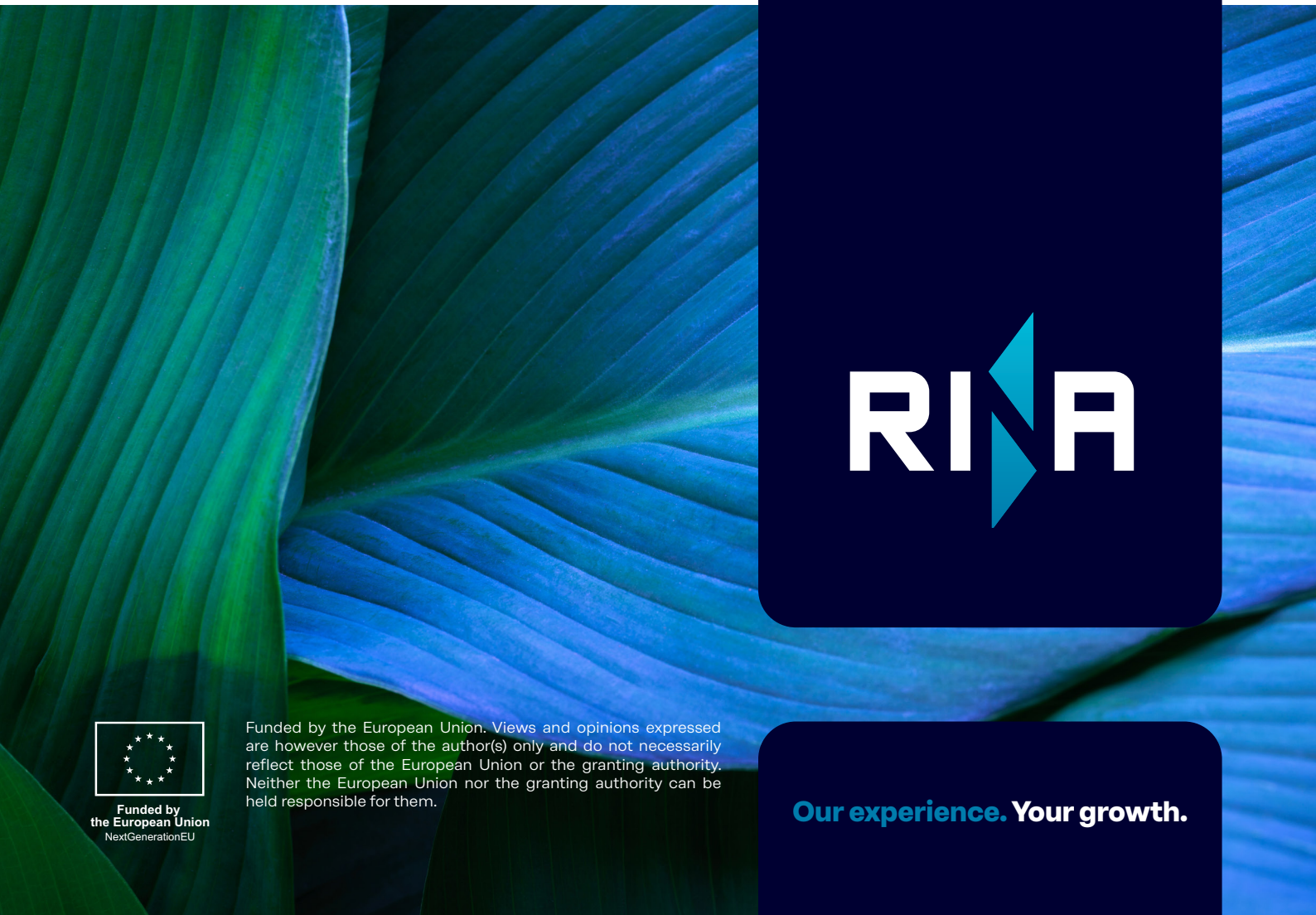
HYDRA



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RINA

Our experience. Your growth.

RINA, through Centro Sviluppi Materiali S.p.A. has been operating in the steel sector since 1963, first as a research center for the public steel industry and then, since the end of the nineties of the last century, as a private company controlled by a group of shareholders of international importance.

RINA, due to its history and the activities it carries out, is a "unicum" that combines a great capacity for in-depth theoretical study with direct practical knowledge of the sector. RINA has expanded its technological capabilities beyond the steel sector to include non-ferrous metals, energy, new materials, the environment, digitalization, Industry 4.0, and the Internet of Things.

RINA is devoted to EU R&D sector and is an active member of national associations and umbrella organizations (Confindustria, AIRI, APRE), that works with the main Italian research bodies (ENEA, CNR, CIRA) and the academic world.

RINA is a high-level participant in European technological platforms like ESTEP (steel) and EuMat (advanced materials) and is also co-founder of RIES (Research Initiative European Steel) for the coordination among the main iron and steel research centers in Europe.

RINA's longstanding role as the Italian reference point in European research (RFCS and Framework Programmes) has led to hundreds of international collaboration agreements and contracts.

8%

Global CO_2 emissions contributed by the steel industry

1.91 (worldsteel data)

Average CO_2 emissions per ton of steel produced

7%

Steel industry consumes about 7% of global energy supply

H2

The use of hydrogen poses serious challenges in terms of industrial standard validation

The **vision**

The steel industry contributes around 8% of global CO_2 emissions, with each ton of steel produced releasing an average of 1.91 (worldsteel data) of CO_2. This high emission rate poses a serious threat to environmental sustainability and climate change mitigation efforts. Traditional steel production methods rely heavily on carbon to effectively reduce the iron-ore to be used in Blast Furnaces (BFs) or mixed with iron scrap in Electric Arc Furnace (EAF) plants.

The HYDRA project seeks the transition to a 100% H2-based production process, drastically reducing CO_2 emissions to a few kilograms per ton of steel produced. This innovative approach not only aligns with global decarbonization goals but also sets a new standard for sustainability in heavy industries, leading to a more resilient, sustainable, and environmentally friendly steel sector.

Hydrogen in the **energy transition**

The European Hydrogen Strategy sets clear and ambitious targets to make the European Green Deal a success. To achieve climate neutrality by 2050, the EU needs clean hydrogen.

Hydrogen can play a systemic role in a number of different applications, and can be used:

- In connections to renewable energy sources to manage the discontinuity of energy availability and demand allowance to storing and distributing energy in different timing and places
- In mobility and transport (e.g. automotive, trains, maritime and aviation sectors)
- As a feedstock in the strategic European energy intensive industries (hard-to-abate sectors), contributing to the decarbonization of clusters such as steel, refining, petrochemicals, glass, cement, for which the core process cannot be efficiently electrified as requires high temperature (i.e. higher than 1000°C)

In this scenario, the HYDRA project aims at:

- Supporting the decarbonization of the hard-to-abate sectors industry, more specifically for the steel sector, through the design and development of pilot plants and related components for hydrogen use in industrial steel environment
- Developing competences and know-how for the industrial use of H2 green energy through the creation of a H2 hub. The H2 hub will be an international excellence centre, including experimental facilities, for design, development, implementation and qualification of solutions and technologies for energy transition and Industry 4.0, focused on the use of hydrogen in energy intensive industries. The centre will also act as training hub, for dissemination and coworking to create new skills and competences and to favour clusters promoting H2 use in the energy transition

Hydrogen

Circular economy

Steel industry

Digitalization

Renewable energy sources

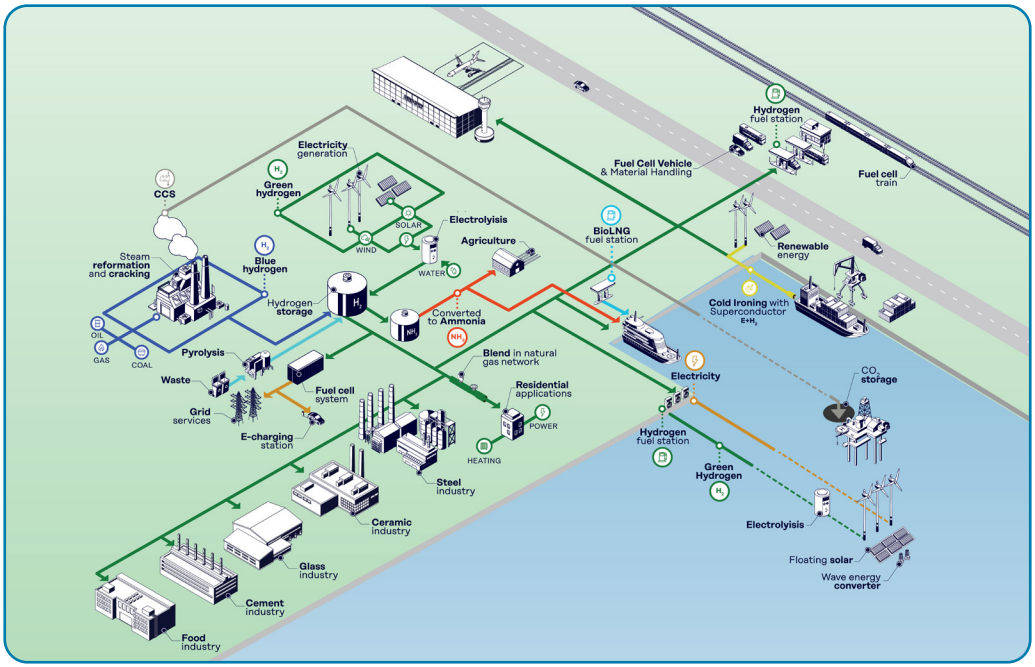
“Hydrogen innovative plants and related processes for the production of green steel in Europe”

HYDRA is a research, development and innovation project coordinated by RINA and approved by the European Commission and the MIMIT (Ministero delle Imprese e del Made in Italy) to decarbonize the steel production process through hydrogen-related technologies. The project, which is part of the IPCEI (“ Important Project of Common European Interest”) funded by the European Union - NextGenerationEU, has a duration of six years and a value of 88 M€.

Based on a model of open innovation, Hydra aims to design and realise a “mini steelworks” at the headquarters of Centro Sviluppo Materiali in Castel Romano that will test hydrogen in every phase of the steel production cycle. The structure will consist of a direct iron ore reduction plant (DRI) through the use of hydrogen as a reducing agent and an electric furnace. The plant, at full capacity, will have the opportunity to experience the production of steel up to seven tons per hour, with a significant reduction in CO_2.

A cutting-edge **technology**

The HYDRA project foresees the use of a cutting-edge technology to revolutionize steel production. Central to this innovation is the 30-meter high direct iron ore reduction (DRI) tower, which uses hydrogen as the primary reducing agent of the iron-ore, replacing the classic carbon-intensive methods. This approach significantly lowers CO_2 emissions, aligning with global decarbonization goals. Additionally, the project features an advanced EAF and a state-of-the-art reheating furnace designed to operate efficiently with hydrogen. These technologies ensure high-quality steel production while minimizing environmental impact. The project also includes a comprehensive testing and qualification hub, where materials, equipment, and internal infrastructure are rigorously assessed for hydrogen compatibility. This hub plays a crucial role in validating the shift to hydrogen-based processes, ensuring reliability and safety. By leveraging these advanced technologies, the HYDRA project will pave the way for broader adoption of hydrogen as a clean source.



The project is structured into four streams of activities:

- WP1: Facilities upgrading for the testing and qualification (T&Q) of materials and components for the transport, storage and distribution of hydrogen
- WP2: Design, construction and development of an innovative direct reduction hydrogen pilot plant (DRP - Direct Reduction Plant)
- WP3: Design, construction and development of an electric furnace (EAF - Electric Arc Furnace) powered by DRI produced with hydrogen up to 100%
- WP4: Study, development and development of operating procedures for the use of hydrogen in heating furnaces and heat treatment (HF/HT) of semi-finished steel products

Hydra - **WP1**

Development of green hydrogen use in iron and steel making
The aims of the WP1 are:

- 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 introduction of H2 in the industrial steelmaking process
- To evaluate the impact of H2 percentage in a CH4+H2 blended mixture on the industrial steelmaking plant equipment, as well as localized distribution piping limited exclusively to the steel plant areas
- To make deeper knowledge and to upgrade the standards and regulation framework for the design and realization of dedicated hydrogen components in the steel making plant, with the HSE related issues

Hydra - **WP2**

Innovative process for the production of pre-reduced products with hydrogen
The main objectives of the WP2 are:

- Testing in flexible reactor, capable of offering the same productivity and quality performance with different methane/hydrogen mixtures
- The development of a “multi-fuel” pre-reduction technology (not limited to hydrogen alone), indispensable both in a transition phase and in perspective for a flexible steel industry. The guiding idea is to load the pre-reduced, in the electric melting furnace, which is still hot (Hot DRI), to reduce the energy consumption of the melting. In alternative, the use of briquetted DRI (HBI) can be foreseen
- The construction of a production plant of significant size, rapidly scalable to industrial sizes, capable of producing quantities of pre-reduced that can be used in industrial furnaces and which allows to study the problems of managing the pre-reduced from hydrogen in conditions similar to industrial ones

Hydra - **WP3**

Steel production in EAF with pre-reduced iron ore manufactured by direct reduction with hydrogen

To study the future electric-arc furnace working with electricity and carbon-free reductant and energy vector, a pilot plant will be realized, before applying the results at industrial level. The pilot furnace design and the furnace operating practices will be purposely designed for the melting of mixed charges, scrap and pre-reduced at different carbon concentrations, up to 100% pre-reduced by hydrogen. The use of hydrogen-based DRI reduces the carbon introduced into the process. To compensate for this reduction, additional carbon must be added from renewable sources, such as biomass-derived char, waste materials like plastics, and opportunities arising from industrial symbiosis. The intensive use of DRI from hydrogen requires the revision of the metallurgy practices of liquid steel in furnace and electric (and also in downstream processes) "in and out" with the aim of obtaining finished products with adequate characteristics to uses or possibly improved characteristics.

Hydra - **WP4**

Use of hydrogen in furnaces

The decarbonization of the reheating and heat treatment furnaces is an important step in the full decarbonization of the steel production cycle. The core of WP4 is to study the substitution of natural gas with hydrogen in both innovative and conventional burners, using in a flexible manner gas blends, up to 100% of H_2.

This activity requires:

- To study the effect of the new furnace atmosphere (with poor or no CO_2 amount and higher H_2O concentration) on the surface quality of the steel products
- Testing at combustion station of real industrial burners. Both current systems (to check the limits when used with H2/natural gas blends) and innovative systems will be tested
- Installation on a real industrial furnace of a burner, fed with H2, in order to make a first test of implementation on reheating furnace

Toward the **global use of H2**

The use of hydrogen in the steel sector as a reductant of iron ore or in reheating furnaces is relatively limited. Traditional steel production relies heavily on carbon-intensive methods, such as using coke in blast furnaces, which leads to significant CO_2 emissions. Hydrogen, as an alternative, presents a cleaner and more sustainable option, but its application in large-scale steel production is still in its nascent stages. The challenges include the development of efficient hydrogen production and storage systems, the adaptation of existing infrastructure, and the economic viability of hydrogen-based processes.

HYDRA is will be pivotal in addressing these challenges and advancing the global adoption of hydrogen in the steel industry, demonstrating the technical feasibility and economic viability of these processes. The project's pilot plant will serve as a live testing ground for optimizing hydrogen use in steel production, providing valuable data and insights.

This will help in overcoming the technical barriers, scaling up hydrogen applications globally.

Furthermore, HYDRA's knowledge hub will play a crucial role in disseminating information, training industry professionals, and fostering collaboration among stakeholders. By sharing best practices, research findings, and technological advancements, HYDRA will support the broader adoption of hydrogen in the steel sector, paving the way for a cleaner, more sustainable industry worldwide.

Hydra **collaboration**

- Steelworks
- Energy
- Technology providers
- Gas companies

An international **hub for all**

The HYDRA project emphasizes the concept of Open Innovation through its dedicated training center. This center will serve as an international hub for education and collaboration on hydrogen-based decarbonization technologies. It will offer comprehensive training programs, workshops, and seminars designed to equip industry stakeholders with the skills and knowledge needed to implement hydrogen technologies effectively. By fostering a community of experts and practitioners, such knowledge hub aims to accelerate the adoption of sustainable practices across the steel industry. The center will also prompt research and development, encouraging innovation and the continuous improvement of hydrogen-based processes. Through partnerships with leading research institutions and industry players, the HYDRA Knowledge Hub will ensure the sharing of best practices, cutting-edge research, and technological breakthroughs. This collaborative approach will be essential for driving the global transition to cleaner, more sustainable industrial processes.

Hydra markets
services steel

- Steel makers
- Steel transformers
- Plant suppliers

- New steel making practices
- New H2 products
- Use of H2-NGH2 in heat treatment furnaces
- Products testing and qualification
- H2 Plant Failure & Root Cause Analysis
- Smart Solutions for H2 Plant
- IoT for HSE (wearable devices)

Direct expected markets & services

- Steel
- Hard-to-abate Non-Steel
- Energy
- Manufacturers

Hard-to-abate Non-Steel

- Cement, glass, ceramic
- Non steel (aluminum, copper)
- Transportation (road, shipping, avio)

Manufacturer

- Line pipe manufacturers
- Equipment & component person

Energy

- Oil & Gas (incl. refineries)
- TSO, DSO
- EPC

Hard-to-abate non-steel

- Effect of H2 on products quality and performances
- H2 readiness feasibility study
- Products testing and qualification
- Use of H2-NGH2 in heat treating/melting furnaces
- H2 plant failure & root cause analysis
- Smart solutions for H2 plant
- IoT for HSE (wearable devices)

Manufacturers

- Products testing and qualification
- Support to trouble shooting
- Out-of-design / change of use
- Failure & root cause analysis

Energy

- H2 readiness feasibility study
- Life extension and repurposing
- Advanced fit-for-service
- Products testing and qualification
- Use of H2-NGH2 in heat treating/melting furnaces
- Failure & root cause analysis
- IoT for HSE (wearable devices)

HYDRA features Italy's first 30-meter high Direct Iron Ore Reduction (DRI) tower using hydrogen, producing up to 7 tons of steel per hour, showcasing hydrogen-based steel production on a relevant scale.

Hydra in a **nutshell**

95% reduction in CO_2 emissions

The HYDRA project aims to reduce CO_2 emissions from steel production by up to 90%, from an average of 1.63 tons of CO2 per ton of steel to a few kilograms, significantly mitigating the industry's environmental footprint.

6 years

In 6 years, the HYDRA project will erect at RINA's facilities in Castel Romano (Rome) a 30-meter high DRI plant, an EAF plant, and a secondary metallurgy. This platform will serve as the main tool for leading the shift of steel sector to a more sustainable industry.

€88 Million Investment

Supported by an €88 million investment from the European Commission's NextGenerationEU program and the Italian Ministry of Enterprises, the HYDRA project underscores the significant financial commitment to advancing sustainable industrial practices.

DISCOVER
our web page

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RINA consists of the parent company RINA S.p.A., the holding which controls the main sub-holdings RINA Services S.p.A., RINA Consulting S.p.A. and RINA Prime Value Services S.p.A. In order to ensure compliance with the applicable recognition, authorization, notification and accreditation rules, including those relevant to the management of impartiality, RINA has adopted a governance and organizational model. According to this model, the sub-holdings are subject to direction and co-ordination by the holding in the finance, administration, strategic, organizational, managerial and business continuity fields, while technical and operational decisions remain under the exclusive responsibility of the sub-holdings and their controlled companies. The strict separation of duties in the governing bodies and the impartiality risk assessment, which identifies and manages the impartiality and conflict of interest threats coming from the company relations, ensure compliance with the applicable impartiality rules.

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