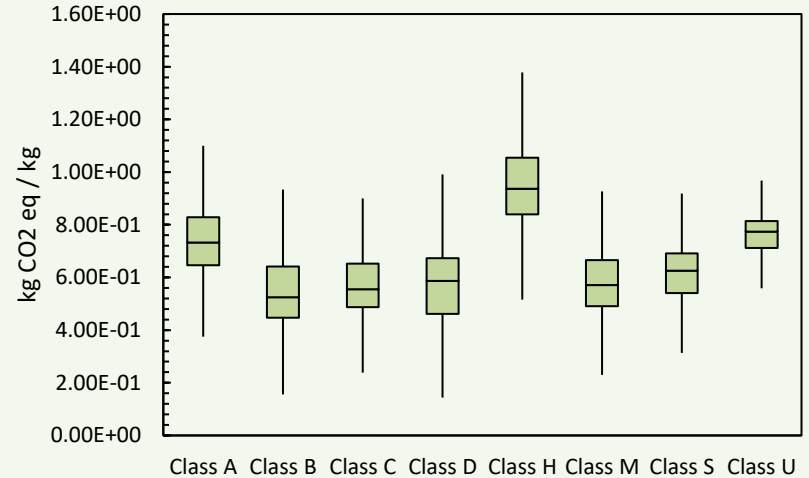


Climate change

Cut-off



System expansion

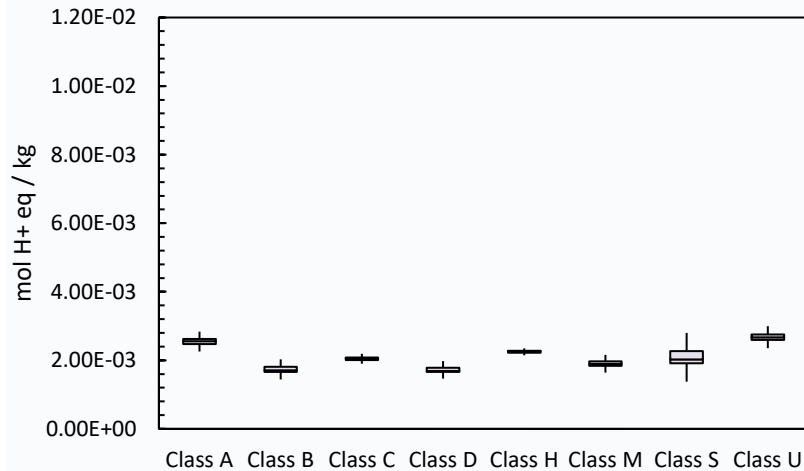


Most relevant impact categories defined by Santero and Hendry (2016)

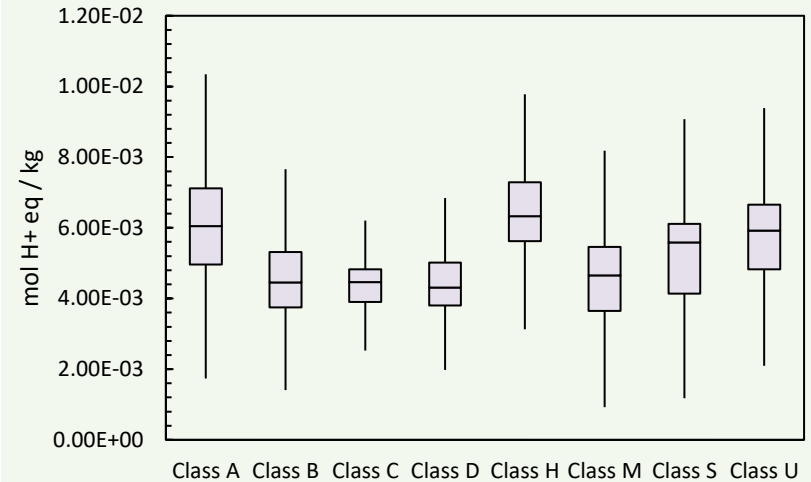


Acidification

Cut-off



System expansion



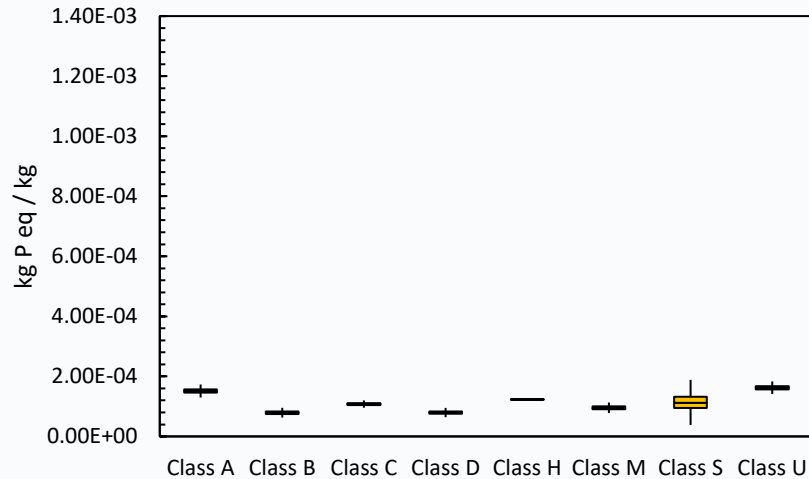
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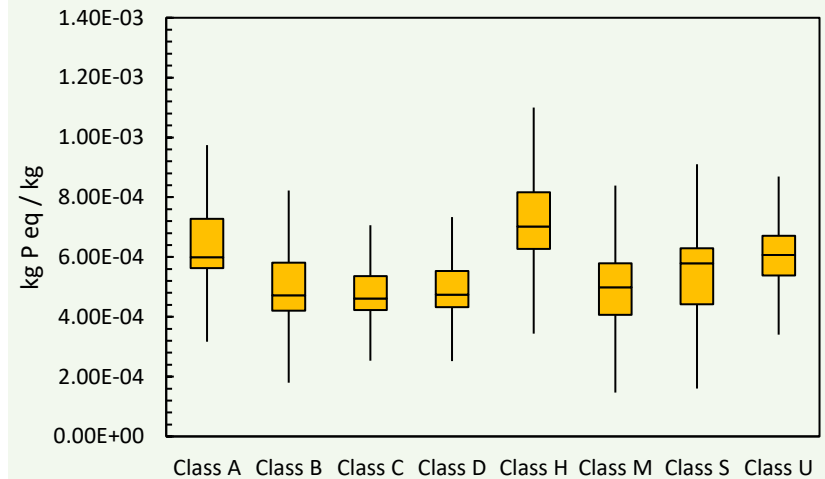


Eutrophication freshwater

Cut-off



System expansion



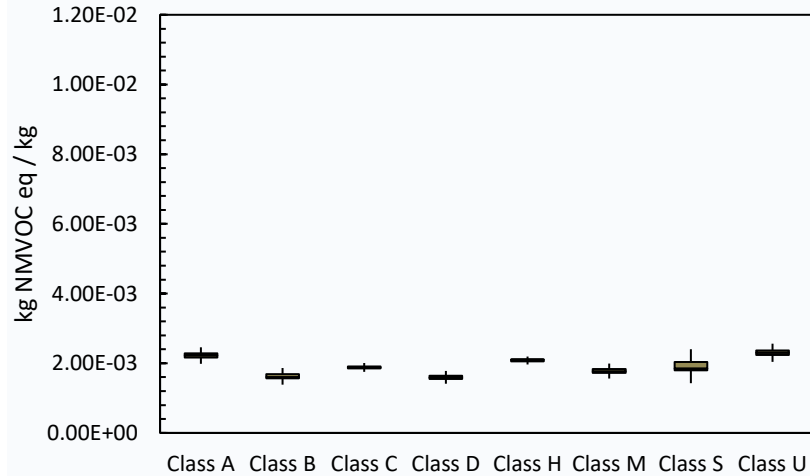
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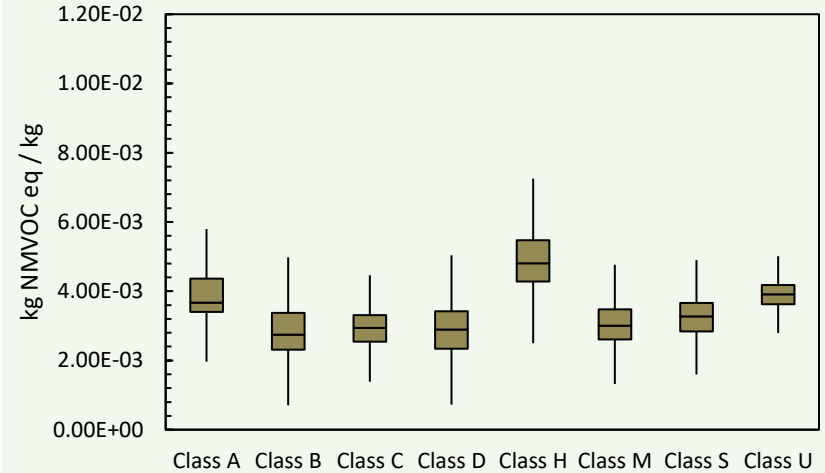


Photochemical ozone formation

Cut-off



System expansion



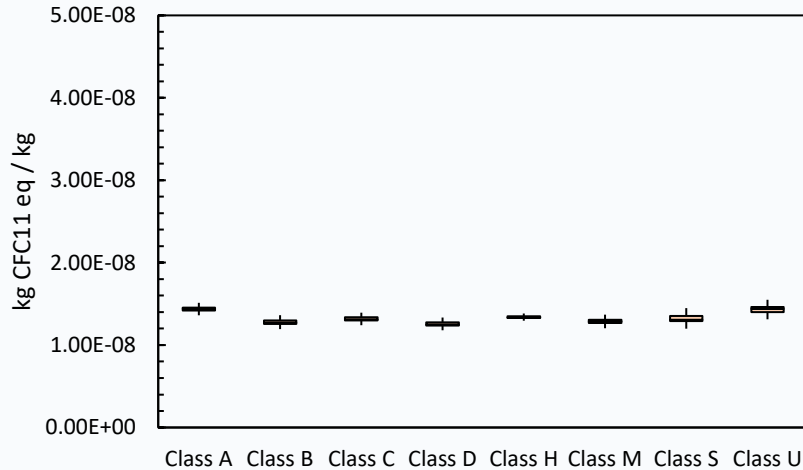
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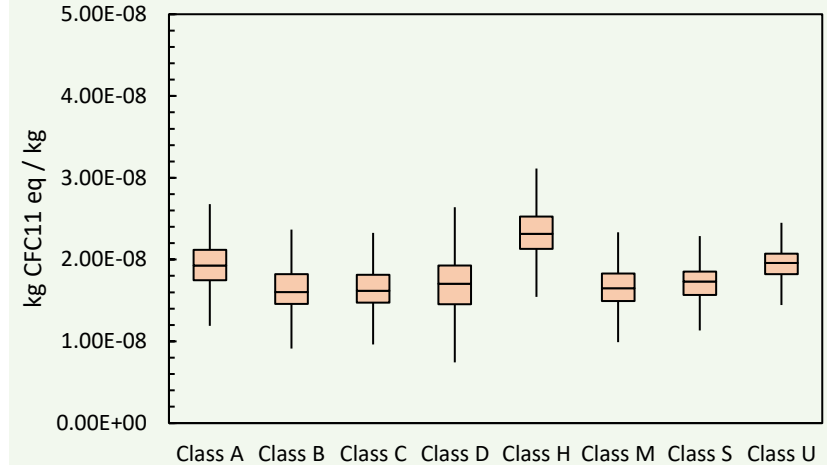


Ozone depletion

Cut-off



System expansion



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Discussion

What we already knew:

The **cut-off** approach valorises the use of recycled materials as burden-free inputs over the recovery of secondary materials as outputs.

The **system expansion** approach valorises the recovery of secondary materials from recycling by attributing them avoided environmental burdens.

What we observed:

For all impact categories, the “**median**” environmental impact calculated using the **cut-off** approach is statistically more significant than the system expansion.

Potential issues: recycling of steel slags and dusts are not accounted for.

Benchmarks

The **system expansion** approach allows to optimize the production process adjusting the materials consumption depending on the scraps composition in every heat.

Potential issues: data availability for scraps materials composition.

ALCHIMIA

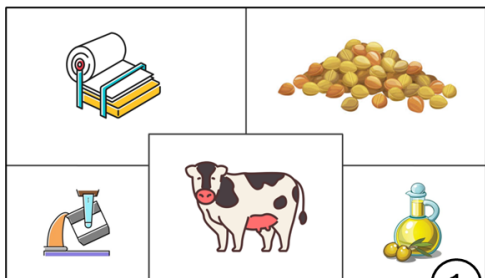


Next steps

Applying the lessons learned from **ALCHIMIA** to the project **GRINS** for aluminium foundries sector.

Step 1

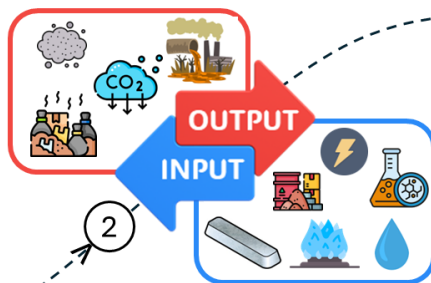
Literature review



Rossi et al. (2024)

Step 2

Definition of the LCI



Step 3

Creation of the datasets

	Growing Resilient Inclusive and Sustainable
Process information	
Key data set information	
Name, Synonyms, Class name	
Quantitative reference	
Reference flow(s): 1 ton	
Temporal representativeness	
Reference year: 2023	
Validity: 2024-2030	
Geographical representativeness	
Location: IT	
The data refer to a production plant located in the south of Italy	
...	
Inputs and outputs	
Input	
Resources	
Water	20.1 m³
Steel	66.8 kg
	From ground
	Recycled
Energy	
Electricity	111.0 kWh
Natural gas	13.2 MJ
	Renewables
	Pipeline
Output	
Emissions	
CO2	0.13 kg
	Combustion

Step 4

LCIA



Rossi, F., Niero, M., Frey, M. (2024). Application of LCA to circular economy strategies in steelmaking industry: state-of-the-art and recommendations. Proceedings of "XVIII Convegno dell'Associazione Rete Italiana LCA" 3rd - 5th July, 2024, Pescara, Italy.



Thank you for your attention!



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Bibliografia

Santero, N., Hendry, J., 2016. Harmonization of LCA methodologies for the metal and mining industry. Int J Life Cycle Assess 21, 1543–1553. <https://doi.org/10.1007/s11367-015-1022-4>
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