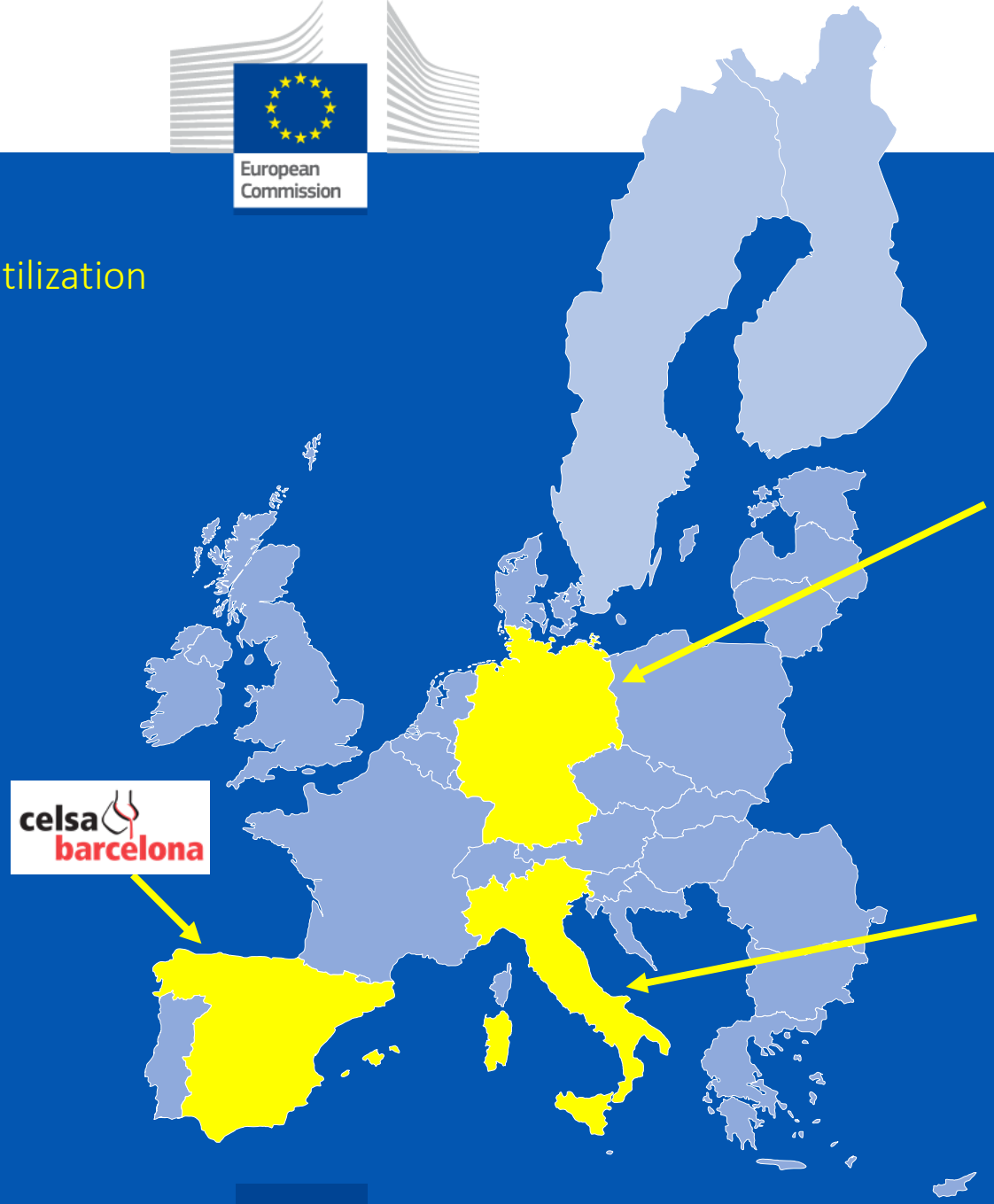
DevH2forEAF

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

Eros Faraci (RINA-CSM)

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



Project Overview

Problem tackled by DevH2forEAF

The project is focused on the evaluation of the influence of the hydrogen combustion in substitution of fossil fuels in EAF process metallurgy.

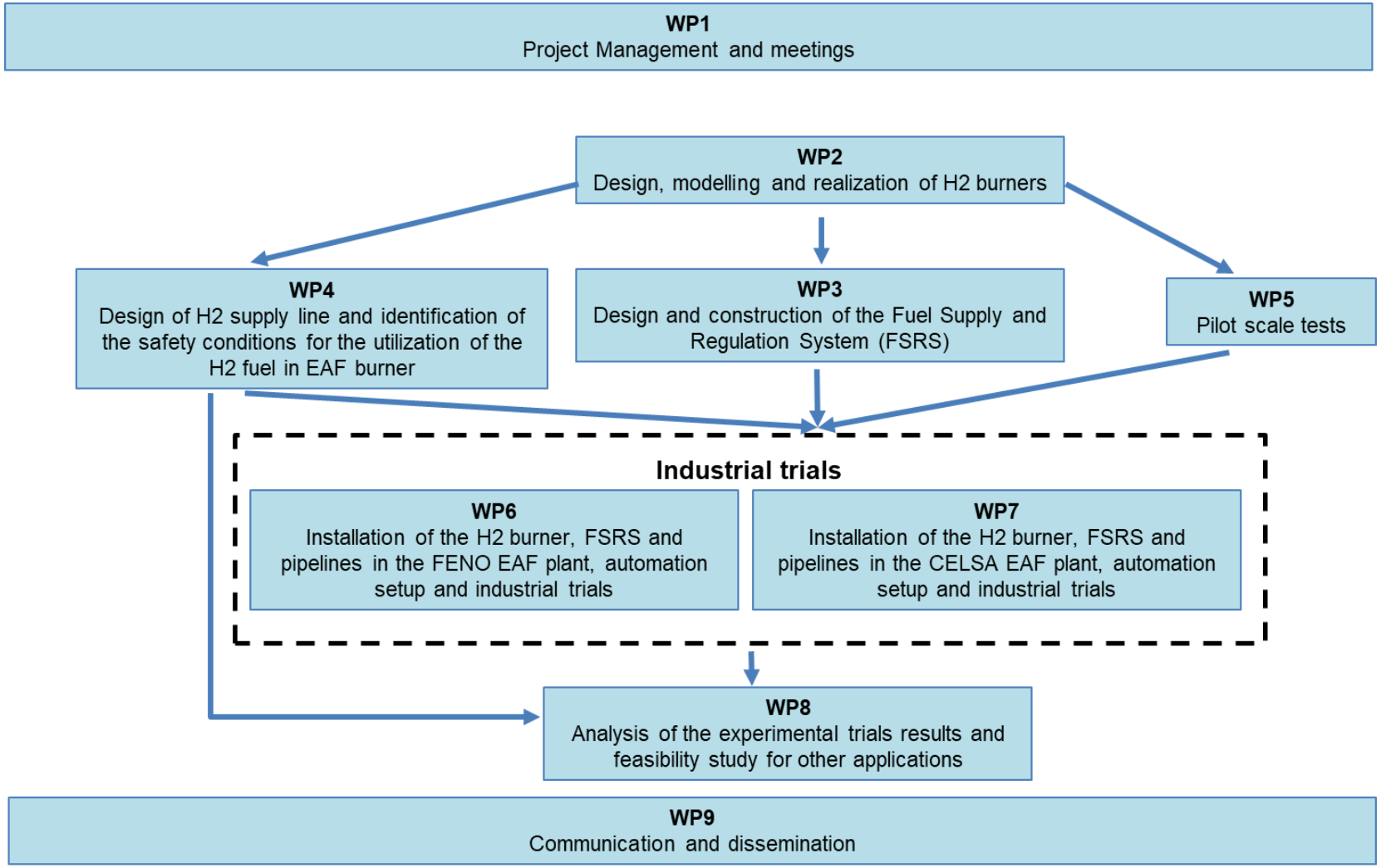
Main objectives

- Reduction of the carbon footprint trough the use a new technology that enables the use of hydrogen in substitution of fossil fuels in EAF process
- Offer an almost ready-to-market technology improving the knowledge of possible applicability scenario for a clean and affordable production of steel.

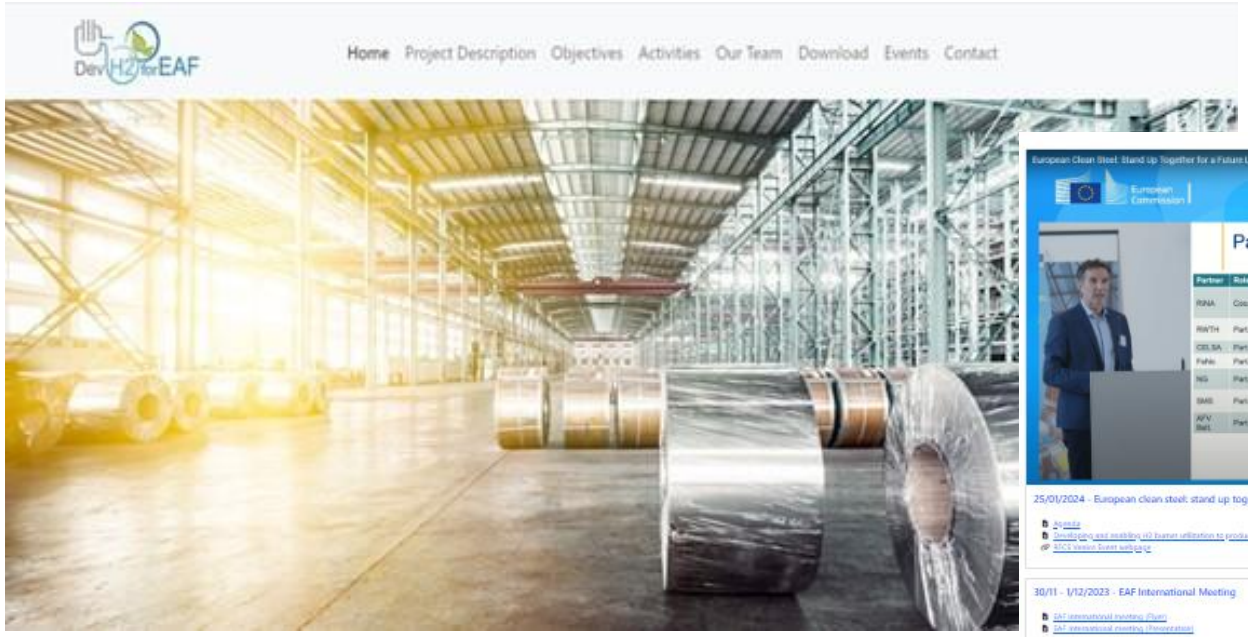
Main Tasks

1. Designing of innovative burners
2. Preliminary risk analysis for Hydrogen use in EAF
3. Tracking the performance of hydrogen burner in replacement of natural gas or other carbonaceous fuels through laboratory trials and industrials trials
4. Analysis of the performance of H2 burners with the definition of future improvements

WPs distribution



DevH2forEAF website



25/01/2024 - European clean steel: stand up together for a future low emission industry - Hydrogen: a powerful ally

30/11 - 1/12/2023 - EAF International Meeting

12-16/06/2023 - METEC & 6th ESTAD (European Steel Technology and Application Days)

05-07/06/2023 - 5th European Academic Symposium on EAF Steelmaking June 2023 - EASES 2023

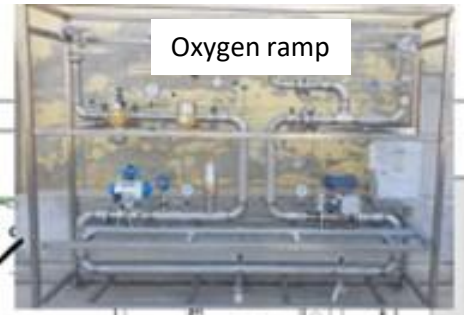
20/04/2023 - La decarbonizzazione dell'industria siderurgica

18-19/04/2023 - Aachen Hydrogen Colloquium 2023

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

Preparation of the CSM Dalmine site for the experimental campaign

The **cryogenic oxygen tank of 10.000l,** the **FSRS** and the **Oxygen ramp, H2 burner and chiller** have been **installed** to RINA-CSM Dalmine.



Experimental trial

On the **19-23 February 2024** the experimental campaign has been carried out, with the objective to verify performance of the H_2/burner in preparation for the industrial trials. These tests have permitted to evaluate:

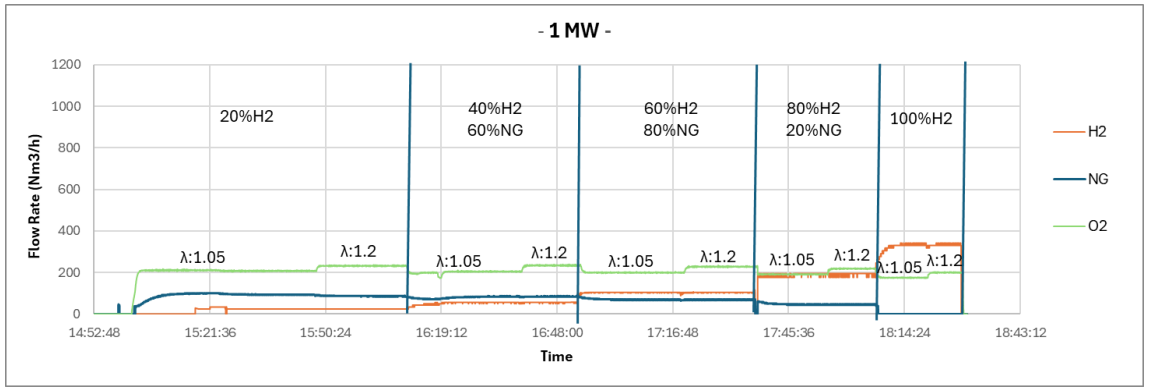
1) The burner functionality

2) The thermal field, heat transfer in the furnace at different power input

Matrix of the experimental trials

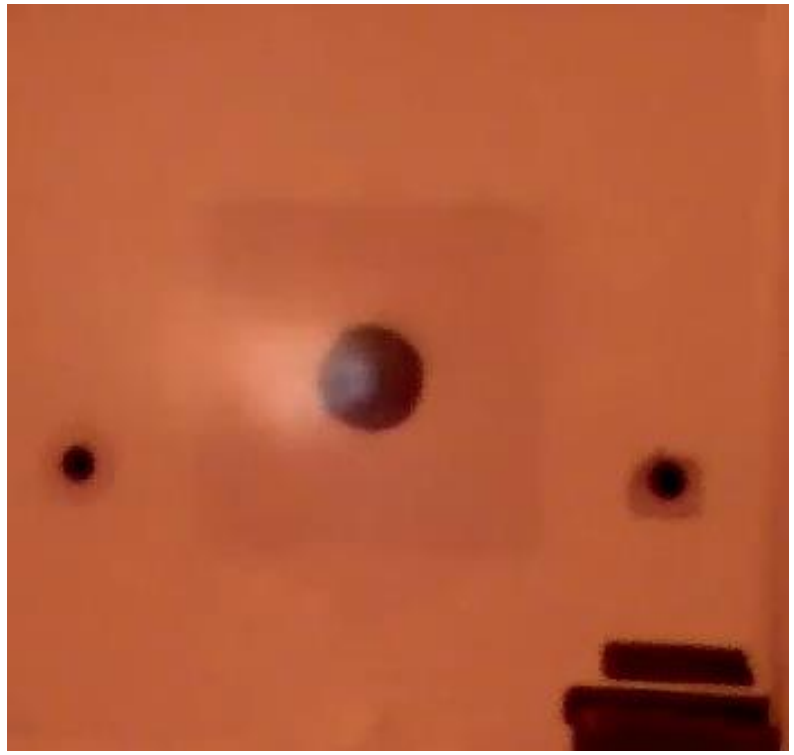
Power (MW)	Combustion ratio (Lambda)	H_2%
1	1.05 and 1.2	0%- 20%- 40%-60%-80%-100%
1.5	1.05 and 1.2	0%- 20%- 40%- 60%-80%-100%
2	1.05 and 1.2	0%- 20%- 40%-60%-80%-100%
2.5	1.05 and 1.2	0%- 20%- 40%-60%-80%-100%
3	1.05 and 1.2	0%- 20%- 40%-60%-80%-100%

Experimental trial



1 MW 100%NG

1 MW 100%H_2



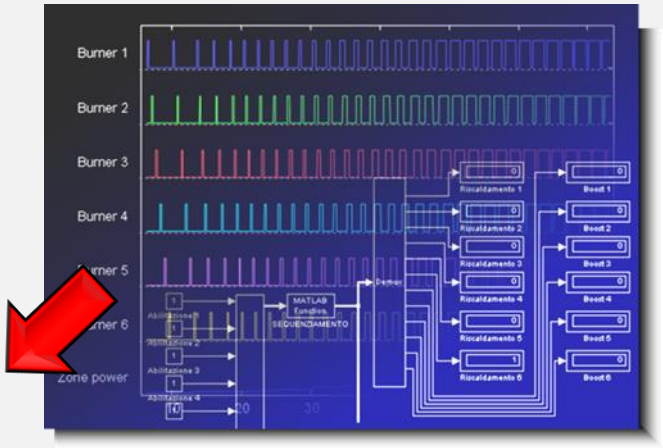
Combustion
Low environmental impact furnaces

Development and testing

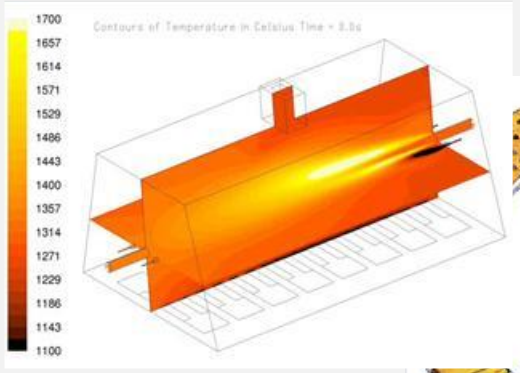
- Since 1963 RINA-CSM develops and tests gaseous and liquid combustion systems in Experimental Station for Combustion Studies located in Genoa (ILVA)
- In 2001 the laboratory moves to Dalmine (BG).
- The main customers are combustion plants producers and end users for applications mainly in the steel industry
- Examples of new burners developed/tested:
  - ✓ from traditional to flameless to regenerative flameless
  - ✓ burners with different fuels (from NG to BFG, BOF, COG and H_2/NG blends, H_2)
- Main issues considered: safety, thermal efficiency, low emission (soot and NOx).

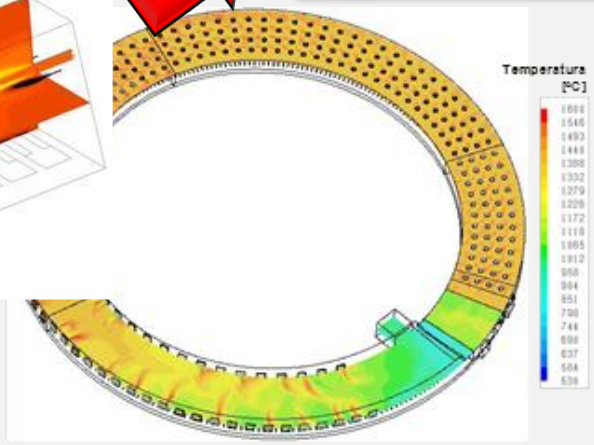
Combustion
Low environmental impact furnaces

Lab Testing



Automation

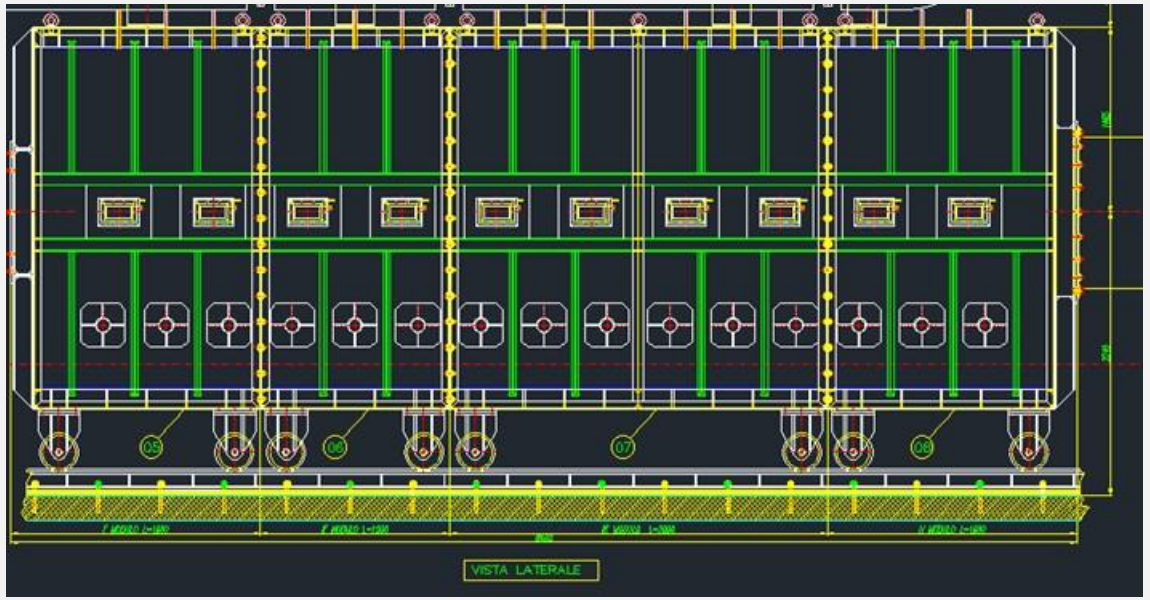




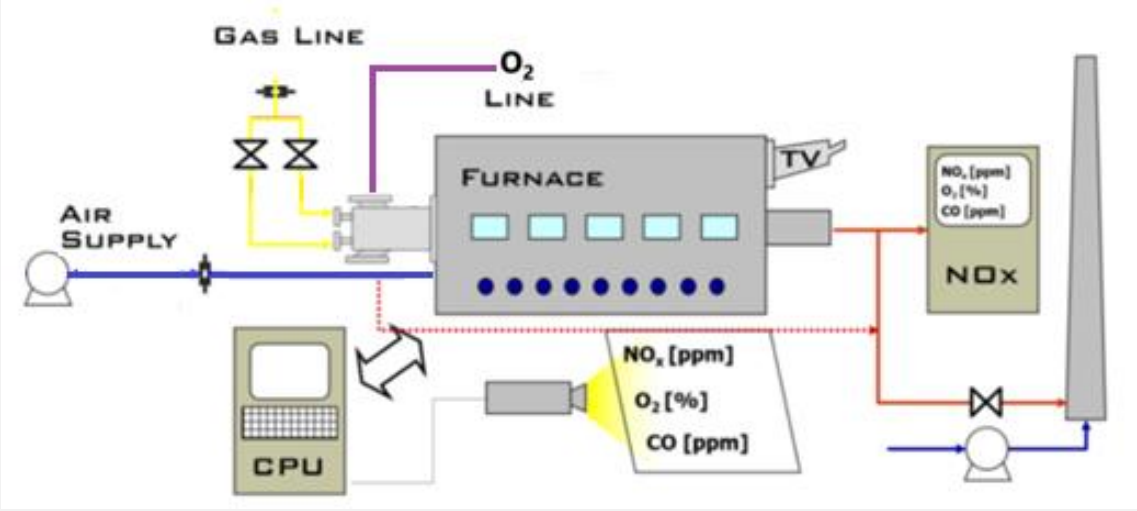
Modeling

Service / monitoring

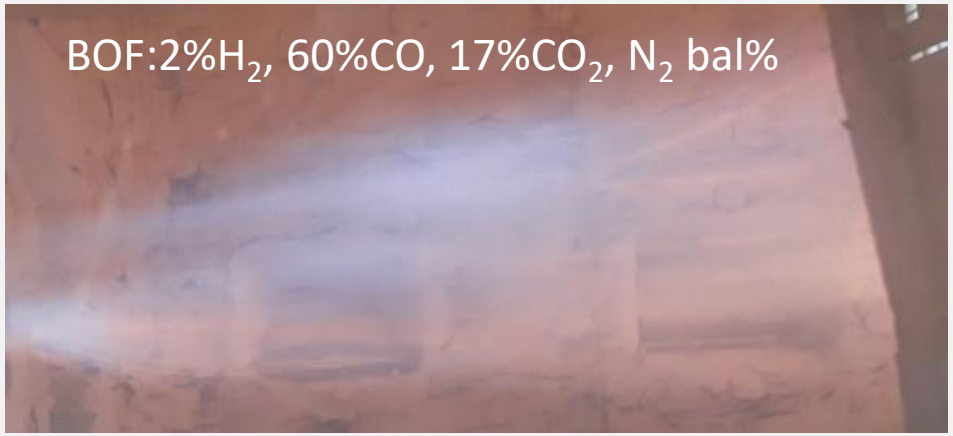
COMBUSTION STATION EQUIPMENT
Modular furnace (1 to 3 MW)

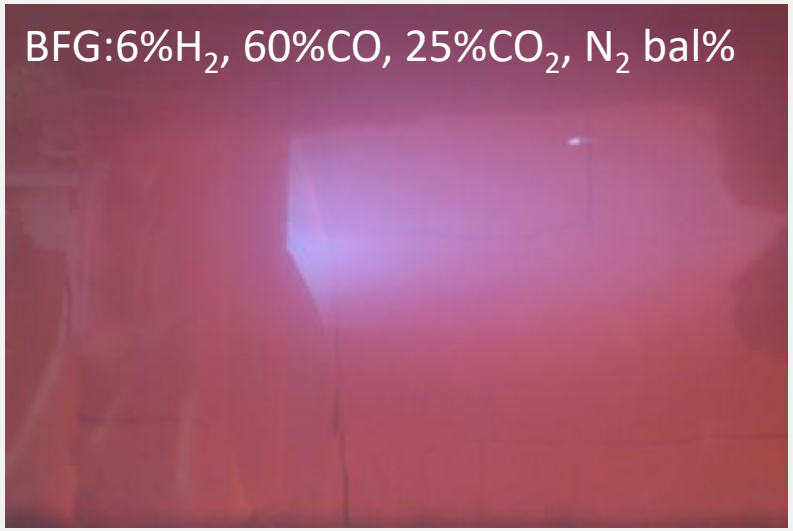


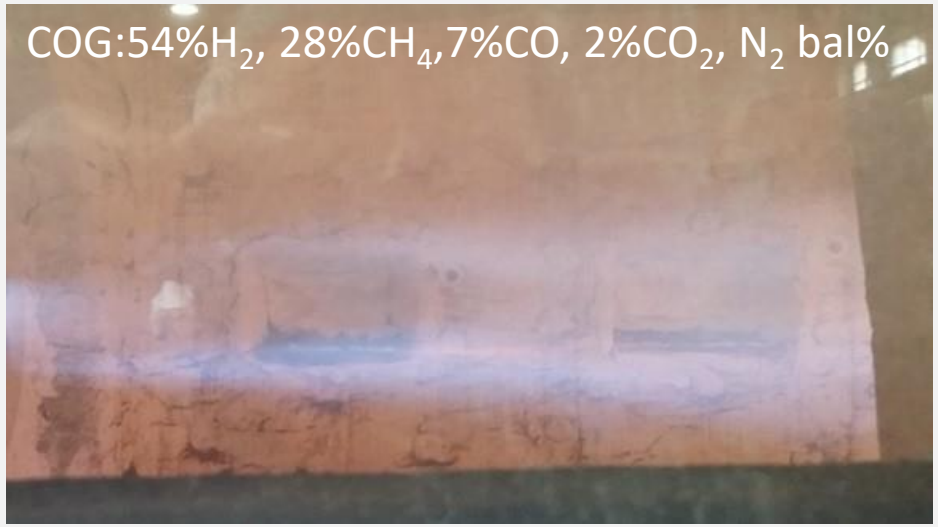
Length (internal)	[m]	3 – 7.5
Cross Section	[mm] x [mm]	2000 x 2000
Maximum Burner Capacity	[$MW_{gas\ based}$]	3
Maximum NG Flow Rate	[Nm^3/h]	300
Maximum Syngas Flow rate	[kg/h]	2000
Maximum Air Flow Rate	[Nm^3/h]	3500
Maximum Working Temperature	[°C]	1250
Stand-alone air preheater (for testing traditional burner)	[°C]	up to 550
Thermocouples for measuring longitudinal temperature profile along burner axis;		
Continuous Pollutants Monitoring system for O_2, CO & NOx;		
Computer Controlled System		
Continuous Video Monitoring		
Cooling water lances to properly control furnace temperature for different thermal load		



Characterization of burner with different fuel





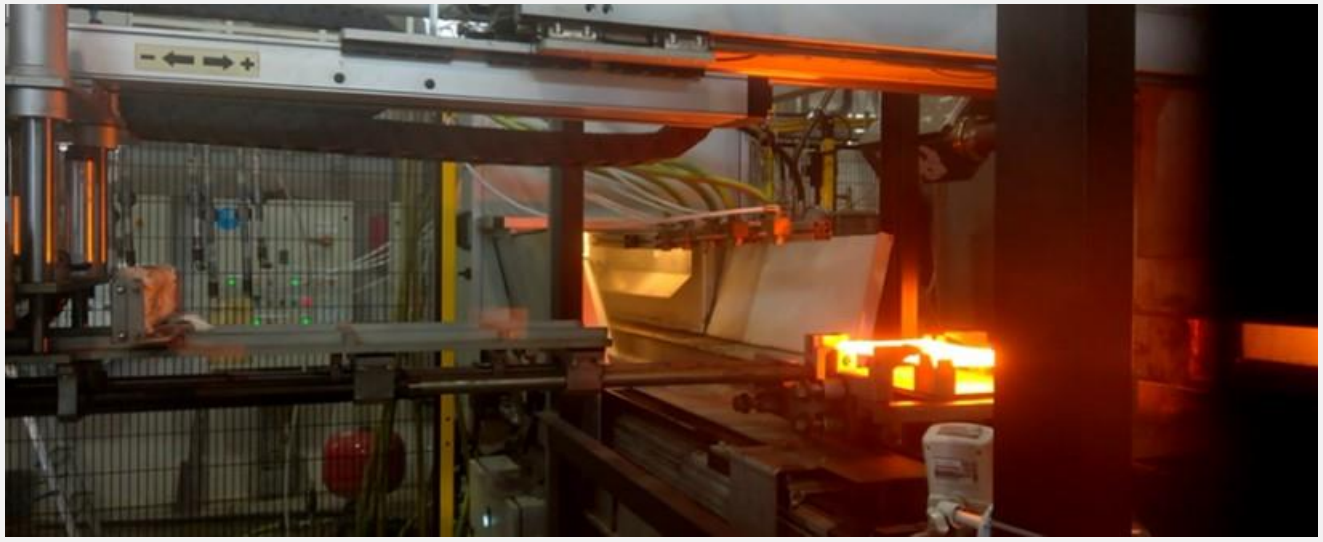


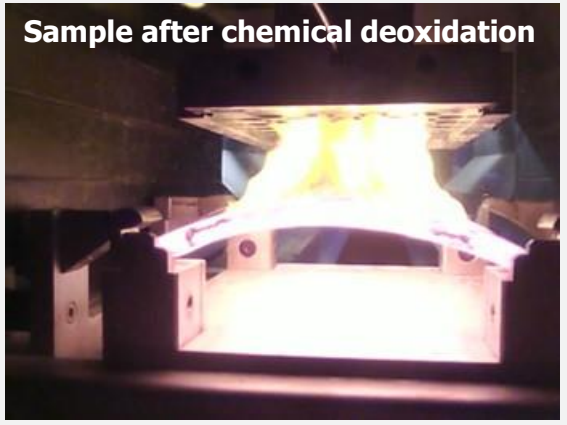
COMBUSTION STATION EQUIPMENT
Descaler Simulator

DESCALING PILOT PLANT

Experimental tests for the conditioning of high temperature surfaces

- Sample heating up to 1300 °C and surface oxidizing under controlled condition (nitrogen, natural or synthetic gas)
- High pressure water descaling or deoxidizing by product addition (flow rate up to 132 l/min at pressure up to 400 bar, travel speed: 1 to 4.2 m/s)
- Use of different nozzles type and geometrical dispositions-
- Metallographic characterization
- Descaling map for the industrial setup optimization
- Overlap effect
- Double descaling

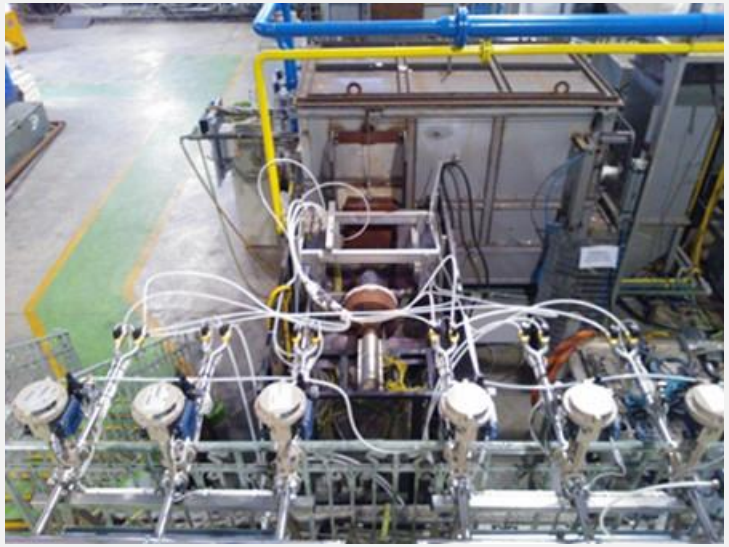




COMBUSTION STATION EQUIPMENT
Thermal Fatigue & Quenching

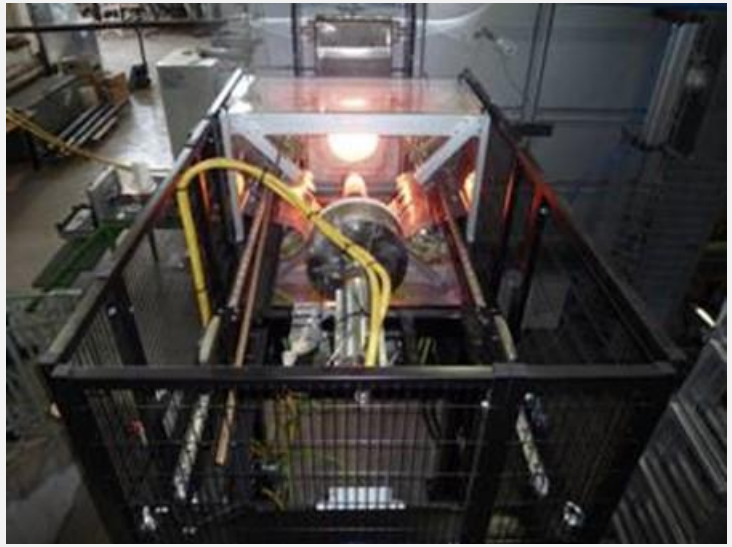
EXPERIMENTAL FACILITY FOR THERMAL FATIGUE AND QUENCHING TESTS IN REAL INDUSTRIAL SCALE

- Flexible system: only air, only water or air / water spraying nebulization
- Temperature heating furnace: up to 1300 °C
- Samples temperature monitoring (thermocouples and infrared camera)
- Maximun size and weight samples: 300x200 mm (length, diameter with several shape), 50 Kg
- Automatic repetition of test (fatigue tests)



Pilot furnace

Nozzle valve manifolds



Sample during test

HYDRA Project

HYDRA

Un experimental platform to support EU steel industry decarbonization and the value chain improvement

HYDRA aims at developing an **industrial living platform** in which **develop, qualify and validate** the use of **hydrogen in the Hard to Abate industry** in order to support and boost the decarbonization process in the steel sector.

Funded by
the European Union
NextGenerationEU

4 Work Packages:

- **WP1:** testing and qualification of materials and components interacting with hydrogen
- **WP2:** innovative process for the production of pre-reduced products using up to 100% hydrogen
- **WP3:** production of steel in electric arc furnace (EAF) with pre-reduced iron ore manufactured by direct reduction by hydrogen
- **WP4:** use of hydrogen in furnaces

HYDRA WP1: testing, qualification & training HUB

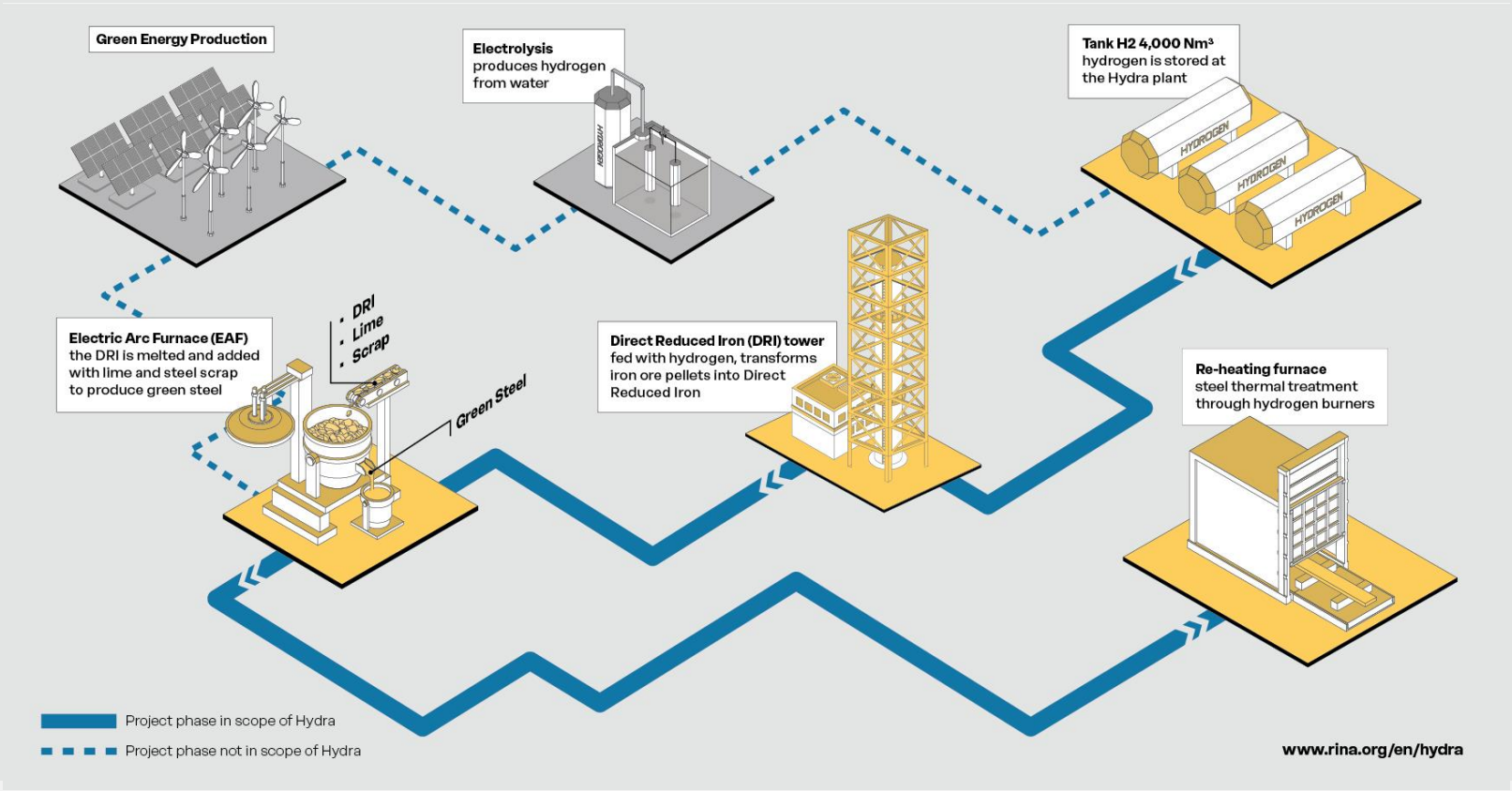
A permanent international research and development platform open to all stakeholders in the steel and energy industries

Testing and **qualification hub** For **hydrogen transportation** and **storage,** to support the transition to **100% hydrogen fueled steel production**

Training centre

Scheduled for completion by H1 2025

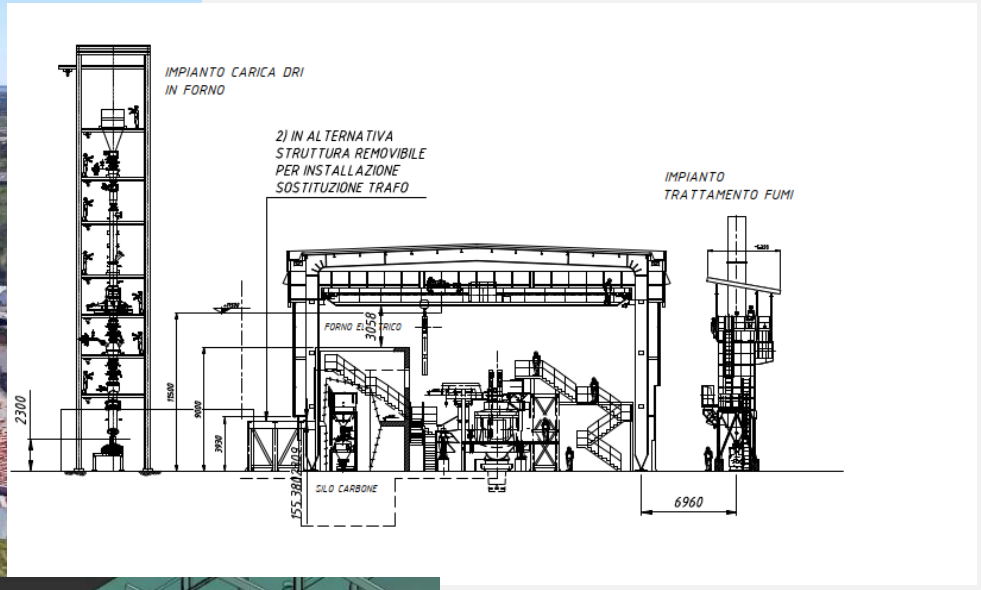
HYDRA WP2/WP3: experimental platform - DRI + EAF

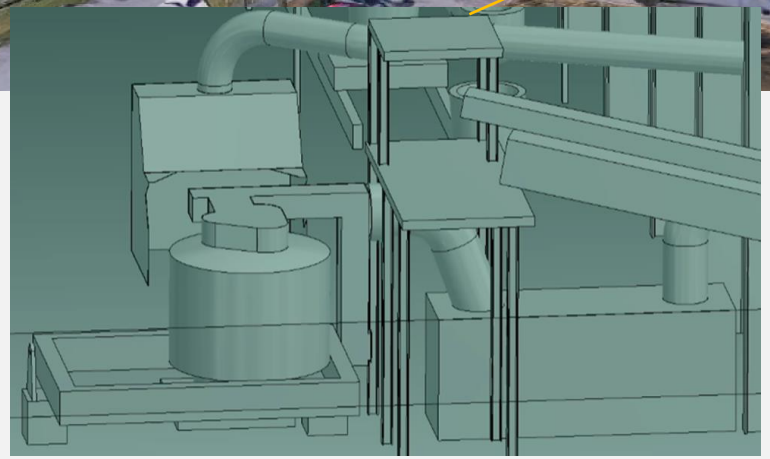


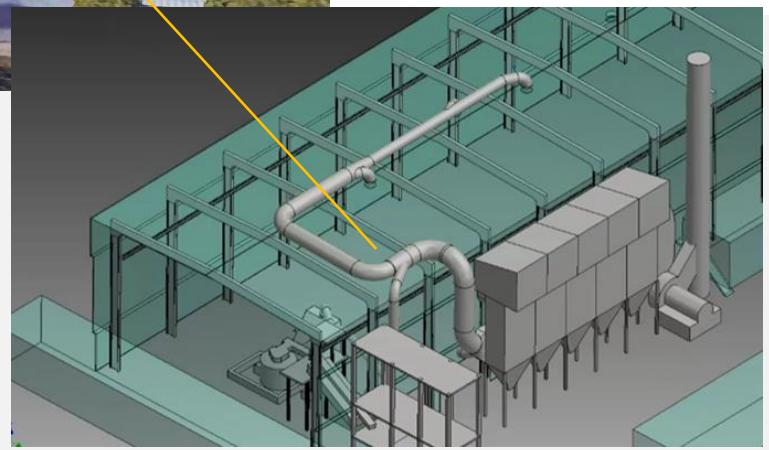
The structure, scheduled for completion by 2025, will consist of a Direct Iron ore Reduction (**DRI**) tower using hydrogen as a reducing agent, an electric furnace (**EAF**) and burners development for reheating **furnaces**, integrating pilot activities with full scale industrial tests

HYDRA

HYDRA - Preliminary Layout (DRI-EAF)







HYDRA – WP2: DRP plant

WP2 Production of DRI with flexible shaft furnace (from 100% CH4 to 100% H2), with productivity of 100 kg/h

Plant potentialities:

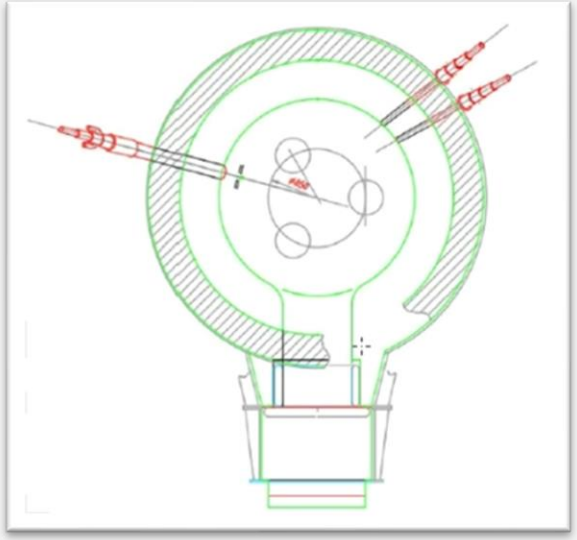
- Test with pellets of different quality
- H2 / CH4 switch
- Process kinetic and efficiency
- Metallization degree (>94% expected)
- Process energy demand as function of operating practices
- Advanced training hub

Typical working condition requires reaction temperature of 1000°C, pressure of 4-6 bar, pellets size 30-40 mm and power consumption of ~400kW

HYDRA

HYDRA – WP3: Production of steel in EAF made by DRI

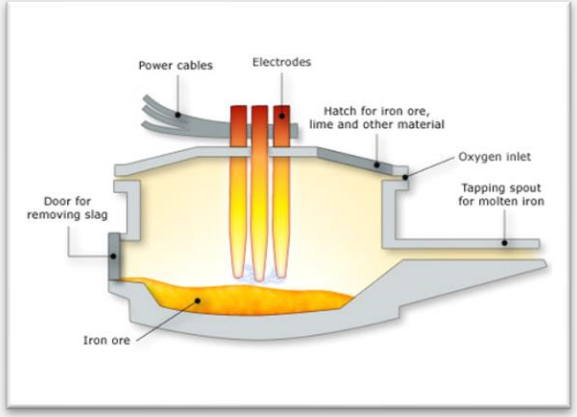
WP3 Production of steel in EAF (7 tons) with scrap and/or pre-reduced iron ore manufactured by direct reduction with H2. Production capacity up to 150 casting/year with DRI by



Plant potentialities:

- Test with DRI at different C percentage
- H2 Burning
- DRI quality and different Slagging practice
- Slag foaming
- Secondary carbon carriers injectionto replace coal
- Process energy demand as function of operating practices
- Advanced training hub

- ≈ 10-12 heats/months



EAF will be ready for even future implementation: (Smelter, Trimming station, …)

HYDRA

HYDRA WP4: application of hydrogen in hard to abate

Burners testing and development campaign at **pilot combustion station** and **descaling testing**

Product quality test **with different steel grades**, simulating natural gas and hydrogen combustion atmosphere

Burners test at industrial premises and new refractory materials

Definition of the best conditions for industrial process implementation by 2024

HYDRA – Project timing

Project officially started on the 1° January 2023 and will last six years

- **Procurement step concluded**
- **Permitting step is on ongoing**

- **Realization of H2 testing lab and facilities March 2024-December 2025**
- **DRP and EAF plants detailed design January 2024 – Sept 2024**
- **DRP and EAF plants erection September 2024-December 2025**

- **Interaction with industrial partners for the definition of activities (oxidation/descaling/burners testing) by December 2024**

ACKNOWLEDGMENTS

This work was carried out with support from the European Union's Research Fund for Coal and Steel (RFCS) research program under the ongoing project: *Development and enabling of the use of the H2 burner to produce liquid steel in EAF – DevH2forEAF-* GA number: 101034081.

Thank you for your attention

For further information visit the website
https://www.devh2eaf.eu/