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Safe H-DRI: advancing the production, transport and storage of Hydrogen-based Direct Reduced Iron (H-DRI) for sustainable steelmaking

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Safe H-DRI

Research Fund for Coal & Steel

This project has received funding from the Research Fund for Coal and Steel under grant agreement No 101150482.

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Project overview

Safe transport of DRI from H_2-based direct reduction considering quality-related H-DRI reactivity, stability, the efficiency of passivation methods and health and recycling aspects

Start date
1.10.2024

Duration
42 months

Overall objective:

- Research methods to prevent hazards and risks and development of a safe and standardized transport, storage and handling for H-DRI, while developing sustainability by fines-reuse and the use of lower-grade iron ores that are so far not usable for DRI-production

Context:

- Transition toward decarbonization challenge for the European steel industry with the goal of achieving climate neutrality by 2050 in increasingly critical global market effects.
- Alignment with the European Green Deal and the Clean Steel Partnership: development of breakthrough technologies for low-carbon steel production

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Key objectives

1. **Develop a safe and efficient handling for H-DRI:**
   Design, loading, transport, unloading, and storage tailored to the specific requirements of H-DRI.

2. **Enhance the utilization of lower-grade iron ores:**
   Such as blast furnace-grade pellets and recycled fines, to produce H-DRI using 100% hydrogen or mixtures of hydrogen-ammonia

3. **Understand and mitigate risks of H-DRI reoxidation:**
   Investigate reoxidation behavior under various conditions, like exposure to dry or humid air, saltwater, and temperature variations, to prevent hazards such as self-heating, ignition, and explosions.

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Key objectives

4. **Develop fines-reuse and recycling solutions:**
   Assess crack formation and fines generation during H-DRI handling and develop strategies for their reuse as alternative to CO2-intensive sinter process

5. **Standardize transport systems and guidelines:**
   Develop innovative standards for H-DRI transport based on the project's findings to ensure safe handling and logistics to provide updated guidelines.

6. **Research passivation methods and develop safety measures:**
   Evaluate and refine passivation techniques (e.g., coatings and treatments) to minimize risks during transport, while preserving metallization and reducing dust generation.

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Key goals

- ✓ Decarbonizing the European steel industry by reducing CO_2 emissions
- ✓ Developing reuse and sustainability
- ✓ Ensuring safety for health and environment and efficiency throughout the H-DRI value chain
- ✓ Finding innovative solutions for the increasing demand for H-DRI and its role in achieving a low-carbon, resource-efficient future.

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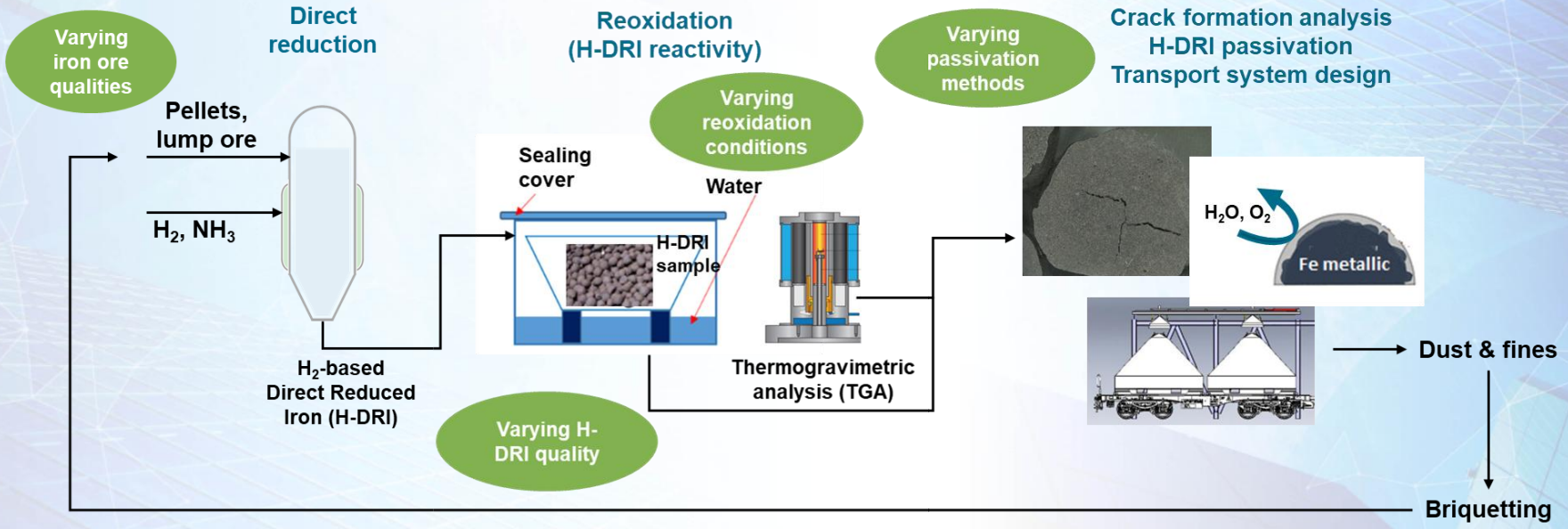
Overview of H-DRI chain



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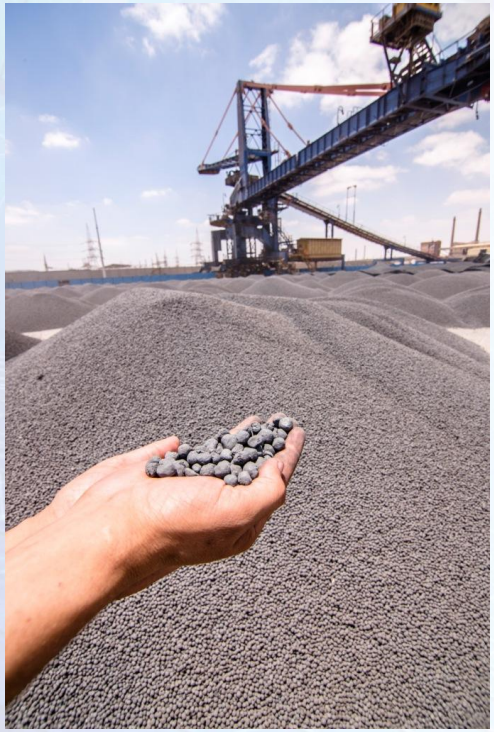
Project structure



WP1: Project management and coordination (K1-MET)

WP2: Production of H-DRI with different qualities and reoxidation behavior (MUL-CFM)

WP3: Process analysis and product quality evaluation (ADI)

WP4: Examination of H-DRI stability, risks for dust explosion during handling and H-DRI passivation methods (TATA STEEL)

WP5: Concept for the adaption of the equipment and logistic processes to transport H-DRI and project exploitation (IFSOL)

WP6: Dissemination and communication (RINA-CSM)

*WPs and their corresponding leading partners

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Methodology

✓ Assessment of the H-DRI value chain:

- Entire H-DRI process, from raw material selection (varying ore grades including low-grade) via H_2-based reduction and passivation to transport, handling, storage, reoxidation mitigation and recycling of fines
- Expertise from metallurgical, safety, and logistics disciplines to ensure a robust analysis.

✓ Experimental campaigns in controlled and “real” conditions:

- Lab-scale tests to investigate **reduction, reoxidation, passivation and fines generation** under simulated transport and storage
- **Industrial-scale trials**, including real-environment tests at seaports and rail transport simulations, to validate results and practical applicability.

✓ Multidisciplinary consortium:

- Close collaboration between **industry leaders, research organizations, and logistics providers** to join comprehensive expertise.
- Partners contribute advanced tools such as e.g. climate chambers, reduction furnaces, specifically developed testing facilities and computational modeling for detailed analysis.

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Methodology

✓ Innovative passivation and handling strategies:

- Passivation techniques, such as coatings or controlled aging, to minimize H-DRI reactivity and improve safety during handling and transport.
- Optimize logistical systems, including container design and transport guidelines, tailored for H-DRI requirements.

✓ Recycling and circular economy solutions:

- Address fines generation by developing methods for low-CO2-briquetting and reintegrating fines into the production process, avoiding material losses and supporting zero-waste goals.

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Current status

✓ Experimental assessment and planning:

- Multi-partner round-robin campaign to assess chemical, physical, and morphological properties of various iron ore pellet grades prior to reduction and ensure high accuracy and reliability of the projects further achieved results and findings.
- First reduction trials performed; key operational parameters under selection to guide upcoming tests.
- Post-reduction assessment initiated for passivation strategies on pre-reduced pellets.

✓ Market and value chain analysis

- Initial market screening carried out to assess the potential for large-scale implementation of H-DRI and related requirements.

✓ Establishment of communication platforms:

- Website launched! (*https://safe-h-dri.eu/)*
- LinkedIn page created! (*https://www.linkedin.com/company/safe-h-dri-project/)*

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What's next?

- Continuously adjust detailed methodologies for upcoming experiments and pilot trials based on obtained findings
- Continue experimental set-ups for H-DRI reduction, reoxidation and passivation, including simulations for transport and storage
  - Complete ongoing round-robin tests to match:
    I. Physical, chemical and morphological analyses
    II. key reduction parameters
    III. passivation techniques and evaluation metrics
- Discuss first preliminary results within the consortium and share conclusive findings through dissemination channels
- Organize technical meetings and attend conferences to strengthen coordination and visibility

Thank you!

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For any further information on the project:

Safe H-DRI

- **Website**: *https://safe-h-dri.eu*
- **Contact**: *info@safe-h-dri.eu*

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