

# The role of slags and other by-products within circular economy in the steel industry

- ZHyRON project: Valorization of iron-rich & Zinc-containing steelmaking by-products via Hydrogen-based Reduction
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*ESTEP Focus  
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# Context

- Existing valorization processes for the treatment of Fe-rich and Zn-containing steelmaking by-products or wastes need a source of heat and a reductant, which is in most of the cases a fossil fuel like coal, coke or natural gas.
- The large rate of fossil fuels/reductants needed make pyrometallurgical processes very intensive in terms of CO<sub>2</sub> emissions, but it also has a big additional environmental impact in terms of SO<sub>x</sub>, NO<sub>x</sub> and particulates emissions.



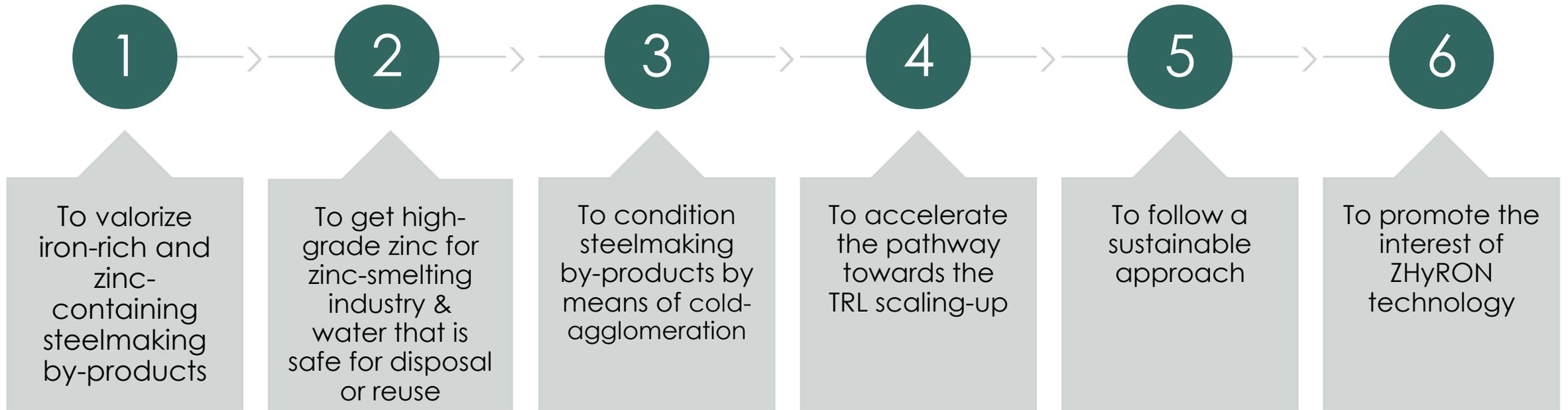
# About the project

- **ZHyRON:** HORIZON funded project which started in January 2024.
- **Goal:** To develop and validate circular industrial solutions in real industrial setting, to transform the steel industry towards more sustainable practices.

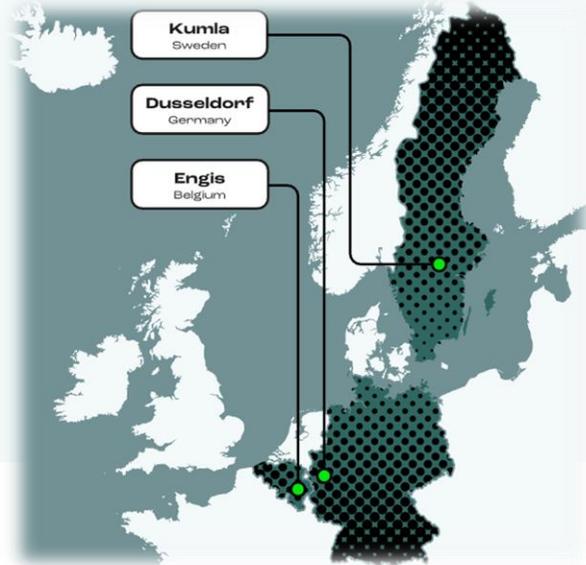
**ZHyRON is striving for a greener future in steelmaking!**



# Objectives



# 9 partners from 6 EU countries

 <p><b>CIRCE - FUNDACION CIRCE</b> CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGETICOS</p> <p>Spain</p>	 <p><b>ArcelorMittal</b></p> <p>ArcelorMittal Innovacion Investigacion e Inversion SL</p> <p>Spain</p>	 <p><b>ArcelorMittal</b></p> <p>ArcelorMittal Maizieres Research S.A.</p> <p>France</p>	 <p><b>Centre de Recherches Metallurgiques ASBL</b></p> <p>Belgium</p>	 <p><b>GreenIron H2 AB</b></p> <p>Sweden</p>
 <p><b>VDEh-Betriebsforschungsinstitut GmbH</b></p> <p>Germany</p>	 <p><b>Jean Goldschmidt International - Hydrometal SA</b></p> <p>Belgium</p>	 <p><b>Fondazione ICONS</b></p> <p>Italy</p>		



# Targeted by-products

- Iron-rich and/or zinc-containing by-products like:
  - Electric arc furnace dust (EAF dust).
  - Steelmaking converter dust (BOF dust).
  - Steelmaking conv. fine sludge (BOF fine sludge).
  - Hot rolling mill scales.
  - Pellet fines from direct reduction shafts.
  - Sludge from direct reduction shafts.



# Cold agglomeration



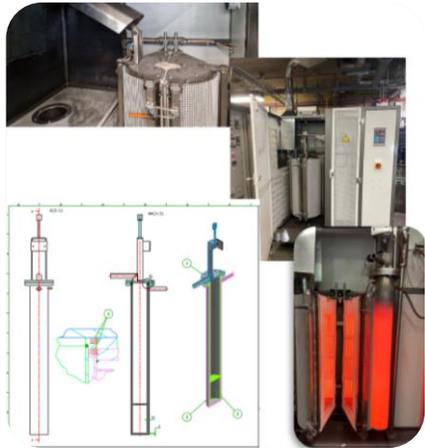
Cold agglomeration -  
pastille making  
lab-test



Drop test



Cold agglomeration -  
pilot-scale test



Reducibility test  
with hydrogen

Degradation test



# Cold agglomeration



## Binder choice

- Molasse
- Hydrated Lime
- Starch
- Polymeric Binders
  
- Cements
- Sodium silicate

Organic

Mineral



Impact of combined use of organic and mineral binders on the hardness of the agglomerates?



# KPIs for cold agglomerates

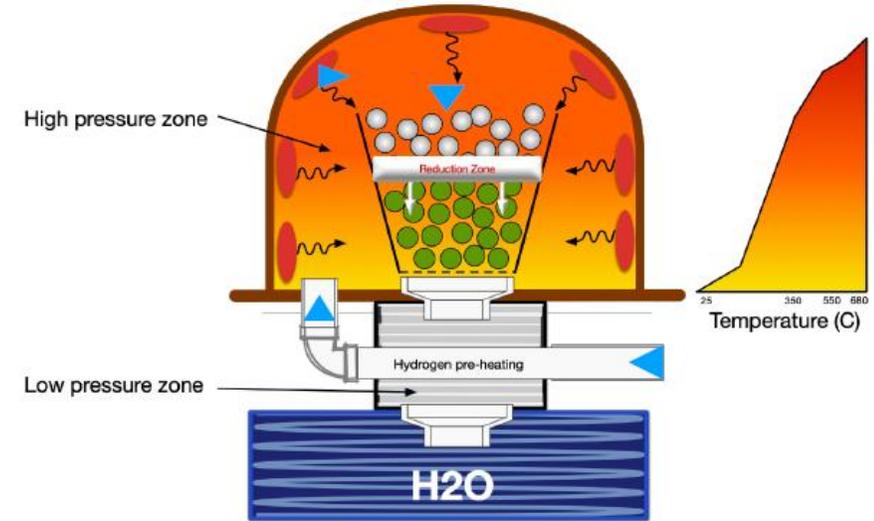
- Mechanical strength of cold-agglomerates must be good enough to withstand piling, transportation and feeding of the materials inside GREENIRON's furnace.

PARAMETER	UNITS	DESIRED VALUE OR RANGE
Drop test, 2 drops, 2 m height	% material > 10 mm	> 95
ISO 3271 – Adapted Tumbler Index (TI) after 50 revolutions	% material > 6,3 mm	> 90
ISO 3271 – Adapted Abrasion index (AI) after 50 revolutions	% material < 0,5 mm	< 10
Size	mm	9 - 40



# Metallurgical path

- ZHyRON will develop an innovative valorization route based on cold-agglomeration of the by-products followed by green pyrometallurgical and hydrometallurgical stages.
  - → **1:** The iron oxides units will be recovered as direct reduced iron (DRI) able to be consumed in electric arc furnaces (EAF).
  - → **2:** The zinc will be recovered as zinc oxide concentrate with enough purity to be externally valorized by a zinc smelting company and/or used for other applications.
  - → **3:** The water produced will be treated to be internally recycled or disposed to the Environment.





## ACKNOWLEDGEMENT:

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