H2 opportunities for IT Companies in LATAM - Chile

Case study

HYDRA: Open Platform for H_2 based Steelmaking

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Laura Alleva

Head Material Design & Performances

More than 20 years' experience in Material's Engineering

Main positions

2010 – 2016 Deputy - Metallurgy of carbon steel and special alloys
2014 – 2016 Head of department - Metallurgy of carbon steel and special alloys
2016 – 2017 Head of Advanced Materials competence center
2017 to date Head of Material design & Performance competence center

Main technical expertise

- **Metallurgy of carbon, stainless and electrical steels**
- **Corrosion and stress corrosion of steels and alloys**
- **Through process metallurgy in standard and new manufacturing routes**
- **Material testing and qualification (small, medium and full scale)**

Content of the document

RINA at a glance

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RINA today

5600
colleagues

200
offices

70
countries

Our people

More than **90**
nationalities

80%+
educated to **degree level**

42
average **age**

Who we are

Energy

Energy solutions from O&G to renewables, taking care of sustainability and environmental impacts

Marine

Rules, technologies and innovative services to manage transport and pleasure vessels

Certification

Solutions to support products, people and processes on their way to excellence

Infrastructure & Mobility

The path to the next generation of infrastructure and buildings by ensuring their safety and efficiency

Industry

Accelerating clients' success with technology-driven strategies and solutions

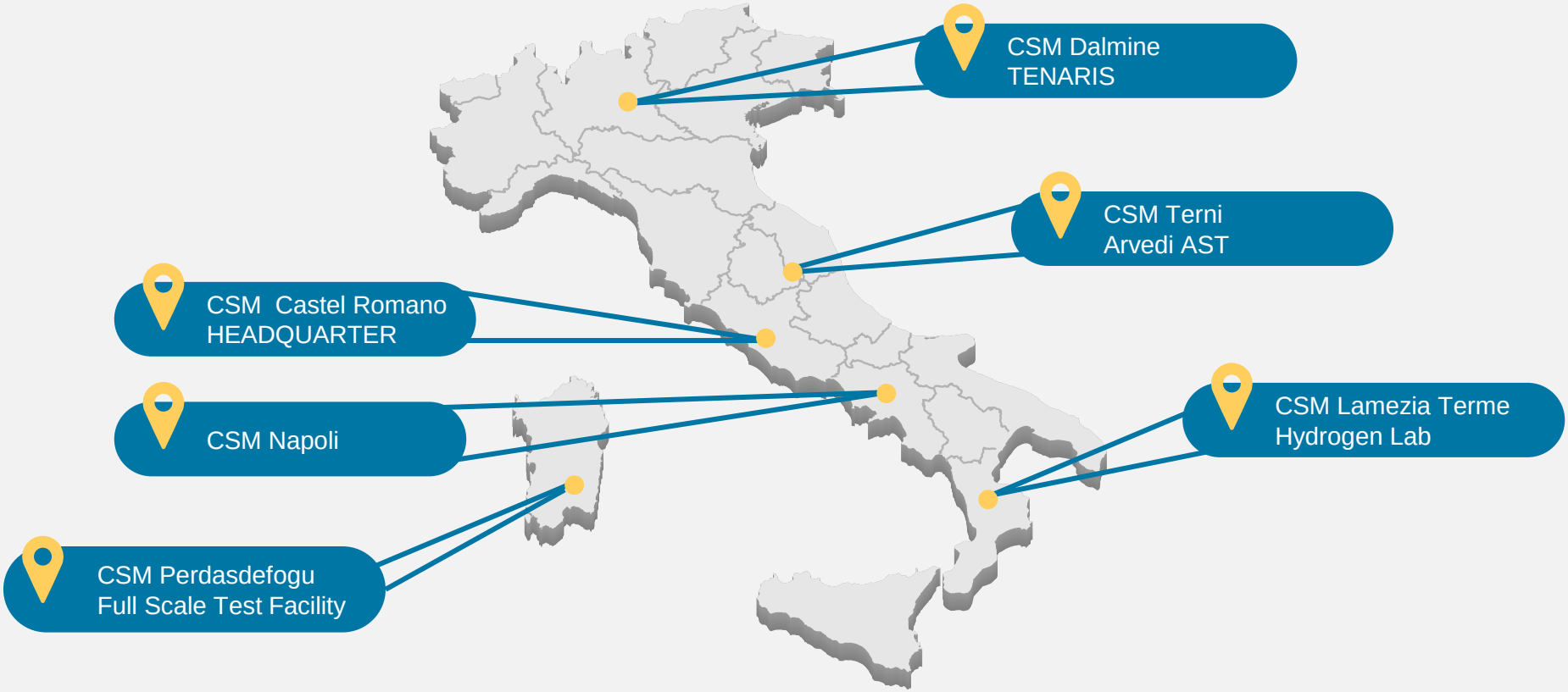
Real Estate

Innovative value proposition of integrated services: Rina Prime Value Services is able to cover all the real estate lifecycle

INDUSTRY 4 Heavy Industry

- The **Industry** BU provides high-added value integrated services with a special focus on manufacturing, steel and heavy industry, aerospace and defence.
- Within the Industry BU, **RINA CSM** is the Company mainly devoted to the Steel and Heavy industry and materials End Users such as Oil&Gas, Power Gen and Automotive.
- **RINA CSM** was founded in 1963 by Italian Government with the mission of developing processes, technologies and products for the Steel Industry.
- Since 2013, RINA CSM has been incorporated in **RINA**.

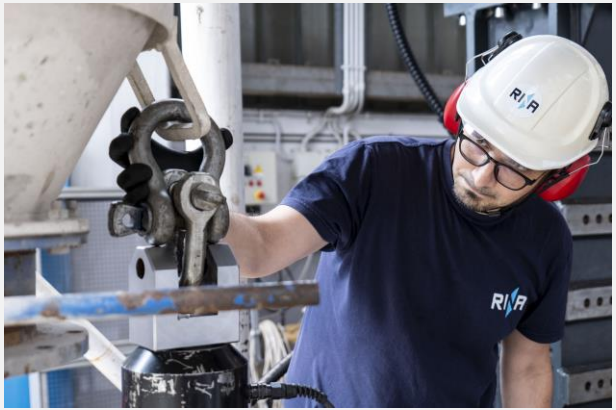
Our CSM Sites in Italy

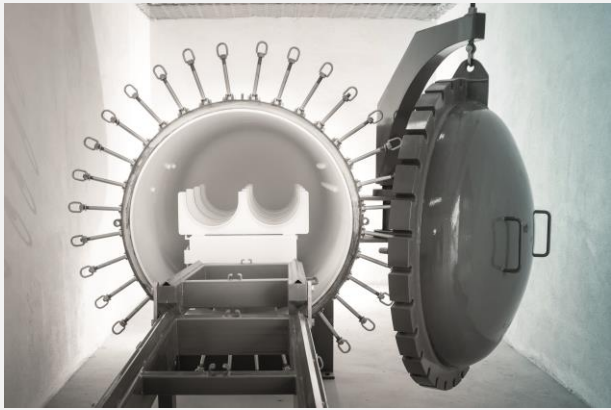


LABS: strengthen our consultancy capability

270 Highly skilled professionals: engineers, consultants and also scientists and technicians

11 Labs and Pilot Lines for prototyping, Proof of Concept (PoC) integration, testing and qualification: from casting to additive manufacturing, from IOT to I4.0 systems assembly





From Raw Material to Final Product

MATERIAL DEVELOPMENT

- Alloys Design for new materials at higher performance
- Alloy Design for Powders for Additive Manufacturing
- New special coatings

PROCESS DEVELOPMENT

- Steelmaking & Casting & Rolling & Forging
- Additive Manufacturing
- Heat treatment & Surface conditioning
- Welding and Joining

PRODUCT DEVELOPMENT

- Net shape and near net shape products
- Semi-products
- Coatings
- Flat, Long Products and Tubes
- Application Engineering
- Prototyping

CROSS - CUTTING TECHNOLOGIES

- Through process approach
- L2/L3 Control Systems
- Tailor made tools Customized sensors
- Technological DB

ENVIRONMENTAL SOLUTION

- Solid Waste Valorization
- Water Management
- Emission Reduction
- Energy Recovery

CASE STUDY

HYDRA
The framework

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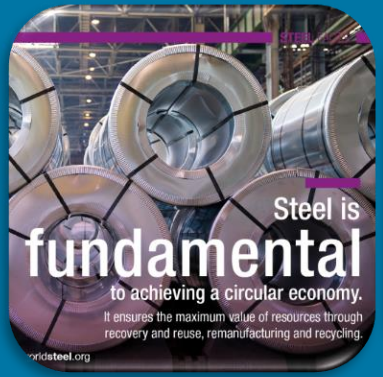
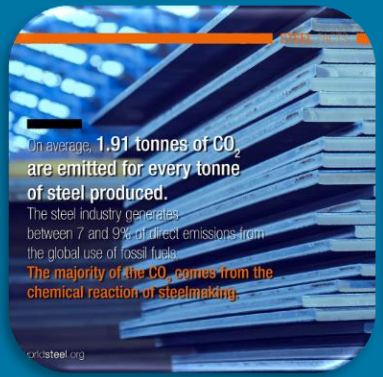
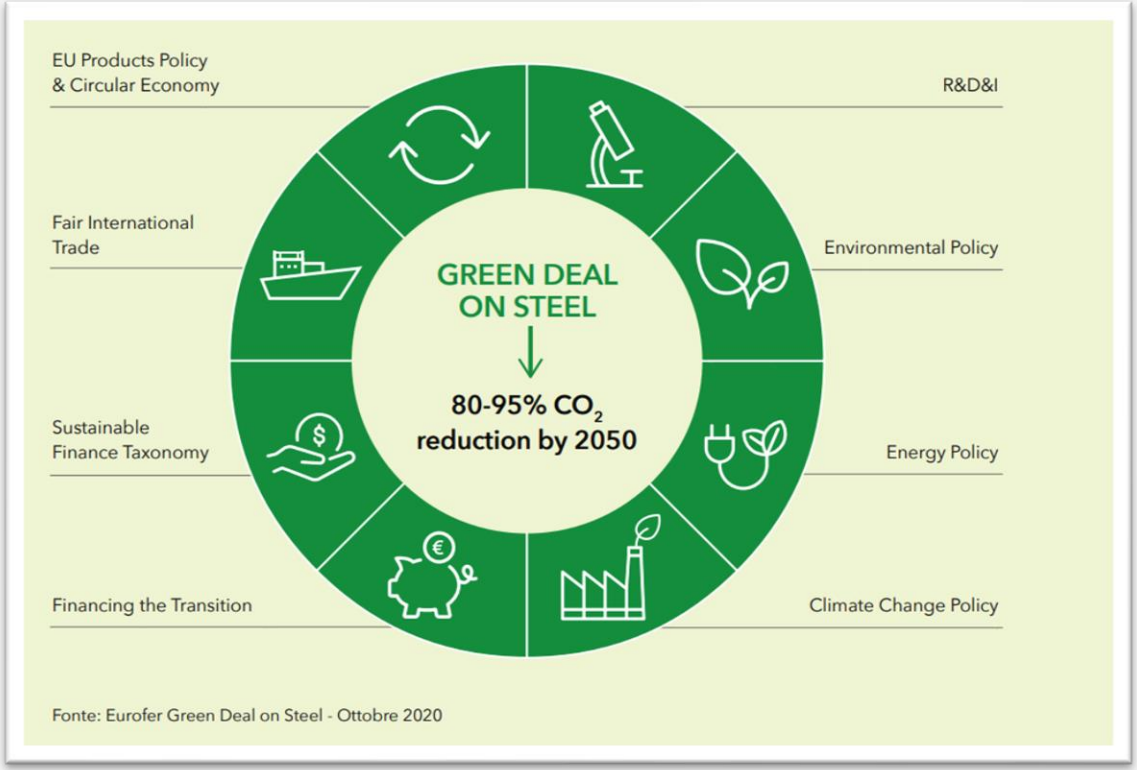
Steel is...

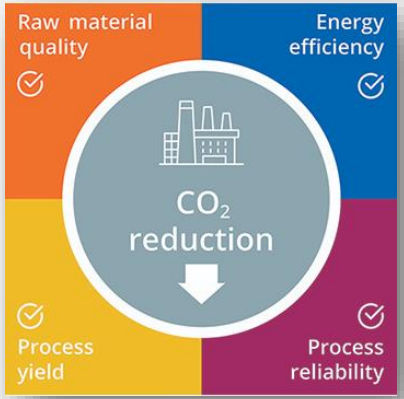
Ref. WORLD STEEL ASSOCIATION





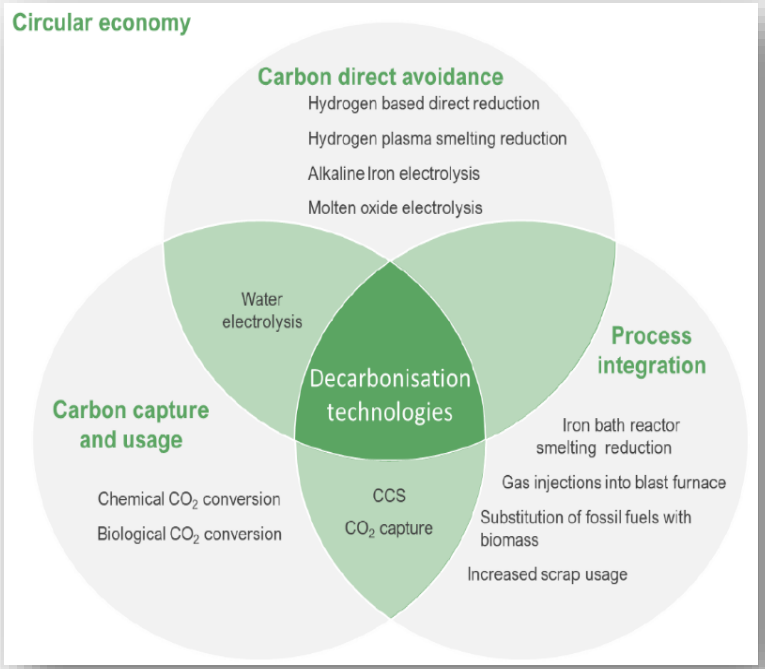
Strategies for the decarbonisation





Europe has set itself the goal of «carbon neutrality« to 2050

The technological options



Carbon Direct Avoidance (CDA)

- Hydrogen-based direct reduction
- Hydrogen plasma smelting reduction
- Alkaline iron electrolysis
- Molten oxide electrolysis

Carbon Capture and Usage (CCU)

- Carbon oxide conversion

Process Integration (PI)

- Iron bath reactor smelting reduction
- Gas injections into the blast furnace
- Substitution of fossil energy carriers with biomass
- High quality steel making with increased scrap usage

There are three routes of possible technological options for intervening on the steel production process, different for CAPEX, OPEX and TRL.

Achieving the decarbonisation goals requires integration of more actions

EUROFER
THE EUROPEAN STEEL ASSOCIATION

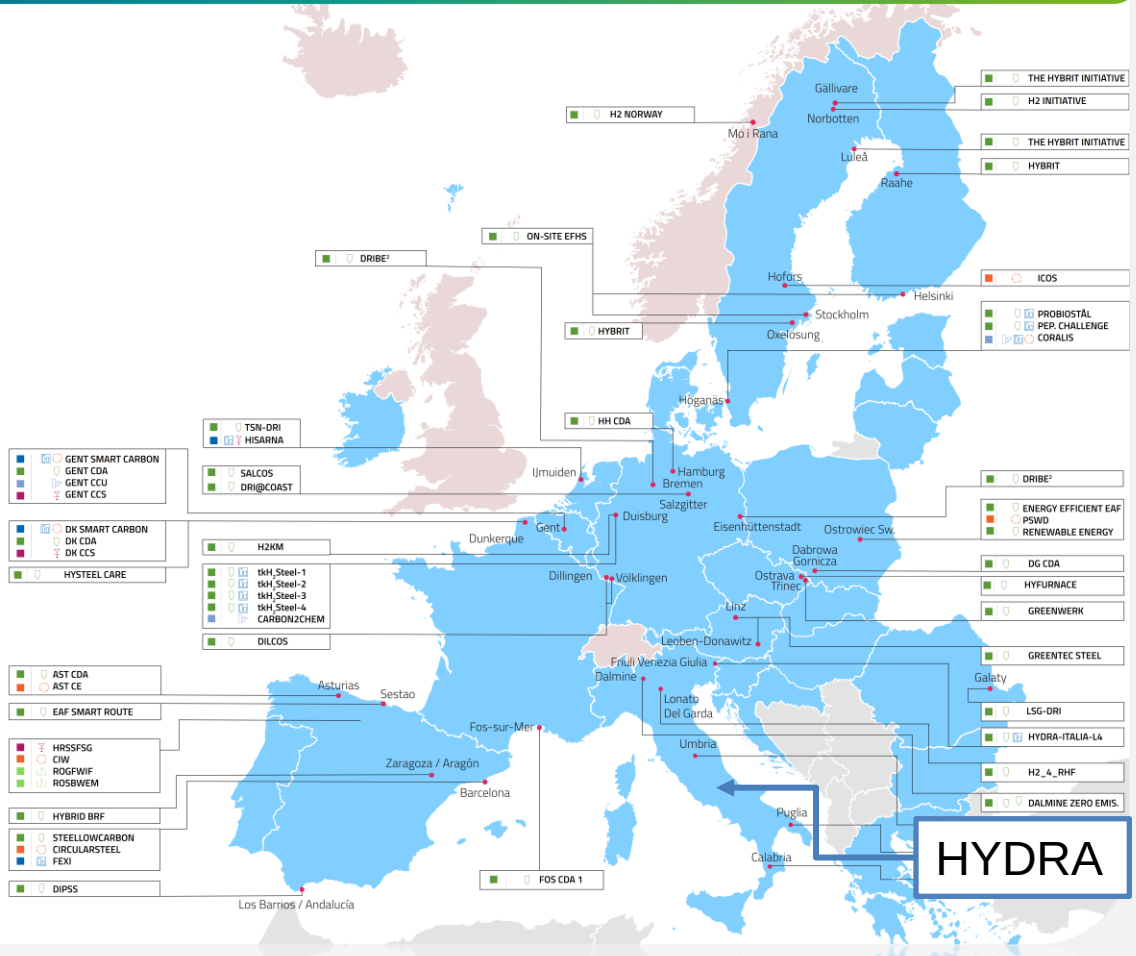
Key steel low-CO_2 projects
Low-CO_2 Emissions Industry

Circular Economy (CE)

Carbon Direct Avoidance (CDA)
- H_2-based metallurgy
- Electricity-based metallurgy

Smart Carbon Usage (SCU)
- Proces Integration
- Carbon Valorisation/CCU

Carbon Capture and Storage CCS²
(not included in SCU, CDA or CE)



HYDRA
The project

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HYDRA

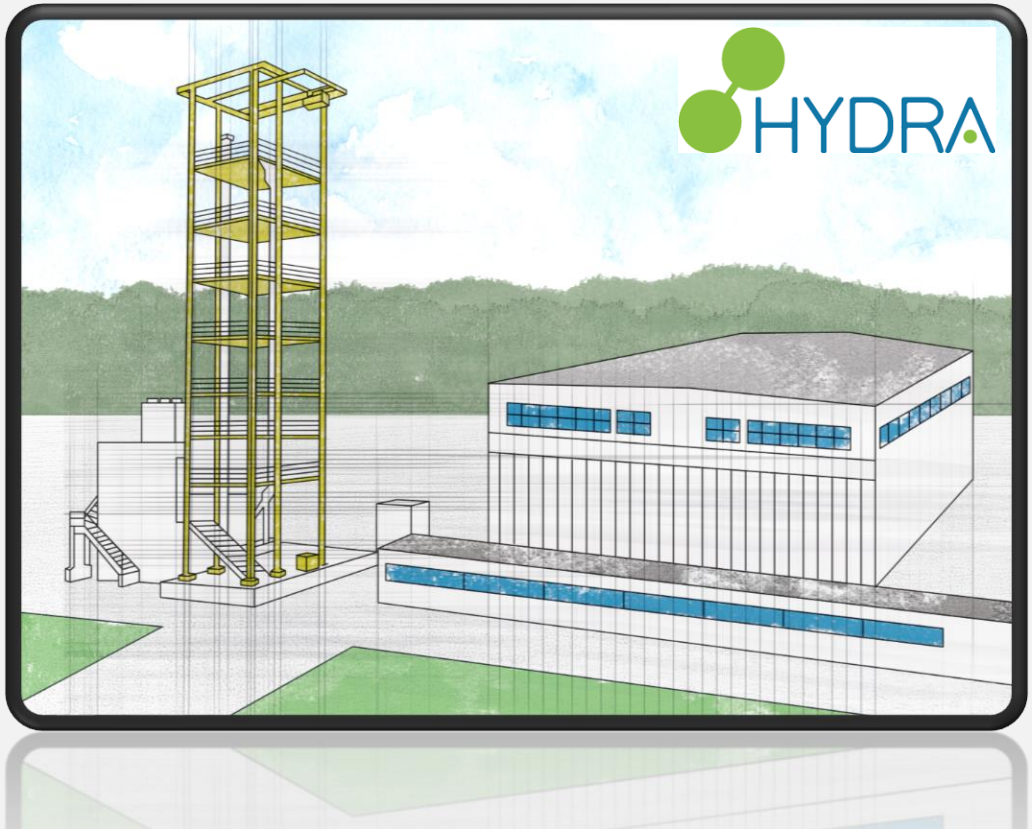
an open research facility to decarbonize the Steel Industry

Funded by the European Union
NextGenerationEU

HYDRA is a European Commission **NextGenerationEU**. Is part of the **IPCEI** (Important Projects of Common European Interest) and will involve a dedicated team of 120 people.

Project value 110 M€ (88 M€ funded)

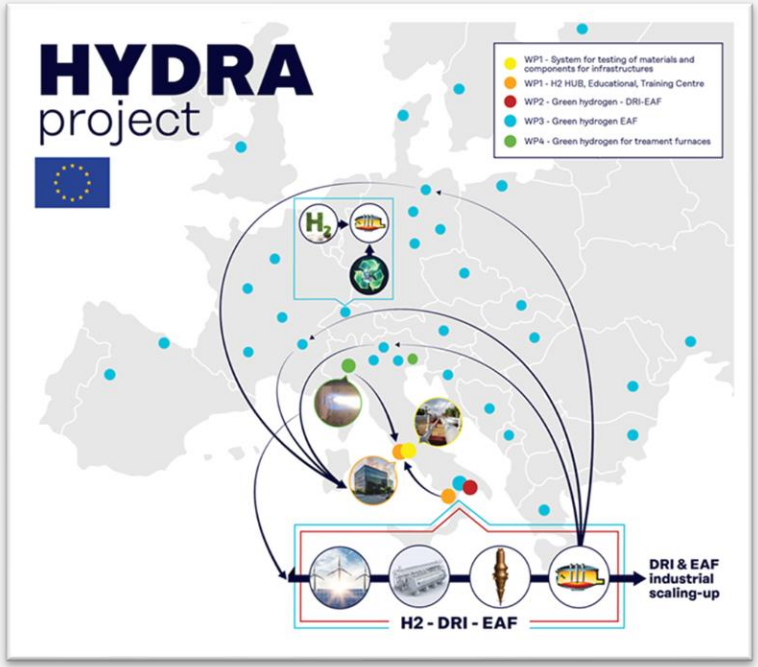
HYDRA aims at developing an **industrial living platform** in which **develop, qualify and validate** the use of **hydrogen in steelmaking** in order to support and boost the decarbonization process in the steel sector.



HYDRA – Project structure

HYDRA Project consists of n° 4 Work Packages:

- **WP1** - Development of green hydrogen use in iron and steelmaking
  - *Methodologies for testing and qualification of Materials/Components*
- **WP2** - Innovative process for the production of pre-reduced products by H2
- **WP3** - Production of steel in EAF with pre-reduced iron ore manufactured by direct reduction by H2
- **WP4** - Use of hydrogen in furnaces



HYDRA - WP1: Development of green hydrogen use in steelmaking

WP1 is strongly linked to the steelmaking activities planned in WP2, WP3 and WP4, with the aim:

- To define the guidelines and procedure for a safe and reliable use of H2 within the industrial steelmaking plants
- To give confidence to the steelmakers about the feasibility of introducing H2 in the industrial steelmaking process
- To make deeper knowledge and to upgrade the standards and regulation framework for the design and realization of dedicated components, for H2, in the steel making plant, with the HSE related issues.

HYDRA - WP1: Development of green hydrogen use in steelmaking

Materials Testing & Qualification

Through a **testing and qualification hub**, the project will also characterize the materials, equipment and internal infrastructure required by steel producers, as well as those required for hydrogen transportation to the plant and storage, for the transition to 100% hydrogen fueled steel production, ensuring a comprehensive and validated shift to hydrogen-based processes, with final scope to assess Materials and components compatibility with hydrogen environment.

- Selection of materials and components for storage transport and distribution lines according to the service conditions (e.g. pressures, mixtures, % hydrogen content), of the different hydrogen storage and separation solutions (e.g. separation membranes, separation by gravity), and the development of guidelines for materials and components selection.
- Functional compatibility of pipelines, components/fittings, equipment (e.g., valve leak testing, compressor stations, regulation and metering stations, burners, etc.)
- Performance and reliability in the different operational scenarios
- Pipeline and fitting integrity status (requiring through integrity assessment)
- Assessment and certification of an existing network
- Support on Design and construction of new lines, equipment in the plants

ΔH Lab


Unione Europea
Fondo Europeo di Sviluppo Regionale
investiamo nel vostro futuro
Programma Operativo Nazionale
Ricerca e Competitività 2007-2013(PON "R&C")
Piano di Azione e Coesione
TEST LAB
PON03PE_00092_1 EOMAT
"Sistemi e materiali innovativi per la produzione e lo stoccaggio di energia rinnovabile"

HYDRA - WP1: Development of green hydrogen use in steelmaking

HSE

There are risks associated to hydrogen properties (fugacity, flammability, ignition energy, permeability, etc.) (leaks, leak detection, odorization, hazardous area classification, safety distances, etc).

It is crucial at EU and national level:

- The upgrading of standards and regulation framework for the design and realization of dedicated hydrogen components in the steel making plant, with the HSE related issues
- The definition of guidelines and procedures for a safe and reliable use of H2 within the industrial plants

Training HUB

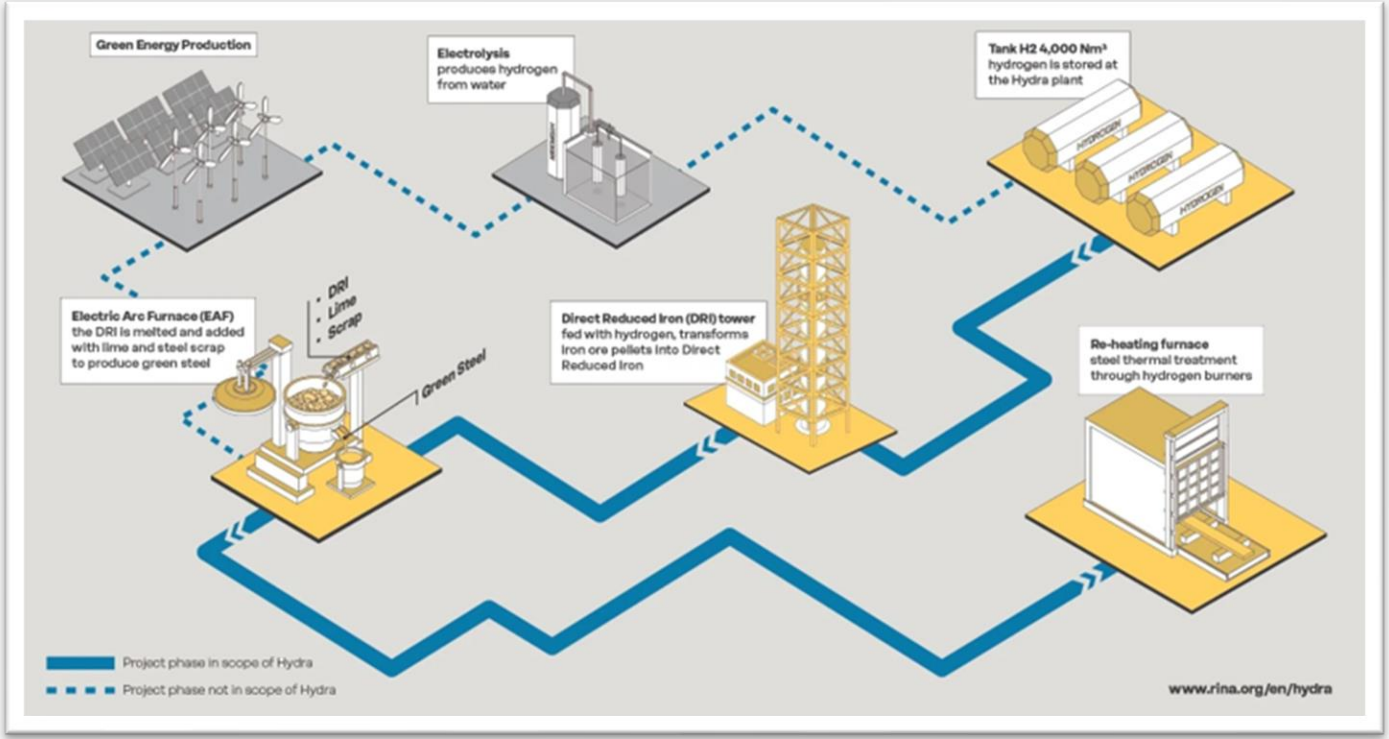
The project also takes into account that the transition to hydrogen steelmaking will be gradual and distributed over time and therefore has the goal of providing knowledge and technologies to better manage the coming transitional phase.

As part of Hydra, RINA will also establish a **training centre** to gather and disseminate know-how related to the design, implementation, and deployment of hydrogen-based decarbonization technologies. The centre will become a **permanent international research and development platform** open to all stakeholders in the steel and energy industries.

HYDRA

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 station for reheating **furnaces**, integrating pilot activities with full scale industrial tests



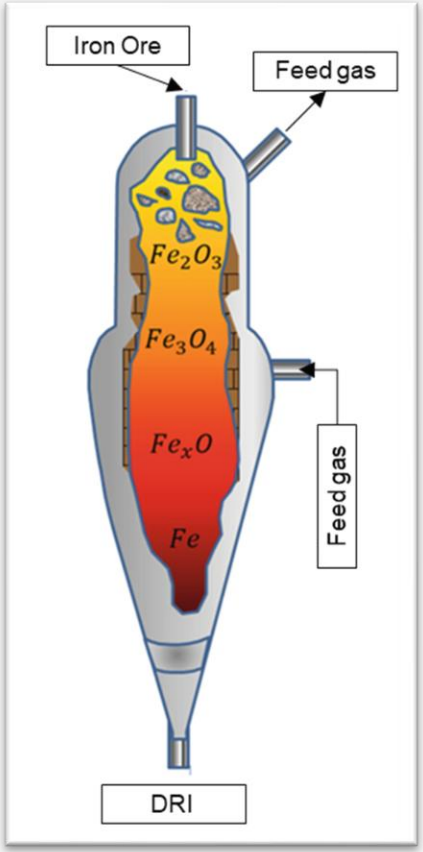
HYDRA – WP2: Innovative process for the production of DRI by H2

WP2 is related to DRI production with H2 to be made by pilot SHAFT furnace

Experimental activities:

- DRI production with pure 100% H2, 100% CH4 or gas blending
- Different Iron Ore pellets as input materials
- Production capacity 100kg/h, up to 1000 tons/year
- Monthly campaign ≈ 20 days; ≈ 50 tons/months

- Manufacturing process performances evaluation:
  - DRI pellets quality
  - Metallic ratio
  - Specific energy



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

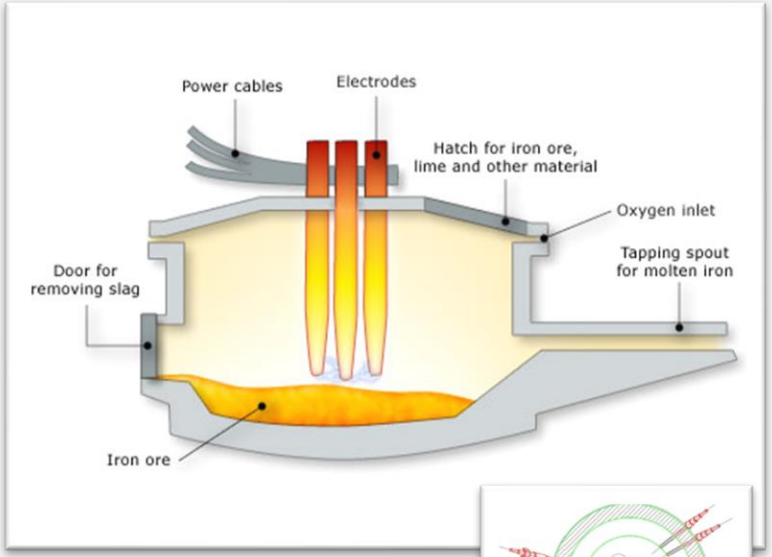
WP3 Production of steel in EAF (3-7 tons) with scrap and/or pre-reduced iron ore manufactured by direct reduction with H2

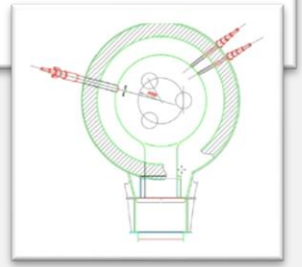
Experimental activities:

- Test with DRI at different C percentage
- H2 Burning
- Alternatives materials addition: biochar, polymers, …..

(*) Production capacity up to 150 casting/year with DRI by H2, doubled with other charge materials

- ≈ 10 heats/months to be made within 2-3 working days



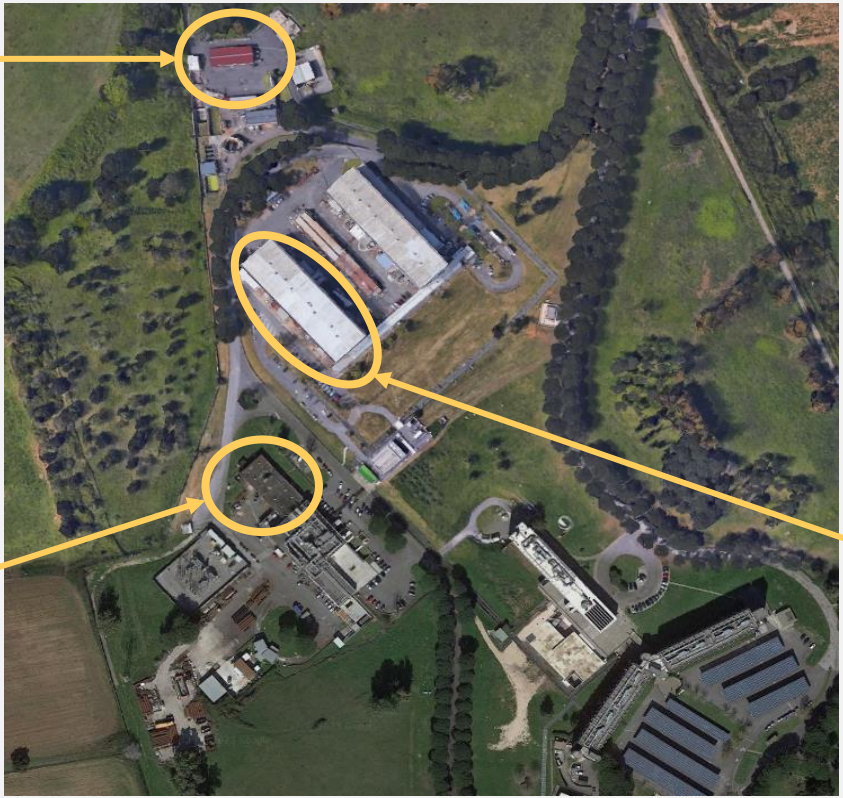


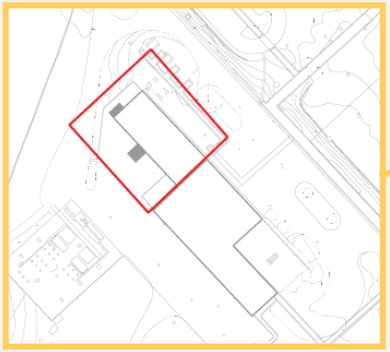
EAF will be ready for future implementation: (Smelter, Trimming station, …)

HYDRA – Castel Romano site

S Building (WP1)
H2 testing HUB

F Building (WP1)
Training HUB
Advanced sensors Lab





E Building (WP2 / WP3)
- EAF
- DRP

HYDRA – Testing and Training HUB (WP1)

F Building :

- Training HUB
- Advanced sensors Lab

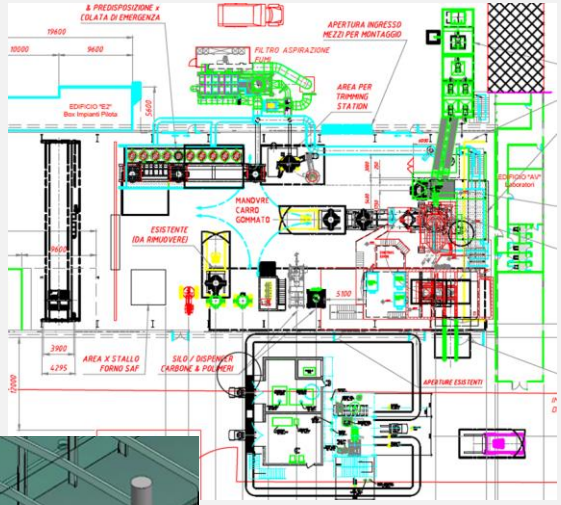
S Building :

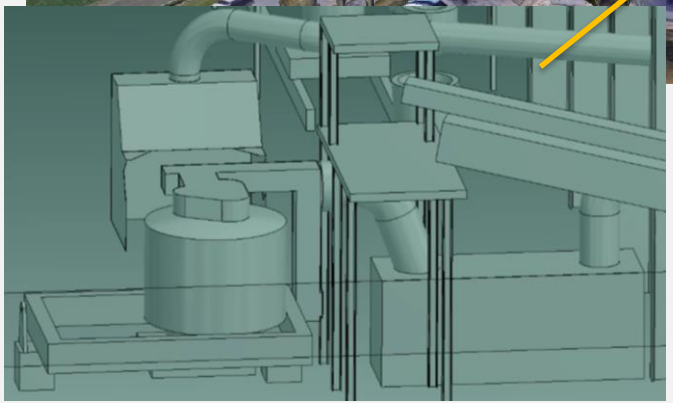
- H2 testing Lab (high pressure)
- H2 testing Lab (low pressure)

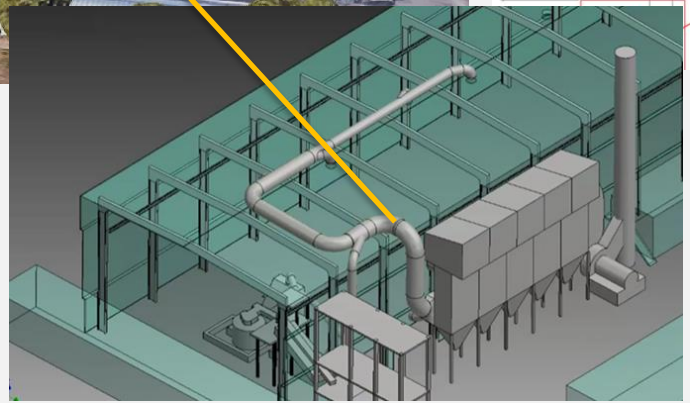
actual

near future

HYDRA – Layout linea pilota (WP2-WP3)





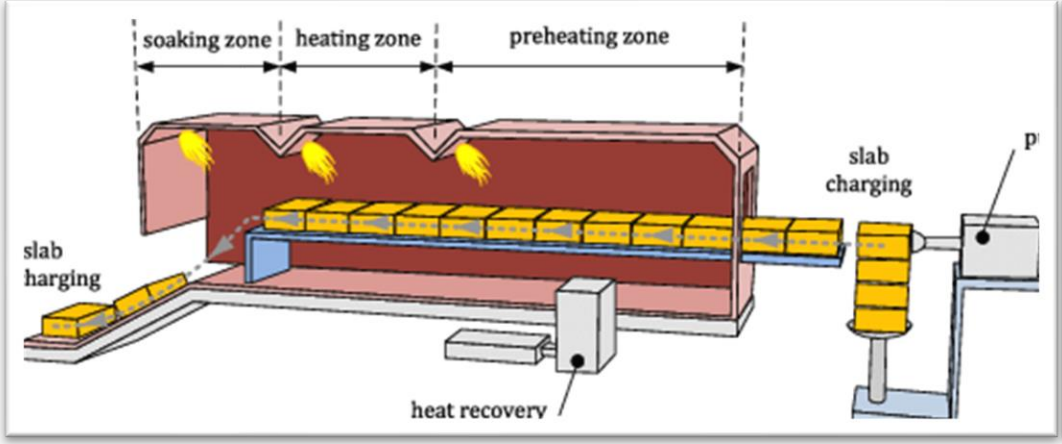


HYDRA – WP4 – Use of H2 in furnaces

WP4 USE OF HYDROGEN IN FURNACES

Experimental activities:

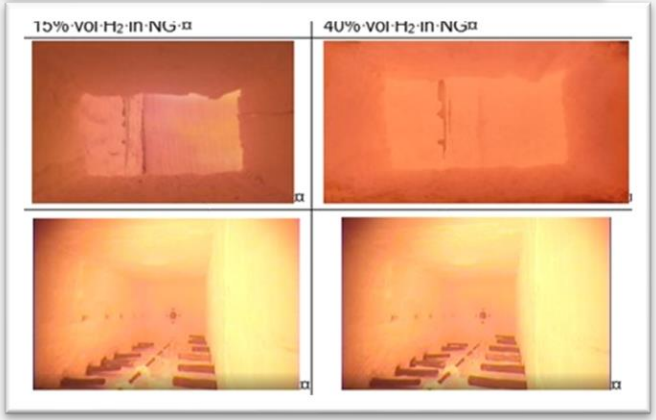
- Burners testing and development campaign at pilot combustion station
- Descaling tests
- Oxidation trials
- Burners test at industrial premises
- New refractory materials

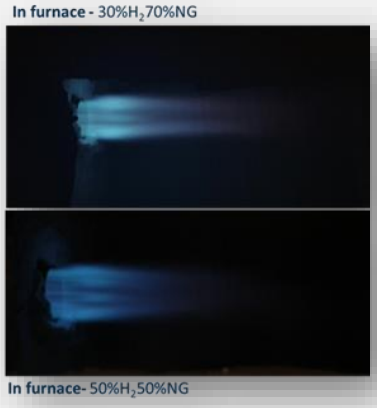


HYDRA – WP4 – Use of H2 in furnaces

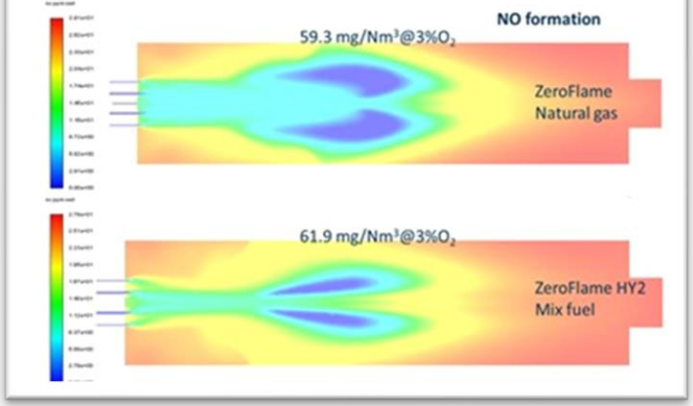
Types of combustion system

- Burners up to 2,5 MW:
  - High speed
  - Side and roof
  - Air preheated
  - Regerative
  - Recuperative
  - Flameless
- Ceramic Regenerators





Courtesy of: SMS group



HYDRA – Project benefits

Development of an **European H2 Hub** for the decarbonization of the European Steel Sector trough:

- Open **DRI+EAF pilot line** for Manufacturing Process Development & Optimization
  - BF+BOF cycle replacement
  - EAF cycle improvement
  - Mining – Iron Ore valorization
  - Mining – Iron Ore → DRI
- **Testing, Qualification & Certification** of components for H2 use in all applications
- Development of **new skill and competences** through training activities
- **Dissemination** at European level of replicable best practices, with particular reference to the replication in other sectors that have in common technologies in intermediate production steps (e. g. glass, chemical, non-ferrous, ceramics, cement, glass, pulp and paper, refinery using H2 as a feedstock).

For the Stakeholders, like:

- **Steelmakers**
- **Mining players**
- **Plant suppliers** of innovative H2 based technologies for steel production
- Materials producers, and **end users** in other sectors

EU companies interested in Hydra

Worldwide companies interested in Hydra

For more info:

Thank you for your attention