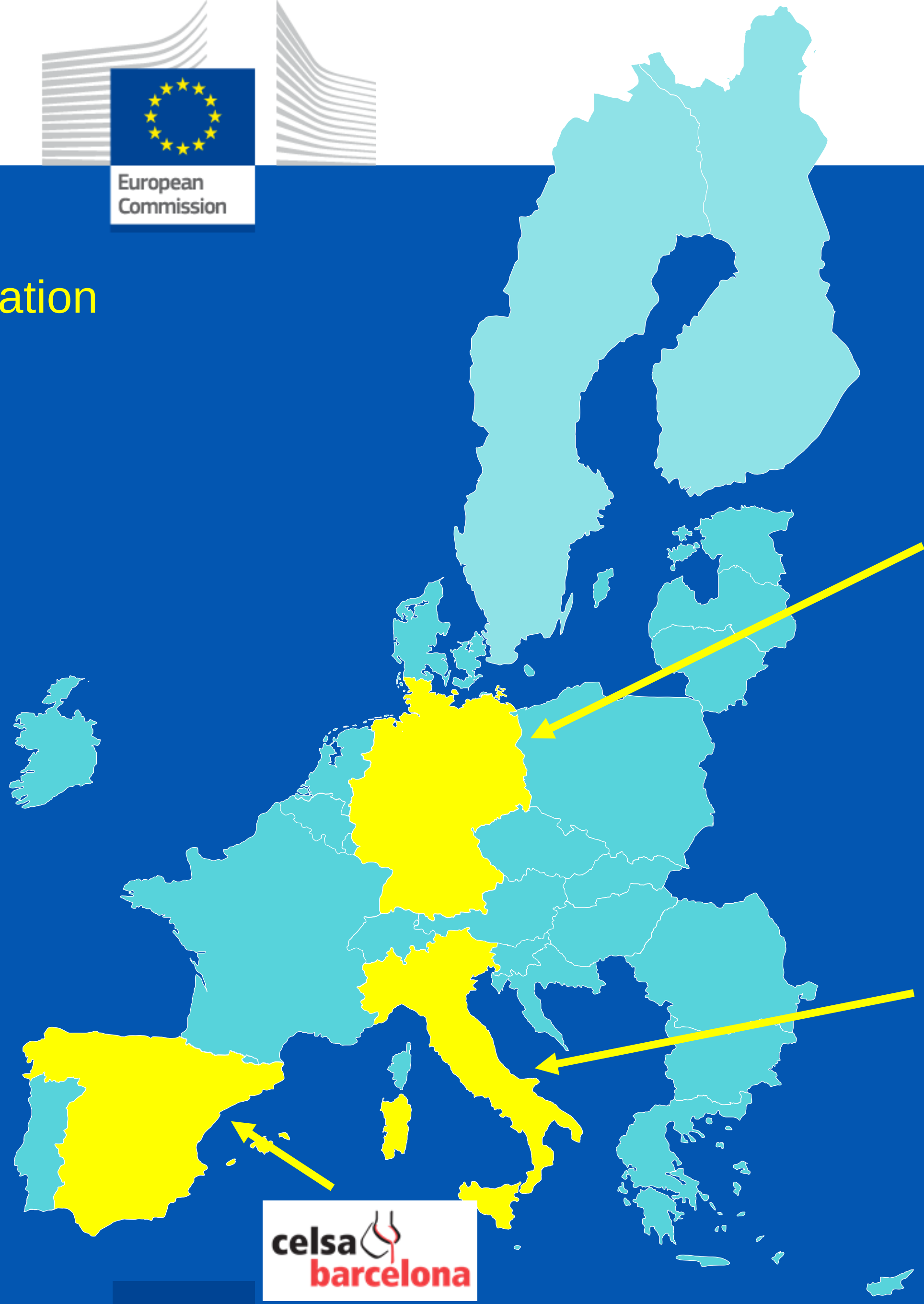
DevH2forEAF

Developing and enabling H2 burner utilization to produce liquid steel in EAF

Eros Faraci (RINA-CSM)



Call: RFCS-2020
Instrument: RR
GA number: 101034081
Start date: 01/07/2021
End date: 31/12/2024
Budget: 3.203.343 €

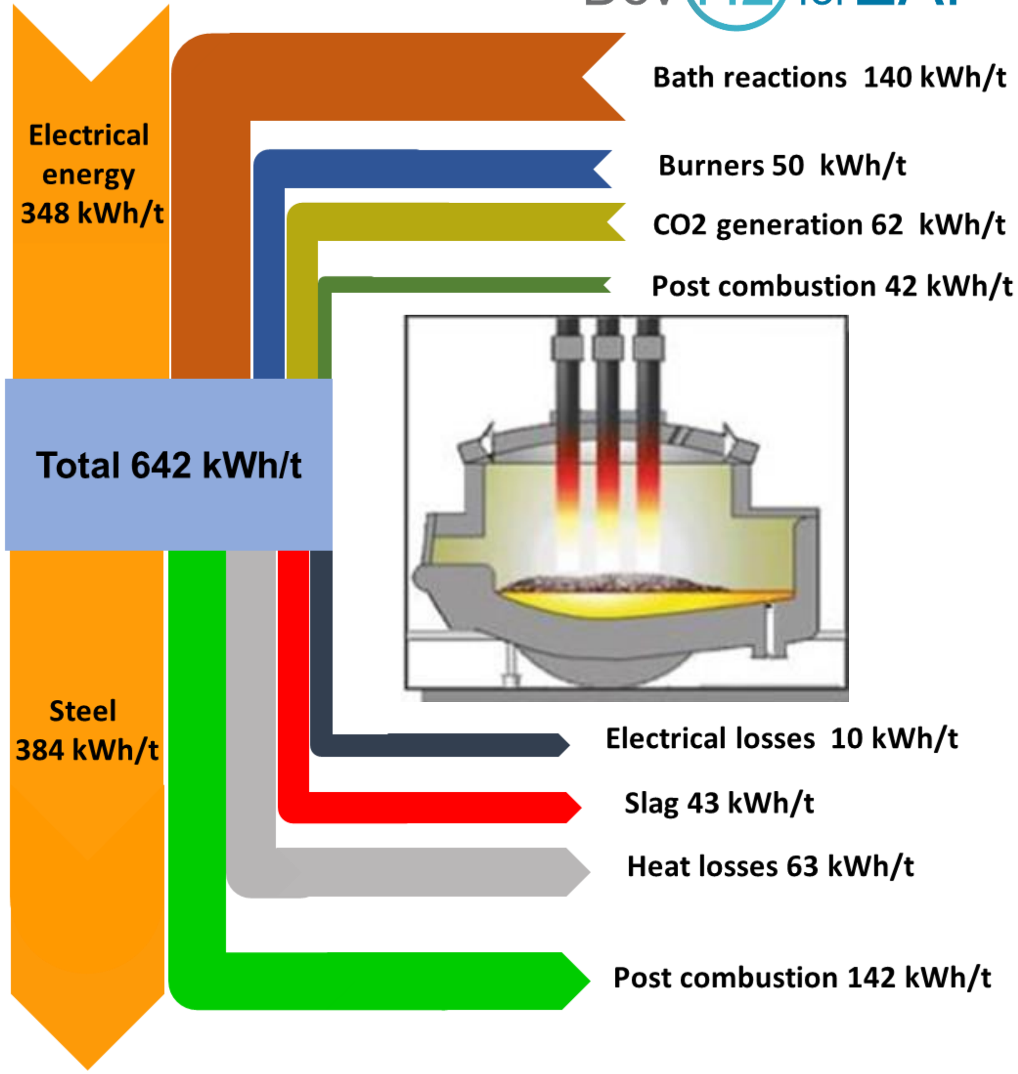
Partners’ roles

Partner	Role	Expertise
RINA	Coo.	Materials research and development specializes in testing, inspection, certification and engineering solutions
RWTH	Part.	Industrial Furnaces and Heat Engineering
CELSA	Part.	Steel producer
FeNo	Part.	Steel producer
NG	Part.	Leading companies in the industrial and medical gas business in Europe,
SMS	Part.	Production of machines and plants for steel production
AFV Belt.	Part.	Steel producer

Problem tackled by DevH2forEAF

- The **DevH2forEAF project is focused** on **reducing the carbon footprint of EAF** steel production through the **development and construction of a burner** that enables the use of **hydrogen** to replace fossil fuels

- **Every ton of steel** emitted on average **1.85 tons of CO_2**, equating to about **8% of global CO2 emissions**. Consequently, the **decarbonization of the steel industry** represents the **fundamental step** towards the ambitious objective **of zero-emission society by 2050.**



Main objective(s)

- In the frame of EU climate target 2030-2050, the main objective of the DevH2forEAF project is to reduce the carbon footprint in EAF process by means **set up a burner fed with hydrogen to replace natural gas** .

- **Risk analysis** for the definition of the correct actions and countermeasures when **hydrogen is used in EAF process:** safety issues related to storage, transport and injection must be identified and risks minimized.

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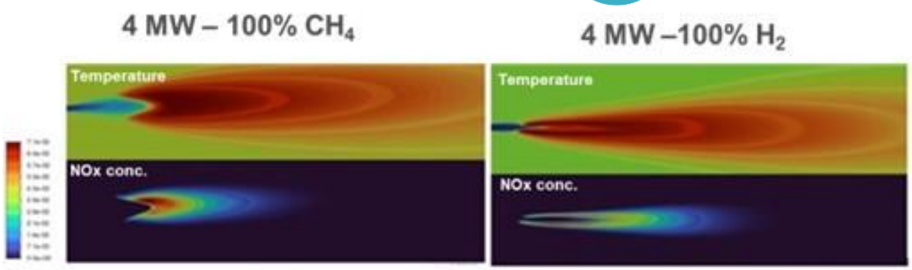
Main results

Development and realization of modern multi-fuel burner

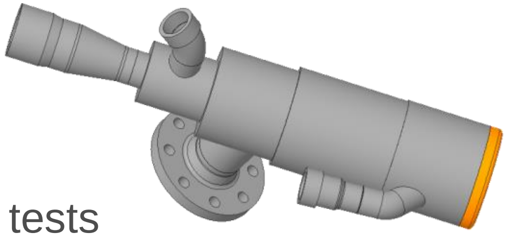


The **main results of the CFD simulations are**:

1) **Flame temperature increases** in shifting from pure methane to pure hydrogen.
2) In the 3MW burner with **100% H2** the combustion is completed in **less than 2 m**
3) **Nitrogen oxides** (NOx) concentration peak **increases** with the **increase of H2.**

Small scale burner prototypes built and **tested** at **RWTH-IoB** and **GWI in Essen**.

1) **Hydrogen flame** as fuel is **hotter** and ignites **closer to the burner tip**;
2) The designed **water cooling** circuit guarantees a proper **cooling in all conditions**
3) **Long run test at GWI in Essen** did not report **any kind of damage** after working **for 20 hours** inside the furnace **at 1600 °C**



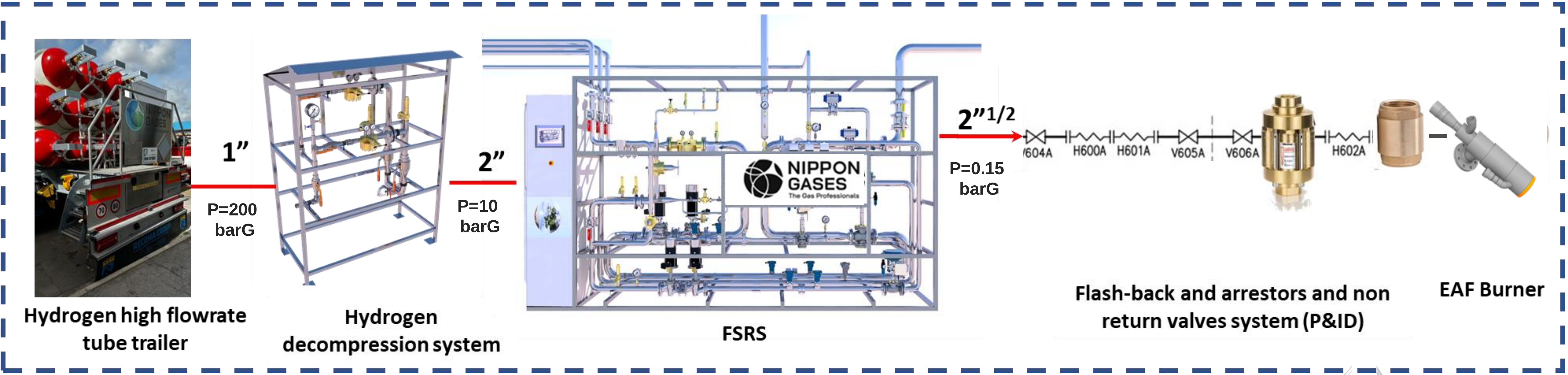
Full scale burners have been **designed** and **realized**

1) the **3 MW** nominal power burner for the combustion chamber tests at the **RINA-CSM Dalmine facility**
2) the **4 MW** nominal power burner for the **EAF plant tests**.

Main results

Definition and design of the whole fuel supply line

1) Hydrogen high flowrate **tube trailer** with **decompression system**.
2) **Hydrogen pipeline design**.
3) **Fuel Supply and Regulation System** (FSRS) to mix various percentage of H2 and NG.
4) **Flash-back arrestor and non-return valve** system to protect the equipment from damage or explosion.
5) **SIL3 design** for stoichiometric ratio control.

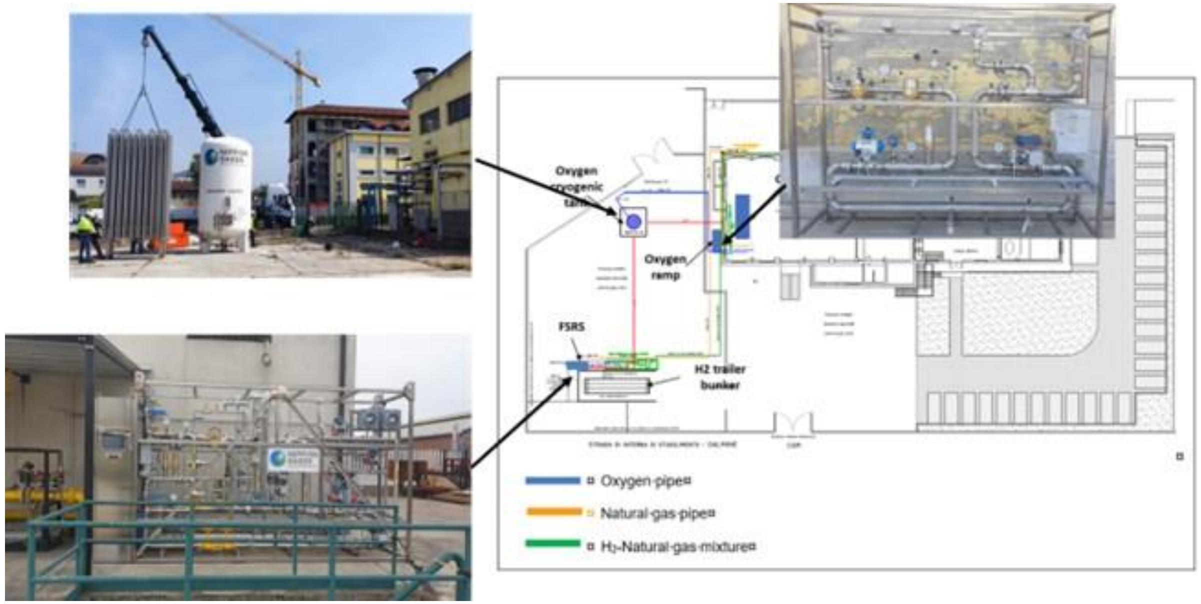


Main results

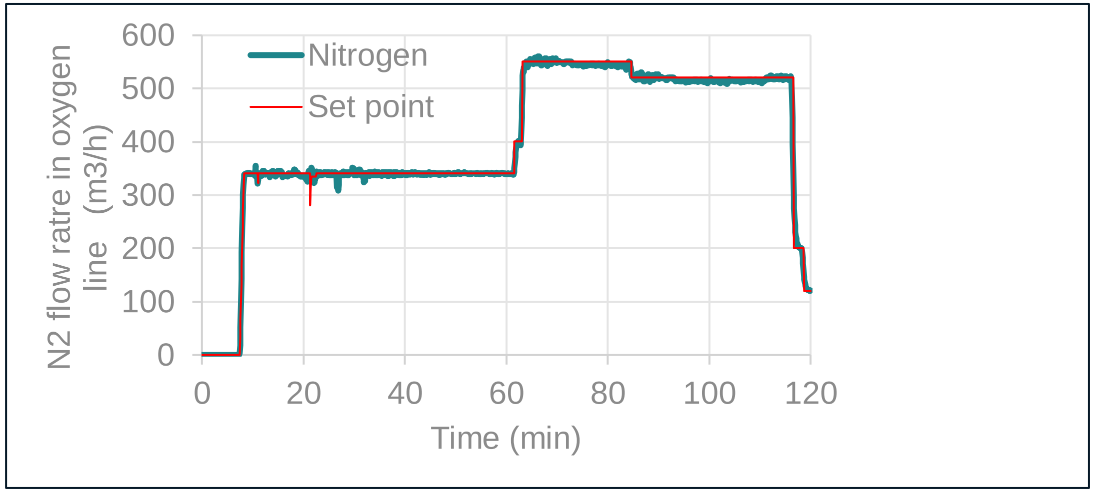
Preparation the site for the pilot tests and first test with N2

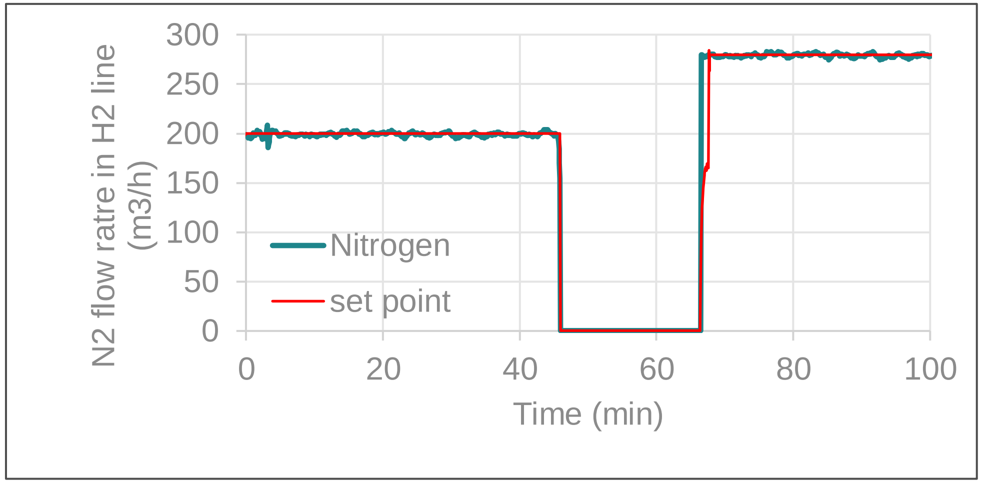
The **cryogenic oxygen tank of 10.000l,** the **FSRS** and the **Oxygen ramp** have been **delivered** to RINA-CSM Dalmine.

These equipment have been **installed** at **RINA-CSM Dalmine yard**.



Trials with N2 in order to verify the whole equipment functionality **have been carried out**





Communication, dissemination, exploitation CDE

The DevH2forEAF web site has been realized at the following address: **https://www.devh2eaf.eu/**. The website page is periodically updated in accordance with the progress of the project and the dissemination activities.

DevH2forEAF website homepage
https://www.devh2eaf.eu/

Event	Presentation/article title	Location	Data
Aachen Hydrogen Colloquium	Influence of hydrogen burners in the electric arc furnace”	RWTH Aachen University (IT)	19^{th} April 2023
La decarbonizzazione dell'industria Siderurgica	Developing and enabling H2 burner utilization to produce liquid steel in EAF	University of Rome La Sapienza (IT)	20^{th} April 2023
European Steel Technology and Application Days (ESTAD)	Developing and enabling H2 burner utilization to produce liquid steel in EAF	Düsseldorf (GE)	12^{th} -16^{th} June 2023
5^{th} European Academic Symposium on EAF Steelmaking	Application of hydrogen operated burners in the electric arc furnace	University of Oulu (FI)	5^{th} -7^{th} June 2023
AIM _ EAF International Meeting - Decarbonizing Steel industry	Developing and enabling H2 burner utilization to produce liquid steel in EAF	Bergamo (IT)	30^{th} November 2023

Main industrial outcomes

1) **Development of modern multi-fuel burners for EAF** able to burn a mixture of fossil fuels **with hydrogen up to 100%.**

2) Definition of the **influence of hydrogen** on steel chemistry and **EAF plant/process**

3) Define the **feasibility utilization of H_2 burner in EAF** by means of both laboratory tests and industrial scale trials

4) Realization of **H_2 burner risk analysis**.

5) **Technical assessment of H_2 burner thought LCA analysis** and comprehensive overview of various technologies to produce H_2 in situ (process integration).

Main socio-economic impacts

1) **<u>Community Engagement</u>**: Local communities may be affected by changes in industrial processes. **Open and transparent communication** with affected communities is essential to address any concerns and ensure a smooth transition.

2) **<u>Skill Development and Training</u>**: The adoption of new technologies may require the **retraining of the workforce**. Investment in **training programs** can help workers acquire the **necessary skills** for the evolving industry.

3) **<u>Job Creation and Retention</u>:** Creation of **new jobs** in the hydrogen production and distribution sectors. Additionally, retaining jobs in the **steel industry becomes more viable as it adapts to more sustainable practices**.

4) **<u>Innovation and Technological Advancements</u>:** The adoption of hydrogen-based technology may stimulate innovation and research in the steel industry, **leading to the development of new technologies and processes**.

Exploitation pathway

The strategic plan to maximize the benefits of the project ha been defined:

1) **Stakeholder identification**: stakeholders are **partners in the project** (steel producer and plants for steel plant producer) and steel other stakeholder are **informed by the project results**.

2) **Communication**: Communication strategy has been adopted to create awareness about the project by means of conference participation and **website realization**, **publication on scientific paper of open source journals**

3) **Collaborations and Partnerships**: There are a strictly **collaboration among the project partners**. Several remote **meetings** have been carried out. Moreover, various **technical meeting in presence** have been held.

4) **Scaling and Replication**: The H_2 burner prototypes has **realized both at small size industrial industrial size**.

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Time to production

The DevH2forEAF project is on-going and in 2024 the following experimental trials will be carried out:

1) Pilot scale experimental tests at RINA-CSM in Dalmine (on-going activity)

2) Industrial experimental trials in Ferriere Nord

3) Industrial experimental trials in CELSA.

Additional funded researches activity with a duration of 3-4 years, **necessary to test the H_2 burners for a long period**, should be envisaged before evaluating the commercialization of the H_2 burners. **The speed of diffusion** of this technology is closely related to the **price and availability of H_2 and the CO2 price trend**.

Remaining obstacles

Benefits associated with the utilization of hydrogen (H2) in steel production are well-know but several obstacles remain, hindering its widespread utilization.

1. **Cost of Hydrogen Production:** The cost of hydrogen production is very expensive. Lowering the **cost of green hydrogen is crucial** for its competitiveness in steel production.
2. **Hydrogen Infrastructure:** Establishing large-scale **green hydrogen production** facilities and developing a comprehensive hydrogen **distribution infrastructure**, **including pipelines and transportation methods**, are necessary to produce and to deliver green hydrogen from production sites to steel plants.
3. **Materials capability**: Some materials used in existing steel production processes **may not be compatible with hydrogen-rich environments**.
4. **Regulatory and Certification Frameworks:** Establishing clear **regulatory frameworks** that support the integration of hydrogen in steel production is essential. **Governments and regulatory bodies need to provide incentives** and policies that encourage the adoption of hydrogen technologies.
5. **Hydrogen Availability and Reliability:** Ensuring a **consistent and reliable supply of hydrogen**, especially green hydrogen, **is crucial for the continuous operation of steel plants**. The intermittent nature of renewable energy sources used for hydrogen production (such as solar and wind) can lead to variability in hydrogen availability.
6. **Safety aspects: Safety is a paramount concern when incorporating hydrogen** into industrial processes. **Hydrogen has different combustion characteristics and safety considerations** compared to traditional fuels, and EAF facilities need to meet stringent **safety standards**.

Lessons learnt to date - recommendations

The utilization of **hydrogen** in for the steel production in EAF is a promising technology that can reduce greenhouse gas emissions and **make the steel industry more sustainable**. Below some **key lessons learned** and considerations for the utilization of hydrogen in steel production:

Hydrogen Storage and Transportation

Developing **safe and efficient methods for storing and transporting hydrogen to steel plants is essential**. Hydrogen is highly flammable and requires special handling and infrastructures.

Economic Viability:

The cost of **green hydrogen production needs to become competitive**. Moreover, the present capability to produce green **hydrogen is another critical points.**

Safety Protocols:

Establish stringent **safety protocols** for handling hydrogen in **steel plants** to prevent accidents and ensure the well-being of workers.

DevH2forEAF

RINA SMS group IOB Department for Industrial Furnaces and Heat Engineering RWTH AACHEN UNIVERSITY NIPPON GASES The Gas Professionals PITTINI celsa barcelona AFV BELTRAME GROUP

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