



Towards Net Zero

February 24, 2021

- **The role of Hydrogen**
- **RINA Projects**

Hydrogen: Strengths and Use

- Carbon Free
- Energy Vector
- Versatility
- Storability



H₂ for Grid Balance

Solutions for innovative utilities and sector coupling

Power-to-X

Island H₂



H₂ for Transport

Solutions for Mobility

H₂ for Marine

H₂ for Rail & Truck

H₂ for Urban transport

H₂ for Material Handling



H₂ for commercial use

Fuel Cells for business continuity and heating

H₂ for Power Supply

H₂ per residential and commercial heating



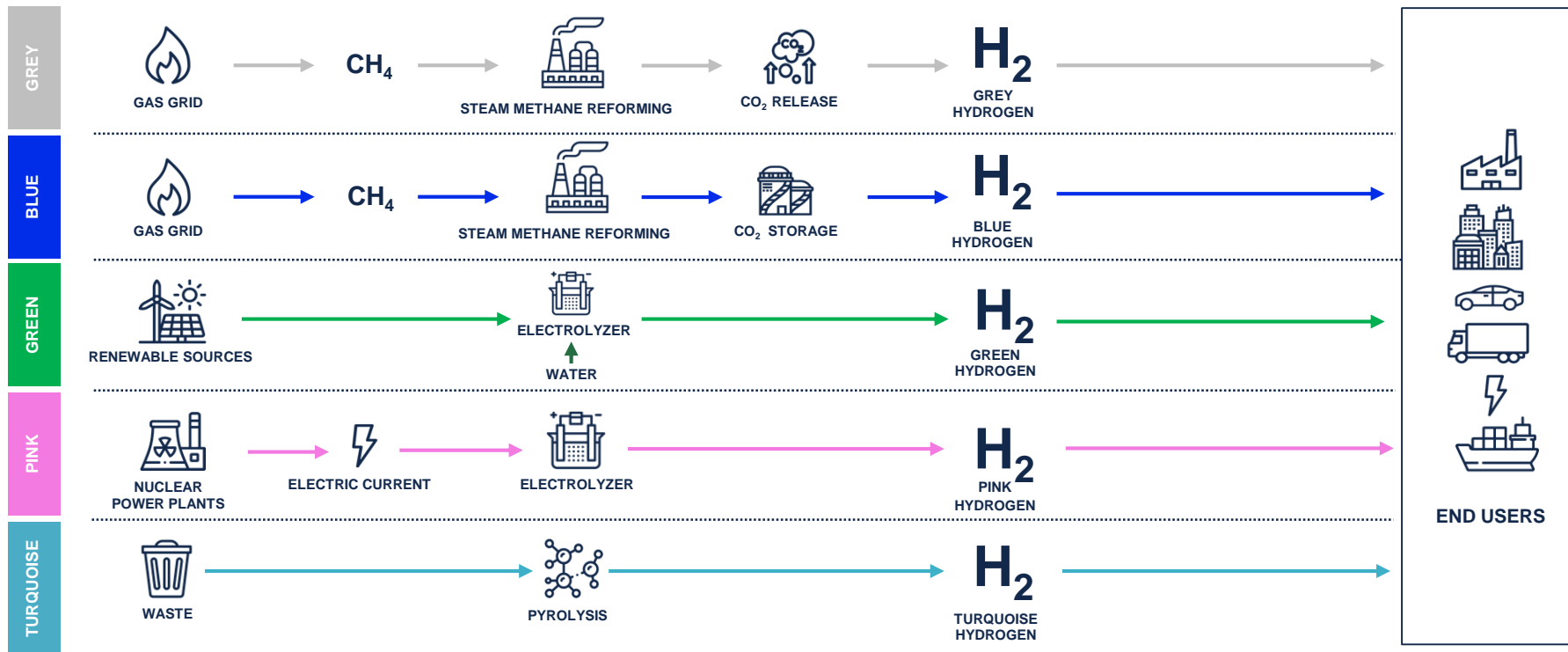
H₂ for Industrial use

Green transition in Industrial Processes

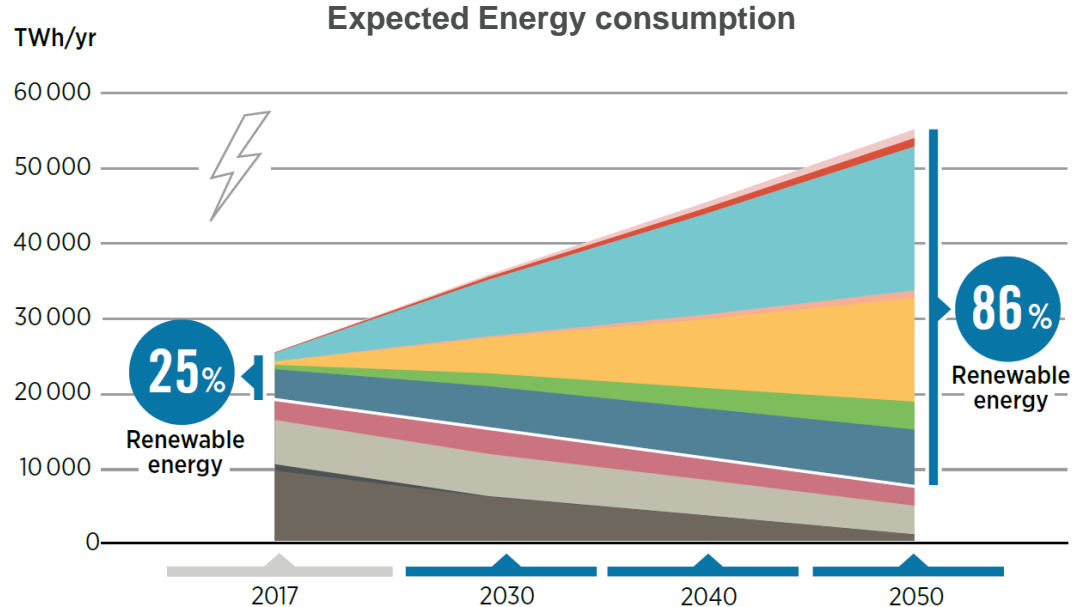
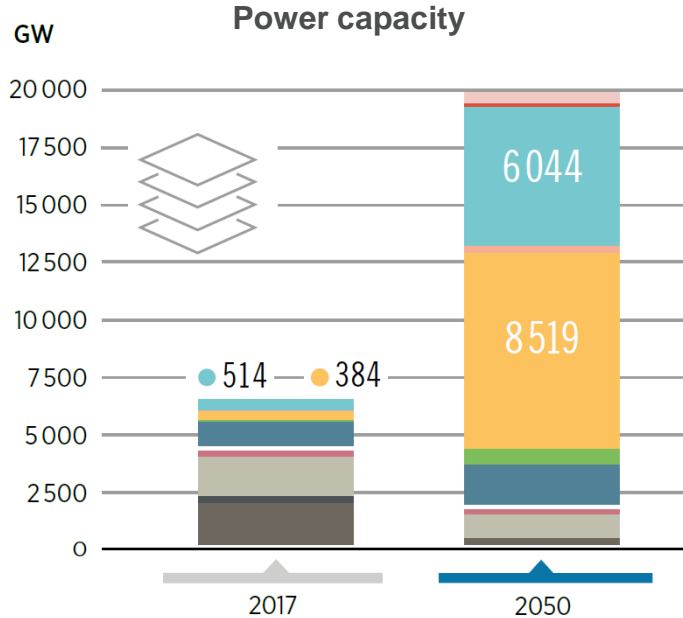
H₂ for Feedstock

H₂ for High Temperature processes

Shades of Hydrogen



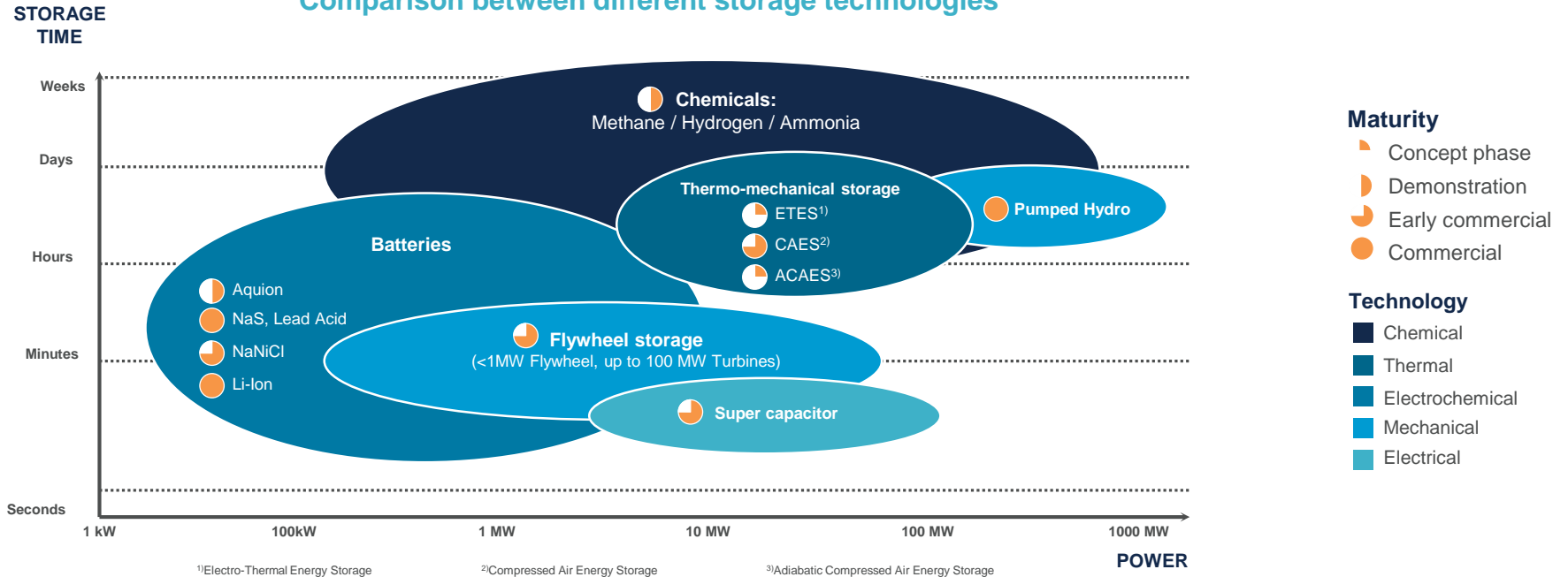
Renewables transforming Energy Scenario



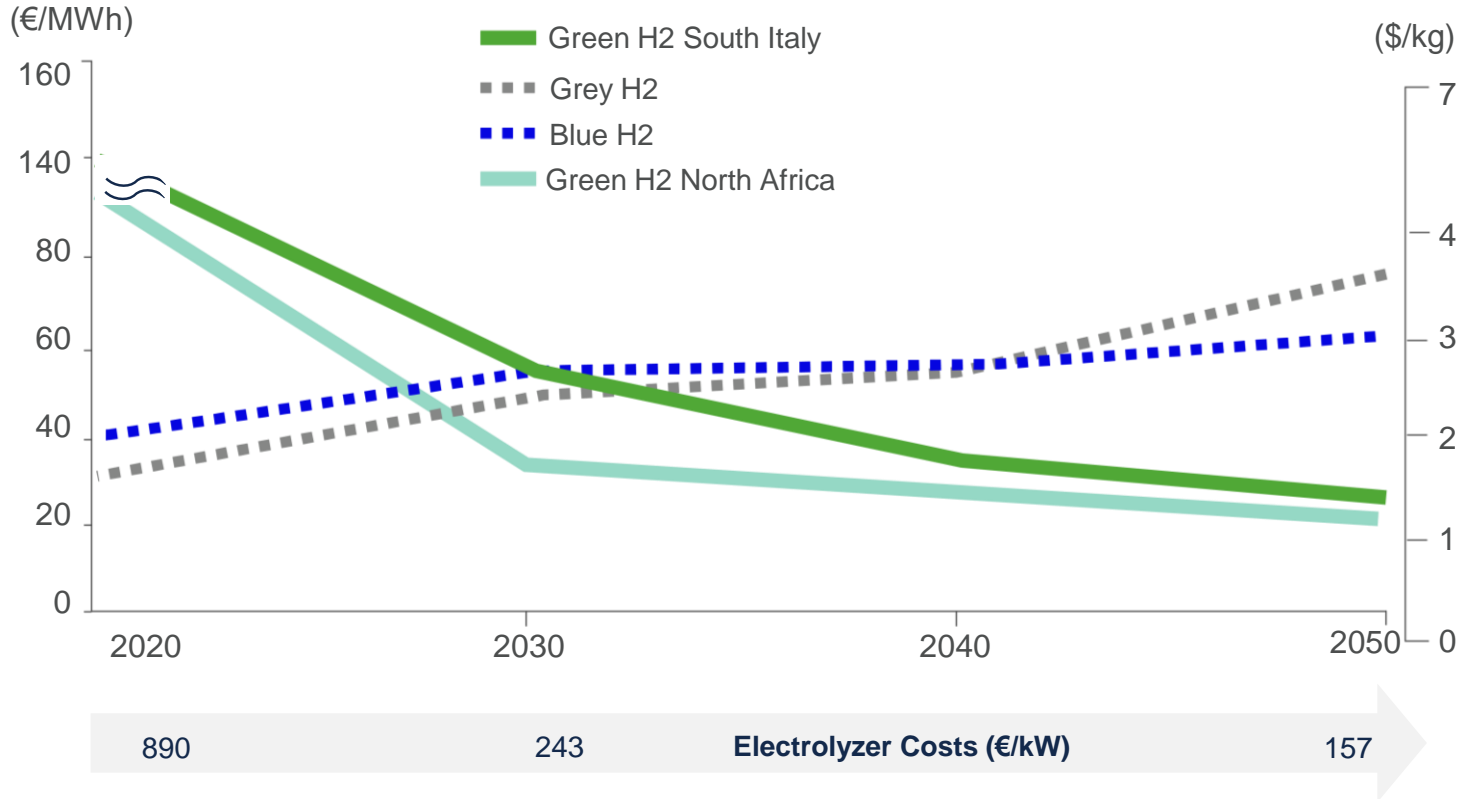
- Others (incl. marine)
- CSP (Concentrating Solar Power)
- Nuclear
- Geothermal
- Hydro (excl. pumped)
- Coal
- Wind (onshore and offshore)
- Bioenergy
- Oil
- Solar PV
- Natural gas

Overview on storage systems

Comparison between different storage technologies

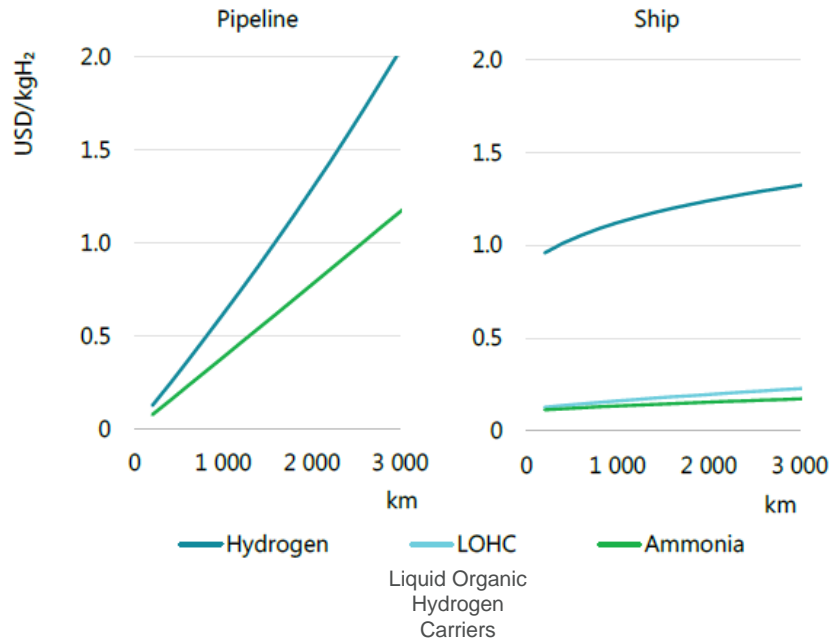


Production cost of Hydrogen

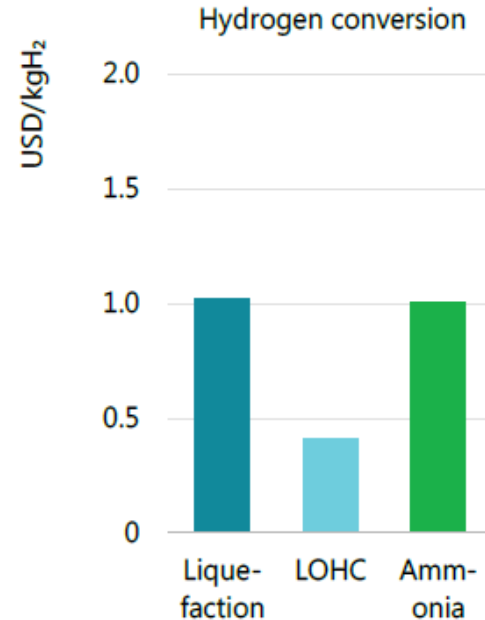


Hydrogen costs of transport, liquefaction and conversion

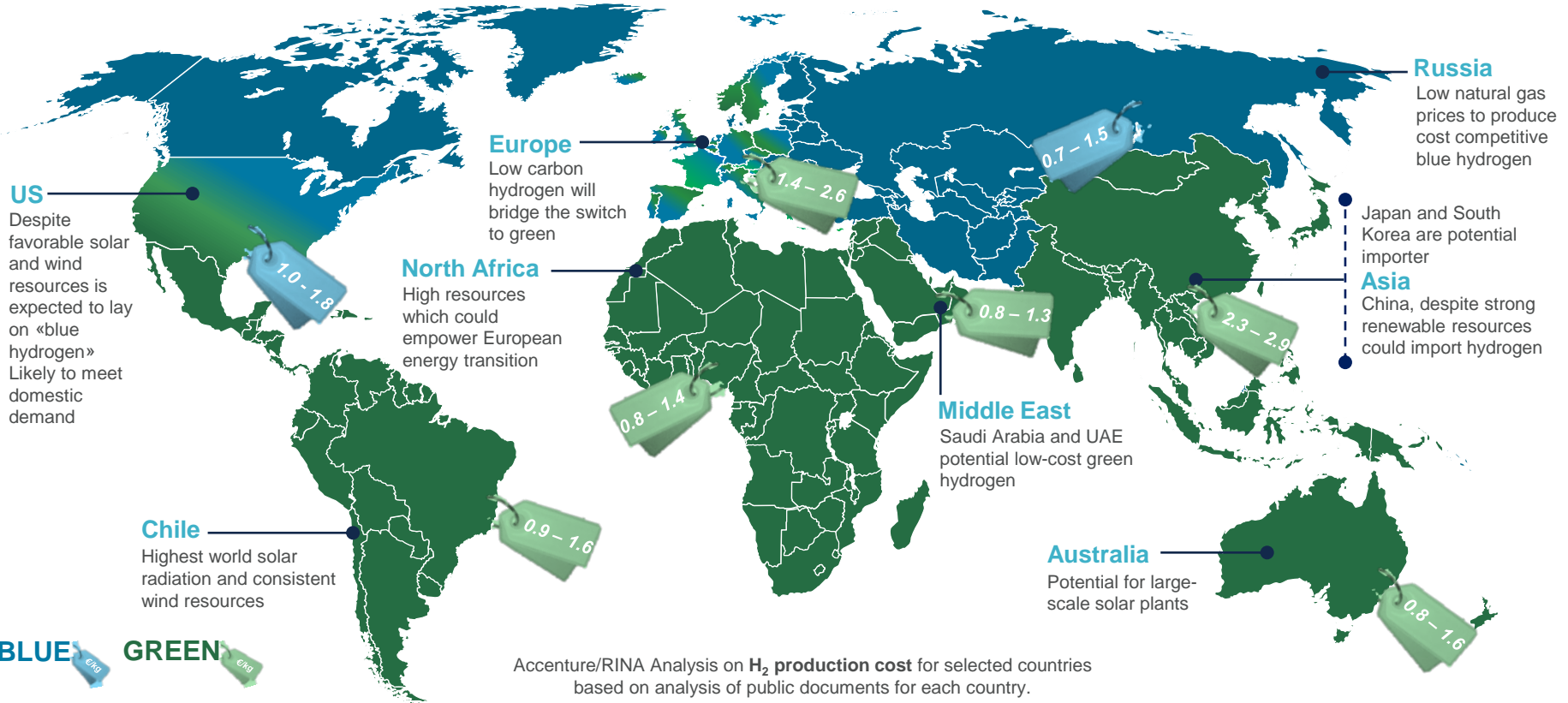
Cost of Hydrogen storage and transmission by pipeline and ship



Cost of hydrogen liquefaction and conversion



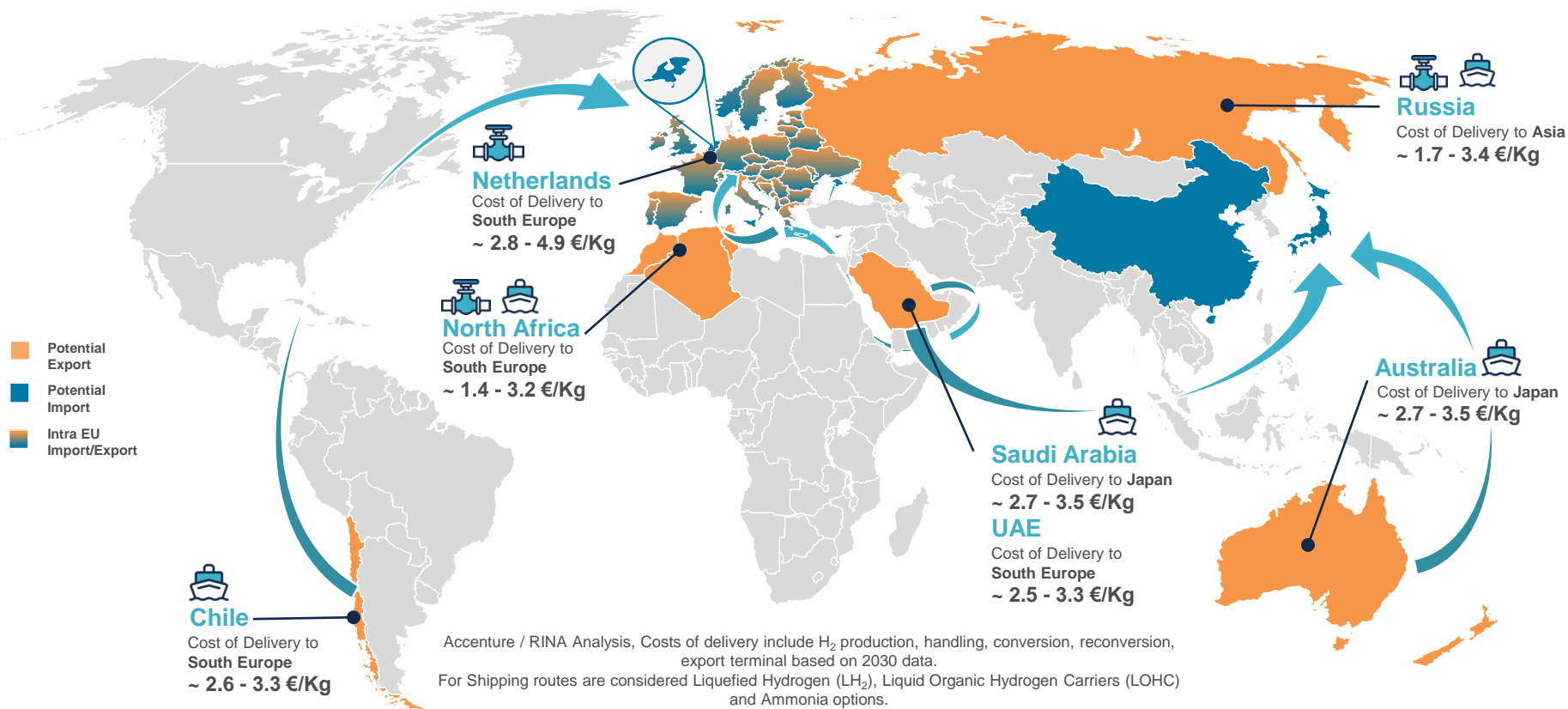
Hydrogen Production - future scenario (2030)



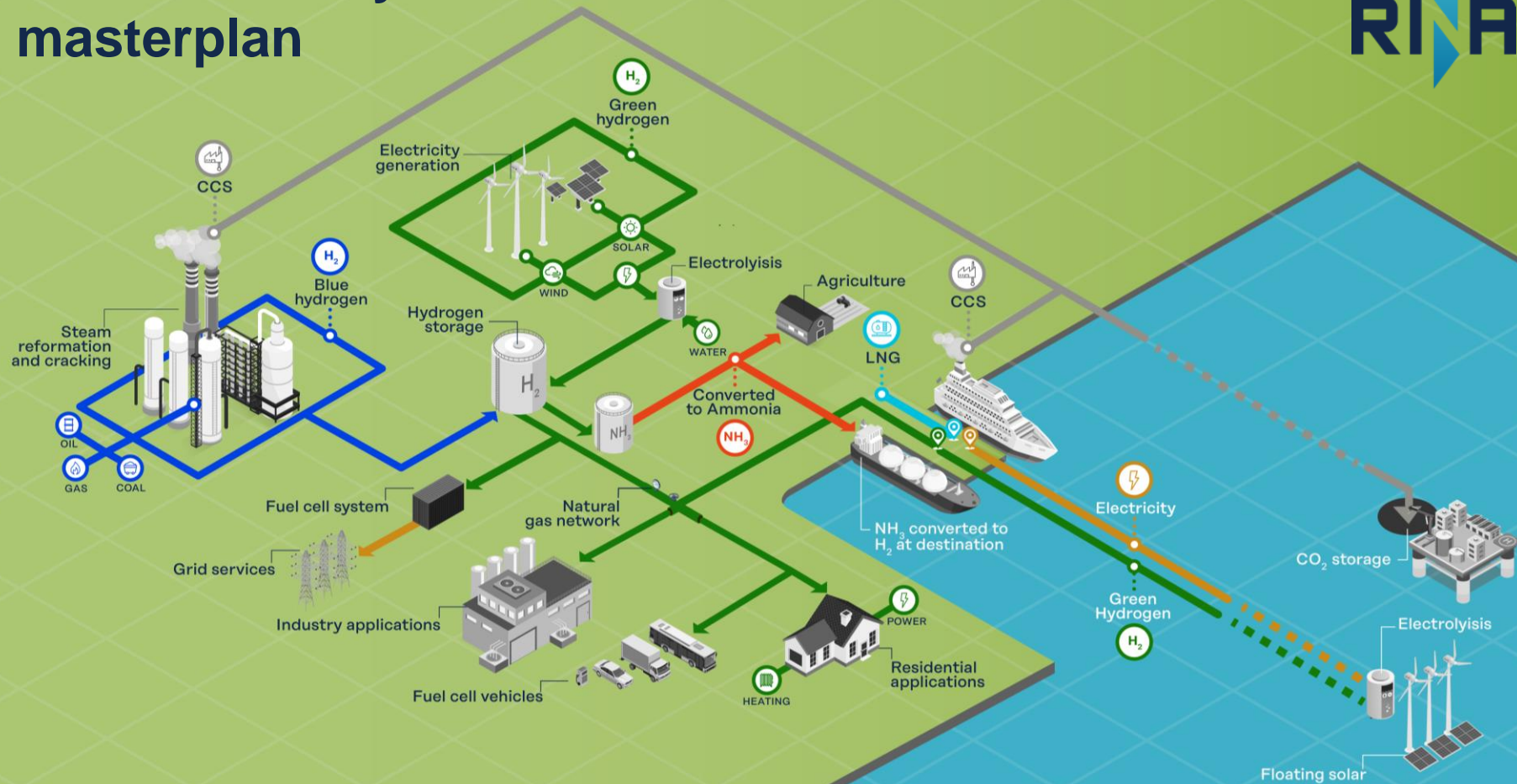
Accenture/RINA Analysis on H₂ production cost for selected countries based on analysis of public documents for each country.



Hydrogen Routes - future global corridors (2030)



Net Zero ecosystem masterplan



Net Zero masterplan

Focus on Ports



— Projects



TecBIA Project

Tecnologie a Basso Impatto Ambientale



Hydrogen Fuel Cell propulsion Ship ZEUS

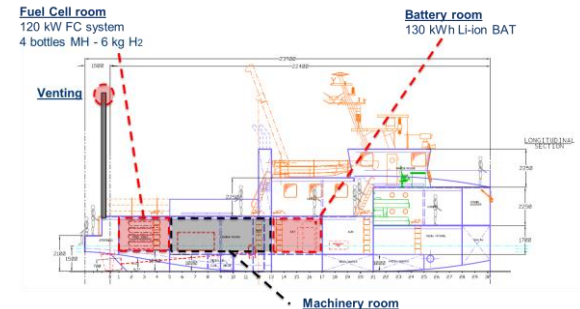
Client: Fincantieri CNR

Objectives of the project:

- Experimental ship intended for Fuel Cells testing
- Fuel Cell will develop up to 120kW, Lithium Batteries up to 130kW, stored Hydrogen up to 50 kg

Goals and Services

- Classification Rules for Hydrogen as Fuel on Board Ships
- Risk analysis for systems handling hydrogen
- HSE procedures
- Basis for development of new scenarios on the way of Marine Decarbonization



Memorandum of Understanding (SDARI)

RINA and SDARI (Shanghai Merchant Ship Design & Research Institute) **to boost application of alternative fuels**



The selected ship type is a tanker but the project, which is the first to investigate using both **Methanol** and **Ammonia** in this type of vessel, will increase understanding of the application of both fuels within the shipping industry with opportunities to apply designs to different types of ships.

- **SDARI** will focus on the ship concept development and design
- **RINA** will verify the compliance with the applicable rules, including those for the use of alternative fuels

Funded Project

Sustainable technologies for future long distance shipping towards complete decarbonization

Funded Project: solutions that focus on two main pillars:

- **promote the global introduction of alternative fuels** (Ammonia)
- **transfer to maritime sector clean energy technologies** robustly demonstrated for terrestrial application (e.g. Waste heat recovery, renewables etc).

Technologies will be demonstrated in real scale engines and on board of three vessels, proving their replicability on board of different type of vessels.



H₂ Material Readiness

Qualification of Linepipes and Cylinders in High Pressure gaseous H₂



Objectives of the project:

- Qualification & Testing of Linepipes for High Pressure gaseous H₂
- Qualification & Testing of Cylinders for High Pressure gaseous H₂
- Fatigue Crack Growth Rate (FCGR) tests in Hydrogen environment

Goals and Services

- Pipeline material (hardness and welding aspects) suitability to resist to HGE (Hydrogen Gas Embrittlement)
- Suitability to transport high percentage of H₂ (up to 100%) in high pressure gaseous H₂ conditions (risk of H₂ embrittlement)
- H₂ fugacity in case of leak (material defect, component leak) and its effects on surroundings



H₂ Burner Readiness

Development / validation of existing / new industrial burners for H₂ / N₂ - NG mixtures



Project: H₂ utilization in reheating furnaces, **effects on steel quality**

Service:

To study the scale **characteristics under the effect of oxidation** conditions in reheating furnaces, **simulating H₂ burning**, thermogravimetric tests will be carried out (Step 1: 100% CH₄ and 100% H₂, with 3% O₂ in both cases; Step 2: Oxidation tests in a mix of CH₄ and H₂)



Project: Assess the performance of existing industrial burners with H₂ NG mixtures

Service: Burners have been **positively tested at RINA combustion station** with a 30% H₂ in volume with no need of hardware modifications.

Further tests will be performed with an H₂ content up to 50%.

Tests will be repeated in an industrial plant, belonging to a worldwide leader in the production of ingots, forgings, valves and actuators.

Asset H₂ Readiness

Distribution Network



Project: Hydrogen blending in existing distribution Network

Service:

- **Preliminary assessment** to check the possibility of transporting a mixture (blend) of methane and hydrogen through existing network
- **Verification on material ready for H₂**
- **Asset Integrity monitoring** (ILI, tests, UT measurements, cathodic protection etc.)
- **Fitness for service** report will be delivered upon activities completion



Hard to Abate

HYDRA



Decarbonization of the steel production processes

Client: Steel Making, TSO, Energy Utilities

Objectives of the project:

- An Integrated Infrastructure System in order to provide **Energy Intensive Industries feeding large volume hydrogen line**
- An **innovative pilot plant for Iron Direct Reduction** (10.000 tons/year) fed with hydrogen only in Integrated Steel Works

Goals and Services

- **Decarbonise the steel production process** by acquiring knowledge and technologies to better manage the transitional phase
- **Investigate the final steel products properties achieved**



Power to Gas

HydroGlen autonomous grid



100% renewable grid autonomous hydrogen solution

Project supported by the **Scottish Government's Community And Renewable Energy Scheme (CARES)**

Objectives of the project:

- Design renewable hydrogen energy solution that will satisfy all electricity, heating, and transport fuel requirements
- Review of energy-use reduction and efficiency improvement measures to maximise contribution to net-zero

Goals and Services

- Specified **renewable technologies** consisting of solar, wind, battery storage, hydrogen electrolysis, compression and storage, and domestic hydrogen fuel cells **for electricity and hydrogen fueled vehicles**
- Modular concept established to support hydrogen scaling



H₂ Storage and Power Station

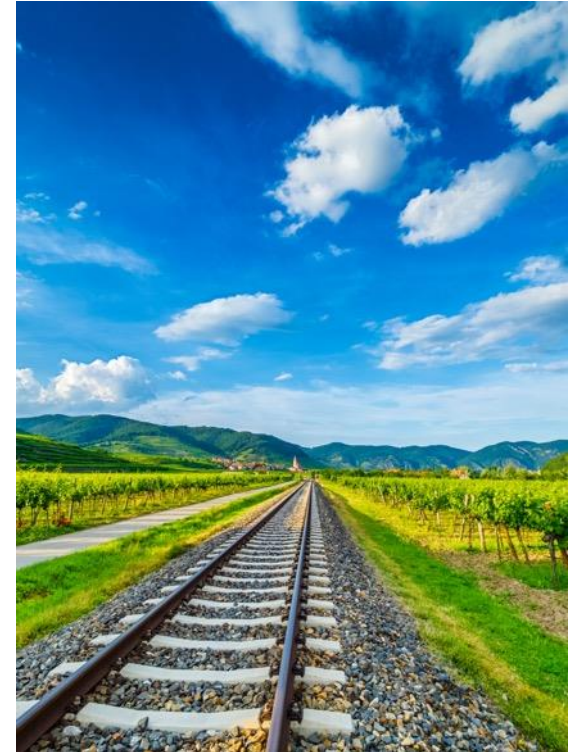
Project Validation



Objectives of the project: to realize a hydrogen mobility in the passenger rail transport sector

Goals and Services

- Within the realization of **storage and power stations** for hydrogen, will be providing Verification and Assistance service for validation purposes



Carbon Capture

Environmental studies



Objectives of the project:

Client is evaluating the possibility to implement two different Carbon Capture projects:

- CO₂ capture at Turbocharger
- CO₂ capture at butadiene boiler

Goals and Services

- analysis of pollutant dispersion in the air
- assessment of the feasibility of the project
- advisory on efficiency works



Power to Gas

Permitting feasibility



Objectives of the project

- two or three optional sites for the project
- the possibility of **powering from self-produced renewable sources** (solar or wind)
- the **production of H₂ for injection into the grid and blending**
- or the **production of synthetic green gas** starting from H₂

Goals and Services

RINA will be providing this preliminary phase:

- **identification of the procedural process** for the subject project
- acquisition and analysis of territorial and urban development plan for binding characterization
- **advisory service** during meeting to be held with local authorities



Waste to Chemical

Green Finance



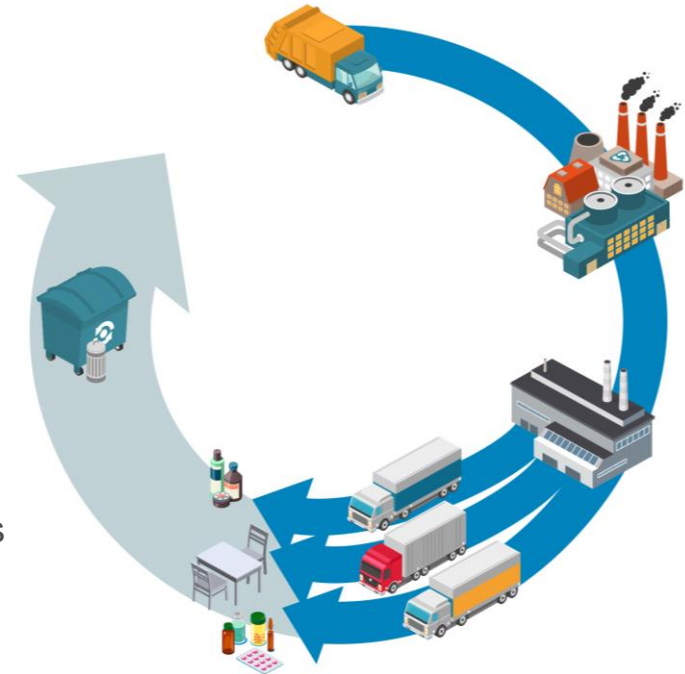
Objectives of the project:

The identification of suitable waste management plant project to be considered for the Next Generation EU fund.

Goals and Services

To drafting the technical/administrative documents aimed at project presentation among with:

- Elaboration and discussion with client of the macro - components of the project proposal
- Proposal and discussion with client of possible sites to be proposed to the related municipality for the location of the plant
- Support to client for the discussion and sharing of the guidelines with the related municipality the design proposal and the proposed site for the location of the plant



EVERYWHERE

Making hydrogen affordable to sustainably operate Everywhere in European cities

Project: European cities can become living lab for the demonstration of **Fuel cell** and **Hydrogen technologies**, starting from their use in niche, but everyday applications such as temporary **gensets** that are used in **construction** sites, **music** festivals and **temporary events**.

Goals and Services

The project will integrate already demonstrated robust PEMFC (Proton-exchange membrane fuel cells) stacks and low weight intrinsically safe pressurized hydrogen technologies into:

- Easy to install
- Easy to transport

FC based transportable gensets.



A detailed **logistic and environmental analysis** will be performed in order to study the complete **techno-economic viability** of the gensets and a decision support tool will be realized to support end-users in future replicability.

RINA Strategic positioning

Support “decarb” solutions from R&D to certification, creating confidence in the blue ocean

Main Stakeholders

- Owners
- Banks
- Investors
- Manufactures
- Community
- Insurers
- Organization
- Authorities



Main goals

- Performance
- Technology Development
- Business continuity
- Compliance
- Cost
- Social perception
- Health & Safety
- Corporate KPI

“Assuring the ROI to each stakeholder”



Make it sure, make it simple.