RecHycle

Recycling renewable hydrogen for climate neutrality

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31/10/2024

ESTEP 2024
Annual Event

ESTEP
European Steel Technology Platform
20 years together

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

voestalpine
ONE STEP AHEAD.

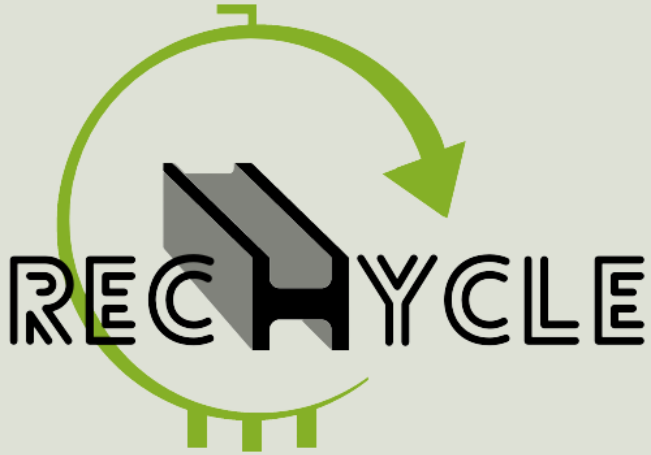
PRIMETALS TECHNOLOGIES

Funded by the European Union

VLAIO

RecHycle has received funding from the European Unions's Horizon Europe - Clean Steel partnership programme (adjustment of steel process production to prepare for the transition towards climate neutrality). Project no: 101058692.

ArcelorMittal Belgium has secured funding from various sources, including the Horizon Europe programme. The Flemish government also provided support through VLAIO, the Flemish Agency for Innovation and Entrepreneurship.



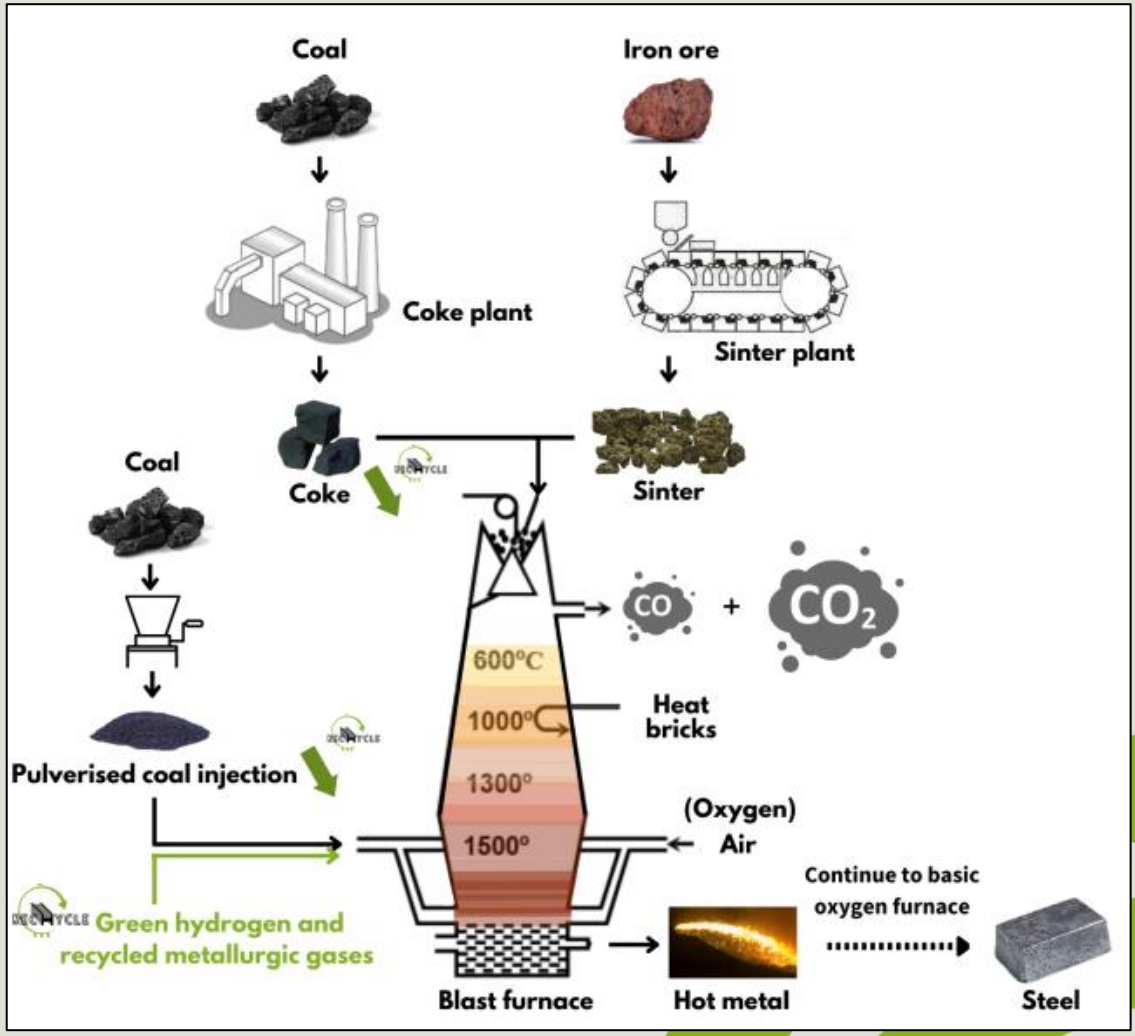
Project overview and description

- RecHycle investigates the use of (green) hydrogen and recycled metallurgical gases in steelmaking to replace coke and pulverised coal.

- $Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$

- Ambitions of the project:
  - Outperform SoA hydrogen rich gas injection in steelmaking.
  - Demonstrate a gas hub mixing different gas feeds and valorising them in the steel industry.
  - Provide a knowledge base on hydrogen impact on materials and components
  - Dynamic optimization of gas mixtures and flows
  - Develop a new ceramic tuyere.
  - Reduce the carbon footprint by valorising and recycling waste gases.
  - Reduce 200 kton CO_2 per year

- https://www.rechycle.eu/



Consortium

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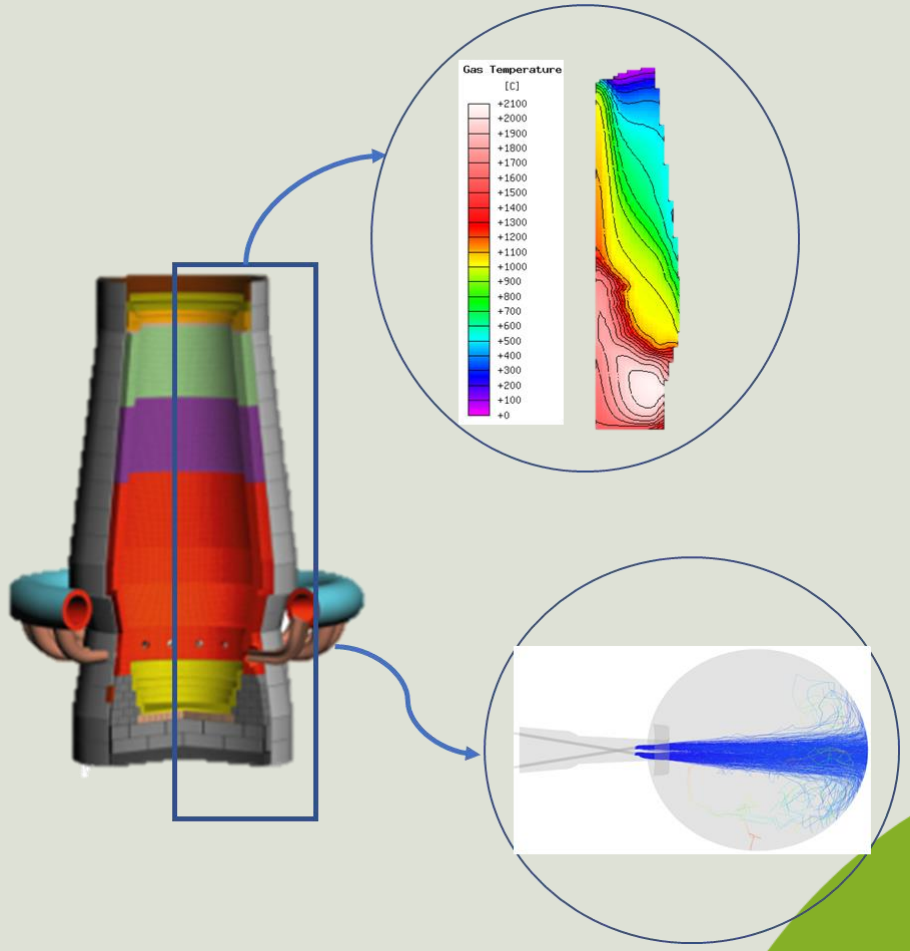
AMMR: Modelling Blast Furnace operation with H2-rich gases

Assessment of Blast furnace performance with the injection of H2-rich gases through the tuyeres:

- Combustion efficiency
- Replacement of Coke and/or PCI
- Impact on furnace performance
- Impact at CO_2 reduction

Main phenomena happening in the Blast Furnace:

- Combustion of carbon and gases
- Heat exchange
- Solid Flow
- Gas Flow
- Iron reduction
- Melting of iron and slag



AMMR: Modelling Blast Furnace operation with H2-rich gases – Raceway simulations

- Assess the performances of the current injection technology (e.g. lances lay-out, etc.)
- Potential performance of future modifications through the introduction of new auxiliary fuels such as NG, metallurgical gases and H_2.

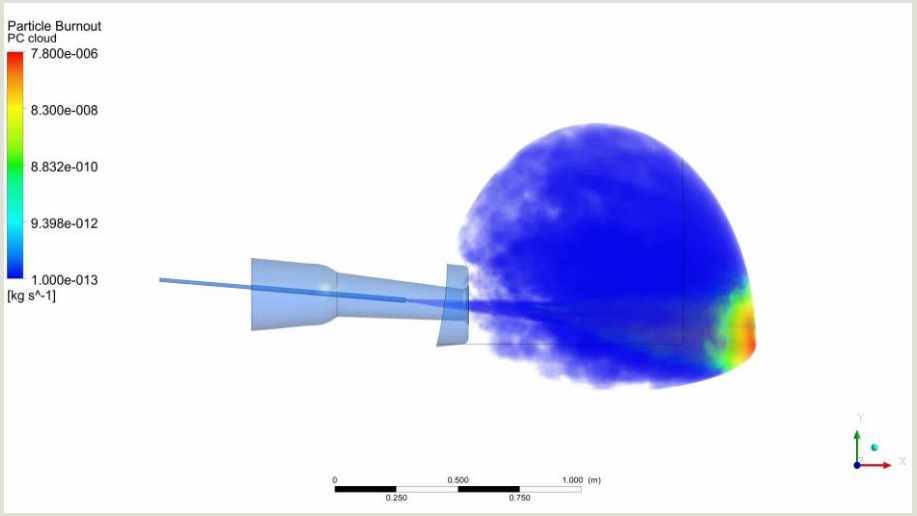
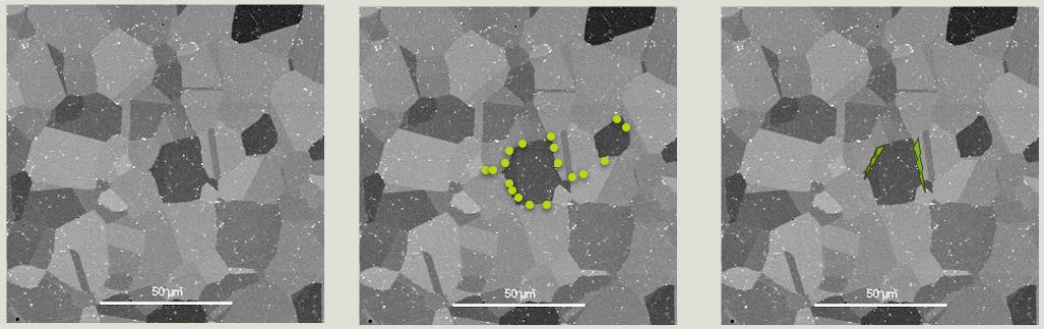


Fig: Simulation of Gas and PCI Flow in the Raceway

JOA - H_2 embrittlement



Before the Hydrogenisation *After the Hydrogenisation* *In exploitation*

Strategy of work:

- **Analysis of the components exposed to hydrogen** and determination of the level of impact of hydrogen on their proper functioning during the steelmaking process.

- **Screening of the materials used to make these components** and the literature review of the impact of hydrogen to their properties, in terms of embrittlement.

- **Material testing campaign to determine this effect physically and chemically**.
  1. Exposure of the material to Hydrogen at room temperature
  2. Exposure of the material to Hydrogen at elevated temperature
  3. Mechanical testing of the exposed vs. non-exposed material – to evaluate comparatively the effect of embrittlement, if any.
  4. Metallurgical observations – to spot the reasons of embrittlement, if appears, in terms of what metallurgical transformation of the material takes place to create the embrittlement.

- **Proposition of measures to improve the component resistance to embrittlement**, by proposition of protective measures (e.g., coatings) and/or other materials.

UPM – LCA

Scope of the LCA:

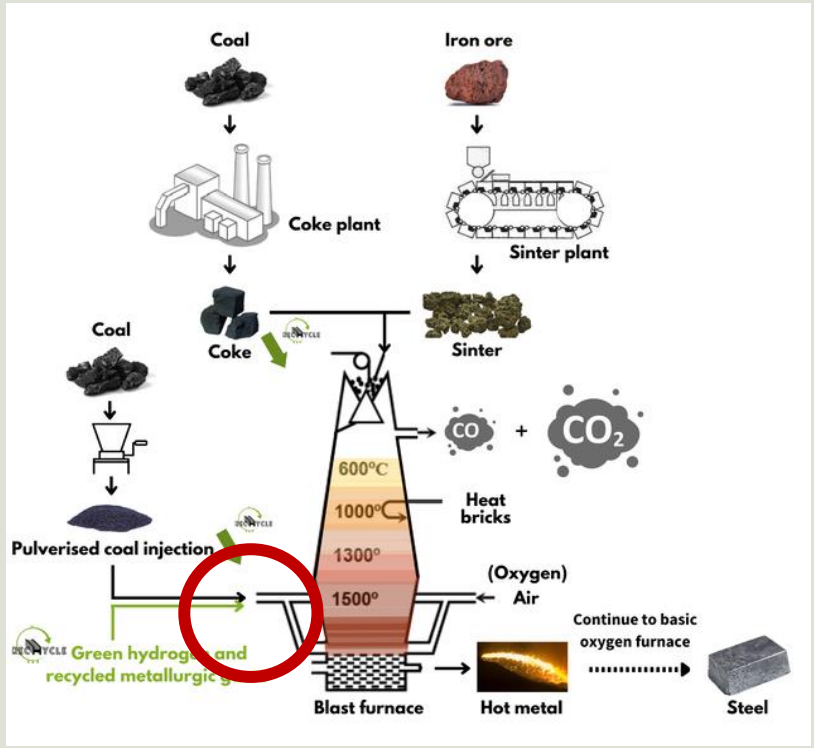
- Defining the object of the assessment (Function, Functional Unit and Reference Flow)
- System boundaries and completeness requirements
- Life Cycle Inventory modelling framework
- Selecting the geographical, temporal and technological boundaries and settings of the study
- Selecting the assessment parameters (preparation of the basis for the impact assessment)

Reference flow: 1 ton of hot metal (produced via the AS-IS system) versus 1 ton of hot metal (produced via the TO-BE system)

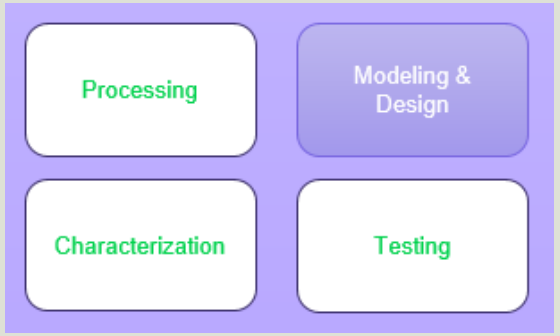
CNRS & IRT Saint Exupéry: Ceramic matrix composite

Joint Objectives

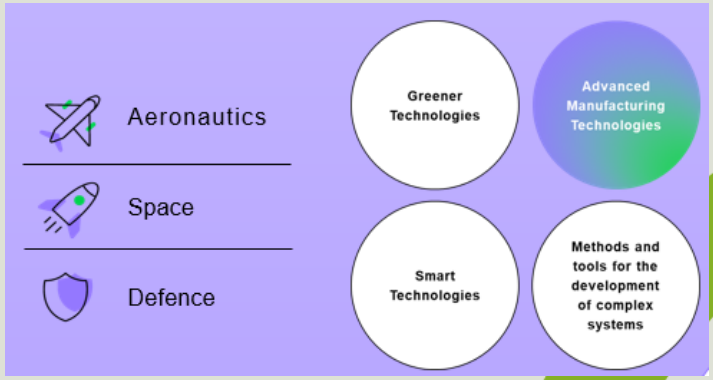
Propose and manufacture a CMC insert for the tuyere :
Choice of the material, modeling, characterization



CNRS - LCTS is a joint research unit dedicated to all basic science aspects on thermostructural composites



IRT SE is a collaborative and integrated technological research center bridging the public research to the industrial one.



Status demonstration

June 2022
- Start of the project

Oct 2024
- Engineering close to completion
- Construction ongoing

Q2-Q3 2025
- First demonstration

June/Nov 2026
- End of project

What's next?

June 2022	Oct 2024	Q2-Q3 2025	June/Nov 2026
• Start of the project	• Engineering close to completion • Construction ongoing	• First demonstration	• End of project

- AMB: focus on the first demonstration and in parallel source hydrogen for the future
- JOA will publish a paper on hydrogen embrittlement
- AMMR will perform the MPVP trials
- CNRS and IRT will construct and test a CMC designed for the tuyere at AM Ghent
- UPM will continue working on the TO-BE scenario for the LCA with data from the demonstration

RecHycle

Thank you

RecHycle - Recycling (renewable) hydrogen for climate neutrality has received funding from the European Union's Horizon Europe research and innovation programme call HORIZON-CL4-2021-TWIN-TRANSITION-01-22, under grant agreement no. 101058692.