



Hydrogen Europe Research

WIVAP&G
Energy Model Region

The role of research in the development of a European hydrogen value chain

Luigi Crema

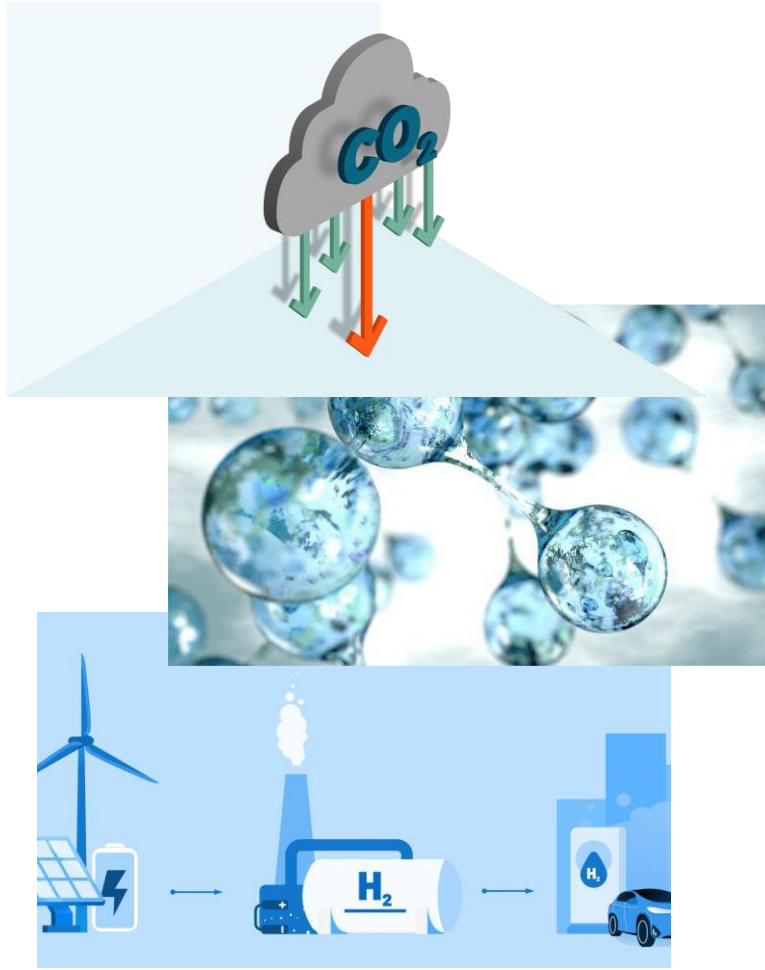
President - HYDROGEN EUROPE RESEARCH - HER

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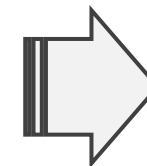
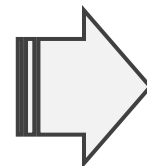
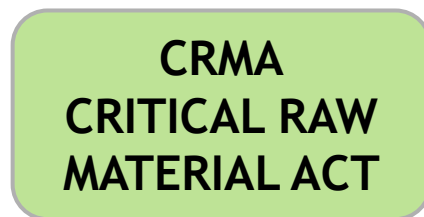
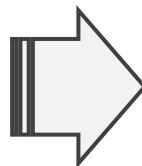
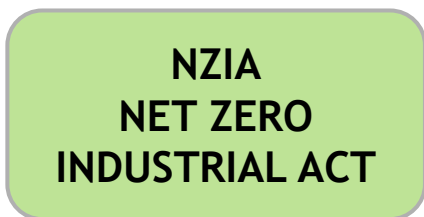
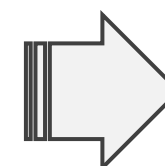
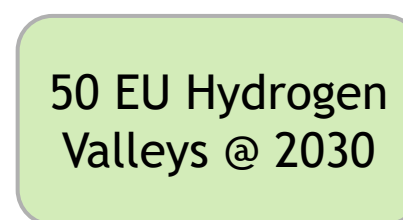
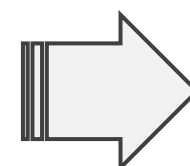
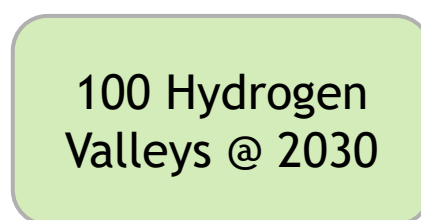
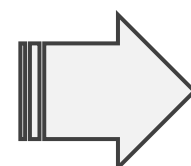
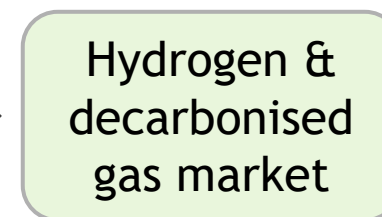
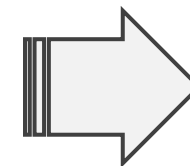
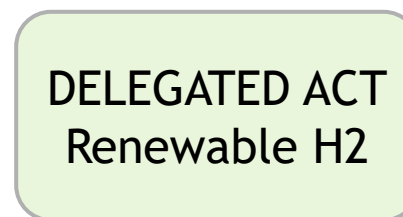
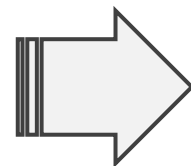
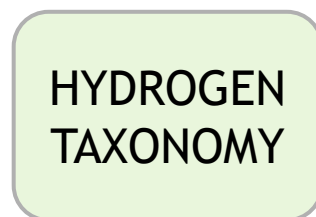
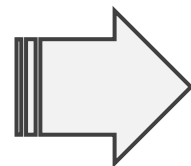
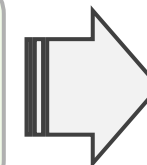
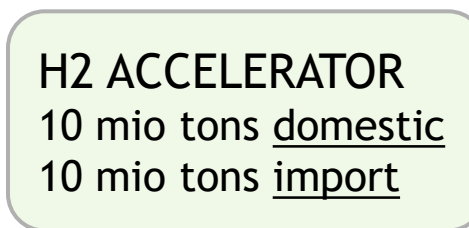
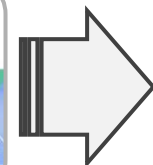
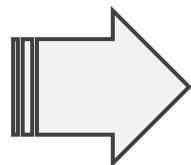
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Hydrogen – From momentum to market creation and implementation



- The **climate urgency** and **energy crisis** requires an urgent reduction on our dependency to fossil fuels
- Hydrogen is since a time considered as the **second leg** of the energy transition, alongside direct electrification...nothing to compare between these two targets!!!
- Momentum is shifting into **ACTIONS**:
 - ❖ We need a market framework to be in place **NOW** and support viable starting conditions!!!
 - ❖ *Industry is postponing/waiting/limiting hydrogen-related **INVESTMENTS** in large scale projects/initiatives waiting for this!!!*
 - ❖ **RESEARCH** IS SOMEWHAT MORE AND MORE NECESSARY TO IMPLEMENT THE FULL POTENTIAL!!!

A Complex Framework from Strategies to Market!!!



Hydrogen Valleys: a multi-level approach

REPowerEU and further policies/initiatives are requiring a **paradigm change** in the way we are facing the present situation, in terms of **timing, magnitude and actions**.

EUROPEAN LEVEL



- **Strategic approach** for a continental plan;
- Common objectives in terms of **impact**;
- Support to **key enabling** factors.

NATIONAL LEVEL



- **Coordinated** policy actions;
- **Development** of the hydrogen value chain;
- Industrial and territorial assets.

REGIONAL LEVEL



- **Implementation** of policies;
- Kick off hydrogen valleys;
- **Support** to key infrastructures and local initiatives.

THE INCREASING ROLE OF RESEARCH ON HYDROGEN TECHNOLOGIES

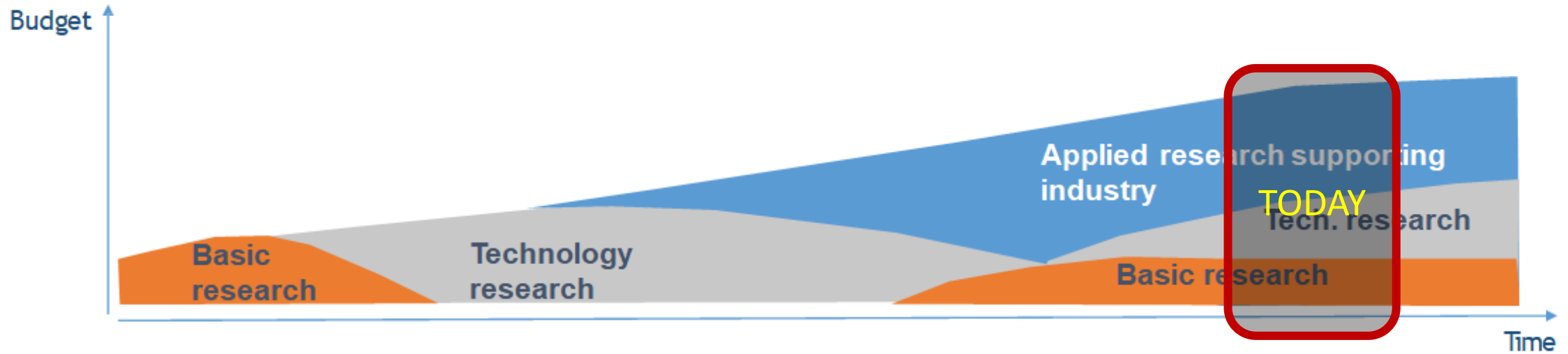


Impact economy and environment on Europe in 2050



Meeting all challenges

- Environmental
- Societal
- Economical



A continuous ambitious research is needed all along the value chain

EU Hydrogen ambition: how the scientific community can support

1

Accelerate technology development

- Novel technologies, codesign & co-development;
- Open/joint/large technology infrastructures;
- Industrial relevance.

2

Integration of learnt lessons into new projects

- Territorial support;
- Onboarding of learnt lessons, striving for scale-up of technologies.

3

Next generation at the forefront

- Support the incremental development of hydrogen technologies.

4

Training of the future workforce

- Train the workforce of the European hydrogen sector;
- Engineers, technicians, chemists...

Clean Hydrogen Partnership

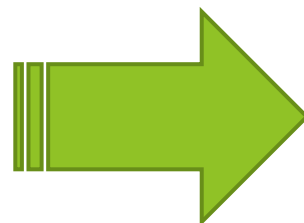
In collaboration with the public and private members of the Clean Hydrogen Partnership, Hydrogen Europe Research participates to the **identification of annual and multi-annual research & innovation priorities** and the **elaboration of research topics** included in yearly Annual Work Plans.



Hydrogen
Europe



Hydrogen Europe
Research

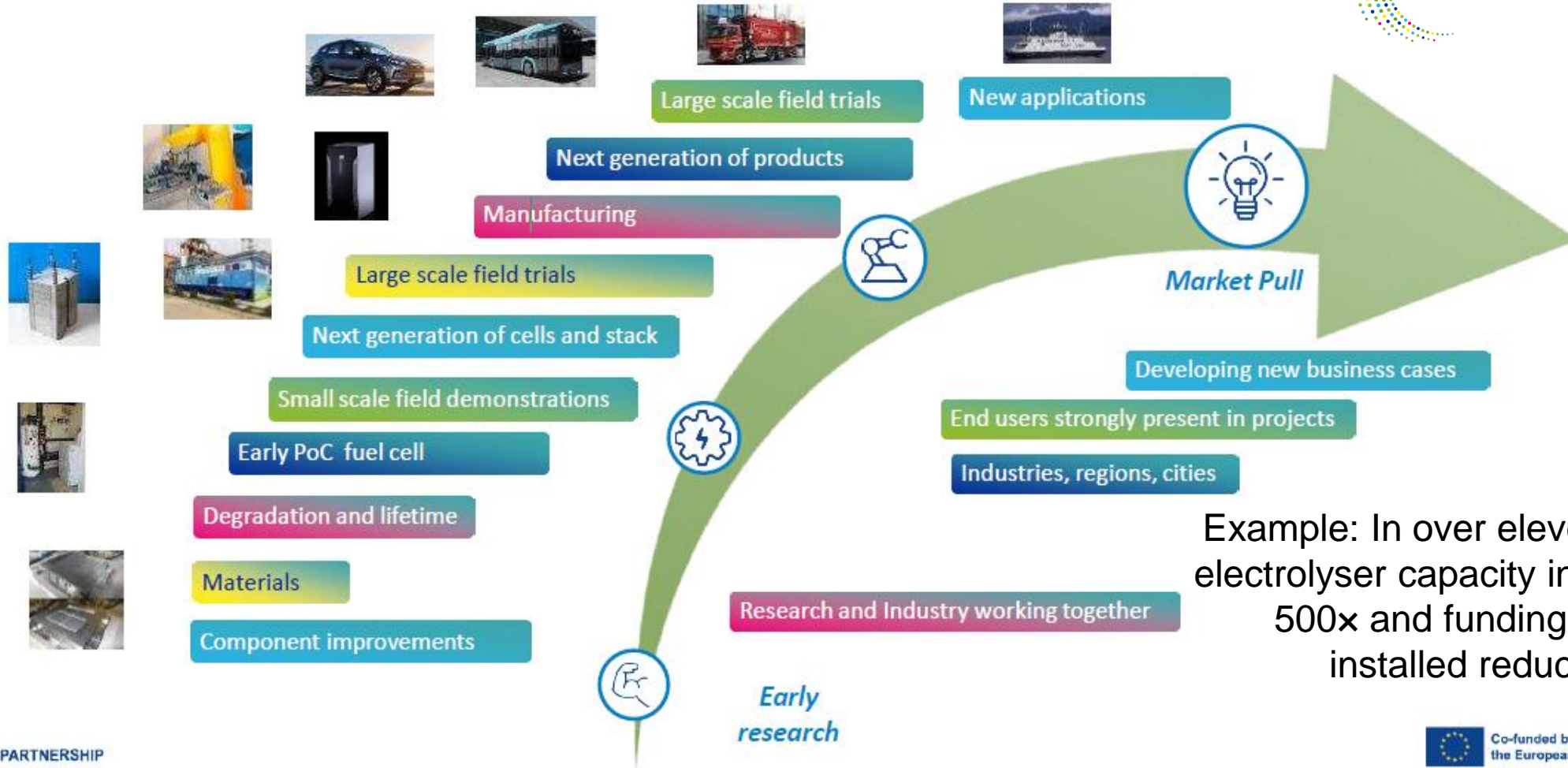


Clean Hydrogen
Partnership



- **EC representation** – DG R&I, DG ENER and DG MOVE
- The **Programme Office** acts as the **executive body** of the Partnership
- The **Strategic Research and Innovation Agenda (SRIA)** outlines the Research and Innovation activities that will be covered during the course of the Partnership

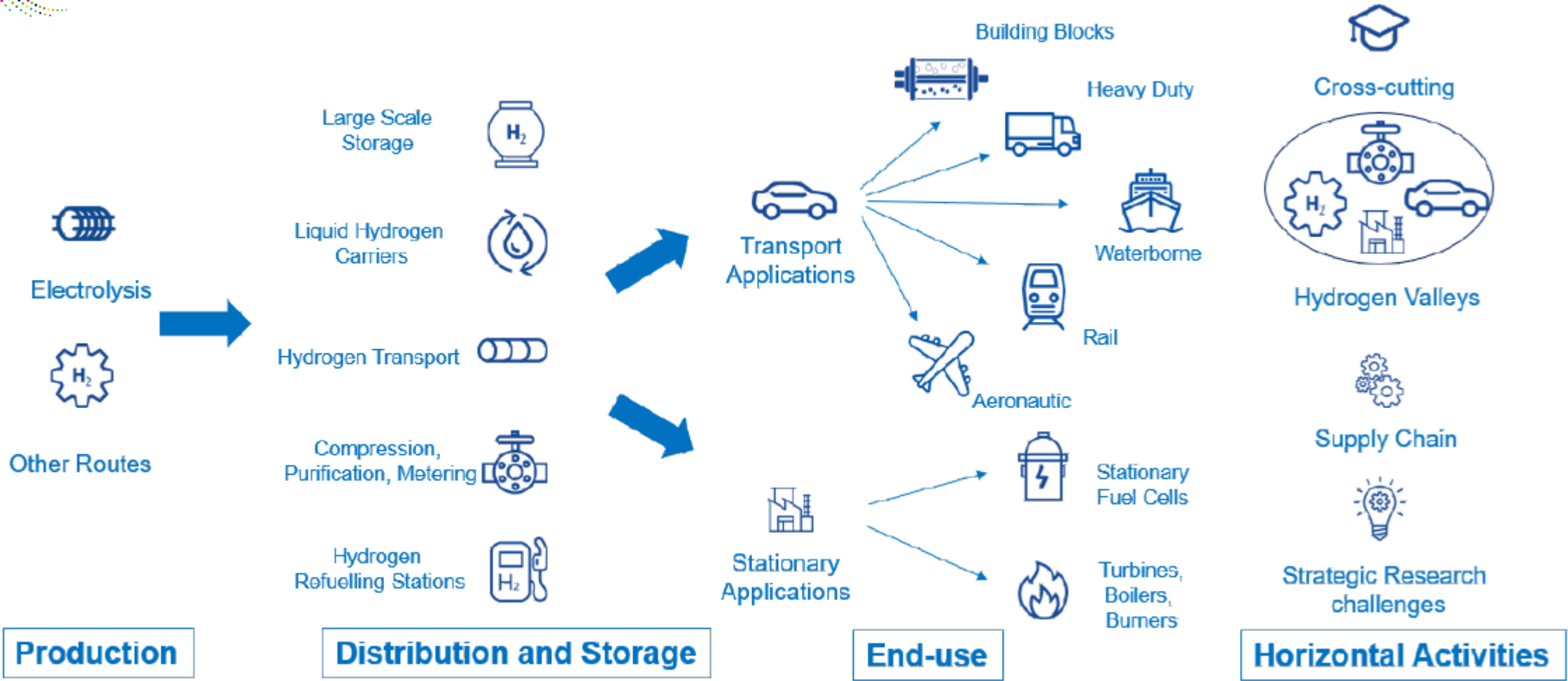
15 years journey of the Joint Undertaking From research to delivering solutions in



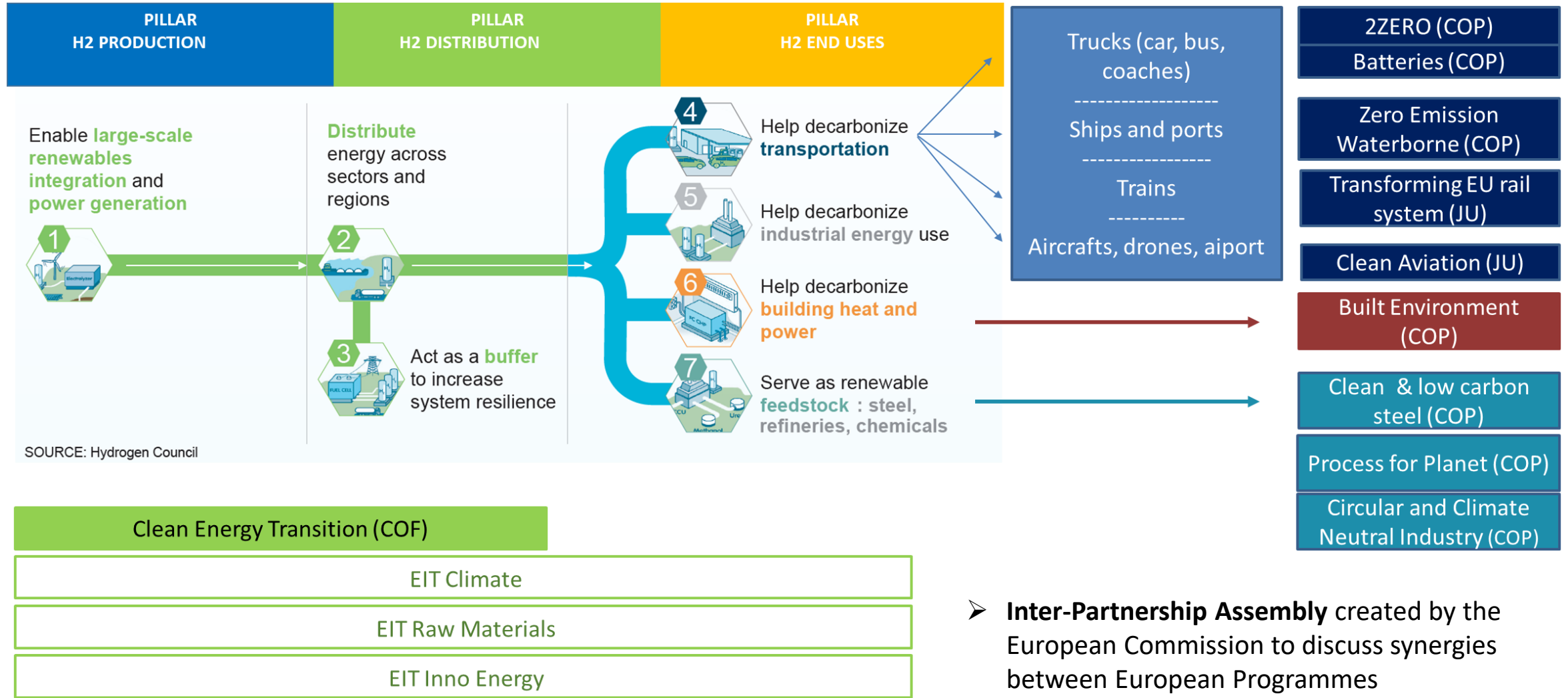
Example: In over eleven years
electrolyser capacity increased
500x and funding per MW
installed reduced 100x



SRIA 2021-2027 Priorities: R&I across the whole hydrogen value chain



Clean Hydrogen Partnership – Synergies with other European Programmes



➤ **Inter-Partnership Assembly** created by the European Commission to discuss synergies between European Programmes

Hydrogen Europe Research – Research Priorities

1



1. HYDROGEN PRODUCTION

- Advanced materials and novel cell designs for electrolysis
- Novel processes to produce hydrogen via photo-induced processes
- Hydrogen from conversion processes

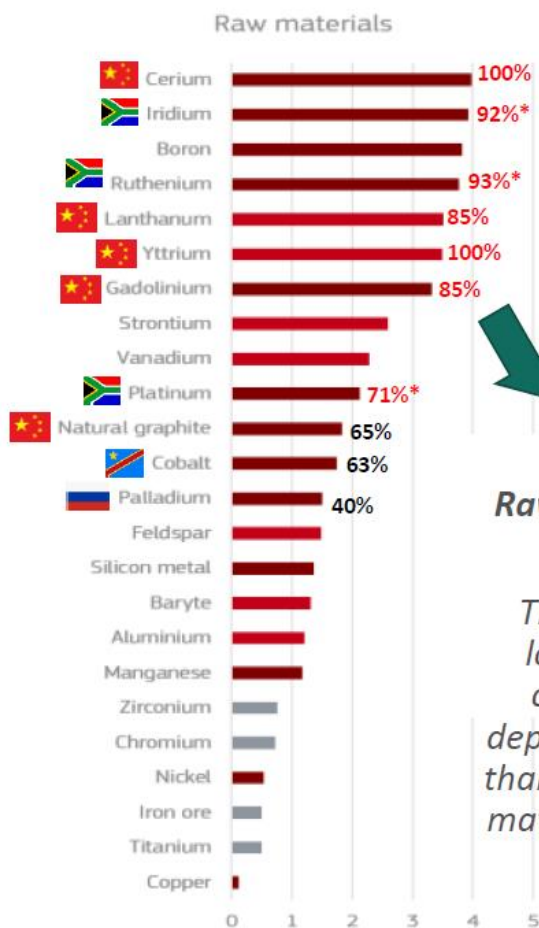
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2. HYDROGEN LOGISTICS

- Novel cost-competitive liquid hydrogen carrier solutions for massive hydrogen transportation
- Advanced materials and technologies for the future gas grid infrastructure
- Novel materials and concepts for efficient and cost-competitive hydrogen storage

Dependency on raw materials (extraction and processing) for electrolyser and fuel cells



Platinum Group Metals (Ir, Pd, Pt, ...)

- **Iridium** (Ir, IrOx) used for oxygen evolution reaction (OER) catalyst at the anode of the PEM electrolyser – best tradeoff between activity and stability
- **Palladium/Platinum** used in both fuel cells and electrolyzers. 47% mining capacity in Russia

Rare earths:

- **Scandium** (3/4 of the global Scandium market in 2017 was on SOFC to be used as an electrolyte), supplied by China and Russia. Then **Yttrium**

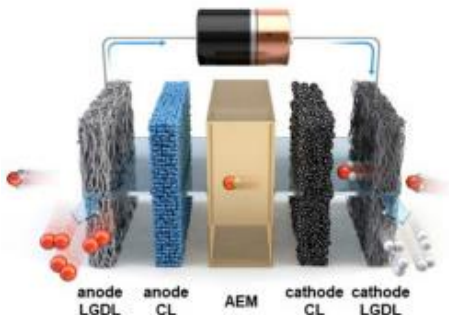
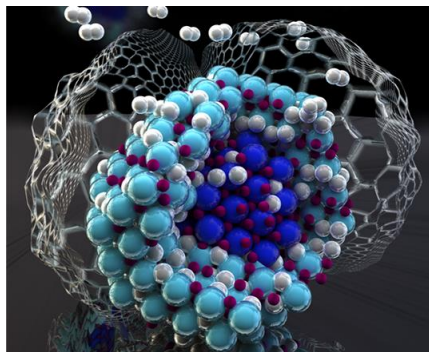
Critical Raw Materials Act proposal

The EU wants to lower its supply chain risks and dependencies of less than 65% on a single material, on a single country

Total metals required for one generation of technology to phase out fossil fuels			
Metal	Required Production (tons)	Known Reserves (tons)	Comment
Copper	4,575,523,674	880,000,000	Reserves cover 20% of requirements
Cobalt	218,396,990	7,600,000	Reserves cover 3.48% of requirements
Graphite	8,973,640,257	320,000,000	Reserves cover 3.57% of requirements
Lithium	944,150,293	95,000,000	Reserves cover 10% of requirements
Manganese	227,889,504	15,000,000,000	Adequate reserves
Nickel	940,578,114	95,000,000	Reserves cover 10% of requirements
Silicon (metal)	49,571,460		Adequate reserves
Silver	145,579	530,000	Adequate reserves
Vanadium	681,865,986	24,000,000	Reserves cover 3.52% of requirements
Zinc	35,704,918	250,000,000	Adequate reserves
Zirconium	2,614,126	70,000,000	Adequate reserves

Fonte: Michaux, S.P. (2023 Feb): Material Supply Challenges for the Green Transition to Phase out Fossil Fuels, SEB's The Green Bond report: Raised forecasts for transition investment, Page 11.

Strategic Research Challenges



- Long term projects **5 years and 10 M€**
- Relevant part of the EU research and innovation community
- Topics supported in the Clean Hydrogen Partnership:
 1. **Electrolysers and Fuel Cells:**
 - Low or free platinum group metal (PGM) catalysts,
 - reducing critical (raw) materials use
 - alternatives to perfluorosulfonic acid (PFAS) ionomers and membranes
 2. Advanced materials for hydrogen storage (e.g., carbon fibres, H₂ carriers)
 3. Advanced understanding of the **performance / durability** mechanisms of electrolysers and fuel cells

Hydrogen Europe Research – Research Priorities

3



3. HYDROGEN END-USES

- Advanced materials for on-board hydrogen conversion in vehicles
- New hydrogen end-uses
- Microgeneration applications
- Hydrogen refuelling protocols for transport end-uses

4



4. TRANSVERSAL ACTIVITIES

- Modelling and characterisation of materials behaviour
- Comprehensive models and scenario analysis tool
- Common scientific methodology to calculate GHG emissions
- Education, reskilling and upskilling of the workforce
- Defining regulations, codes and standards through further pre-normative research and accelerated testing protocols
- Research and Technology Infrastructures

Sustainability and circularity

Projects ongoing and links with other activities

Cross-cutting
Projects



Life Cycle Sustainability Assessment (LCSA)

Assessing the environmental, social and economic impacts



Eco-design guidelines for FCH products

The 1st milestone in the eco-design criteria in the European sector



Recycling technologies dev. and validation

Development of novel and existing technology for recycling



Other activities

European Platform on Life Cycle Assessment

Expert workshop on Environmental Impacts of H2
With the support of:

Better understanding and knowledge of the environmental impacts of hydrogen and hydrogen releases

Cross-cutting
Projects



Hydrogen sensors

Guidelines to select and use the best sensor for a particular application



CFD for safety analysis

Development of best practices, HYMEP evaluation protocol



Safety expert group

Development of H₂ safety expert group



Other activities



Collaboration with the Joint Research Center (JRC)

Hydrogen Incidents and Accidents Database (HIAD 2.0)

Tools for Innovation Monitoring (TIM)

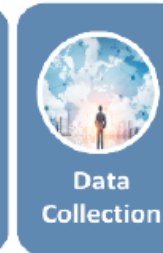
European Hydrogen Safety Panel (EHSP)



Project level



Program level



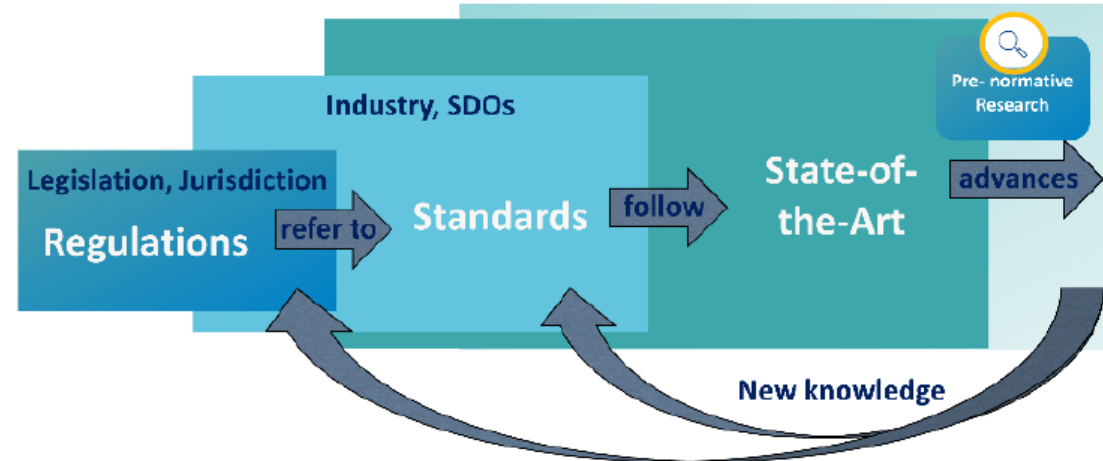
Data Collection



Public Outreach



Pre-normative research (PNR) activities:
An essential step advancing Regulations, Codes, and Standards



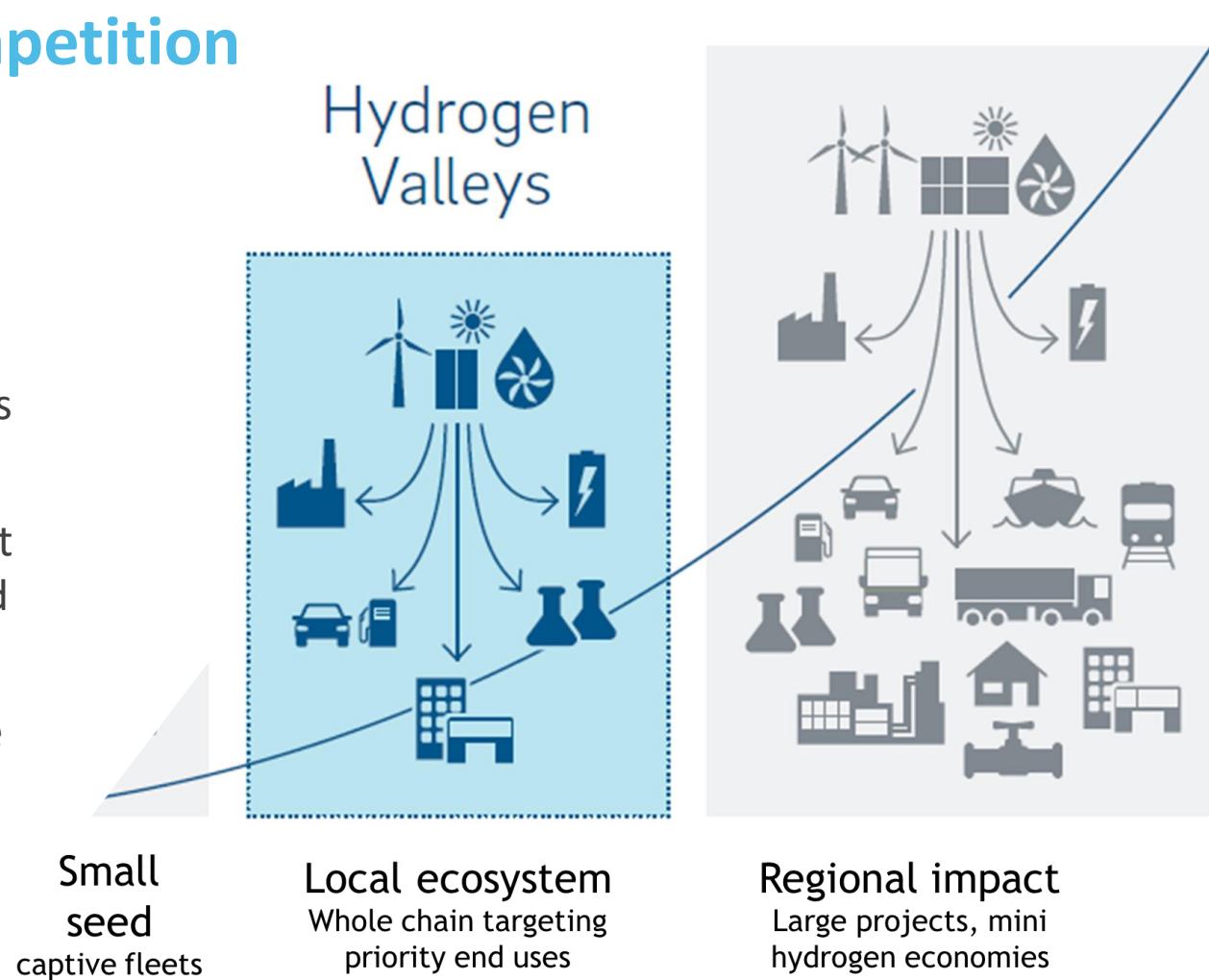
Hydrogen Valleys: the role of research at regional-level

- Research as a key enabling factor for local industrial clusters;
- Support to the development and demonstration of Hydrogen Valleys in hard-to-abate sectors;
- Models and tools to support initiatives at multi-scale and multi-purpose territorial implementation;
- Advice policy-makers in adopting strategic territorial and industrial plans;
- Support to industries in their decarbonisation plans, deploying hydrogen at the lowest cost and highest impact with multi-objective optimisation tools;
- **Lessons learnt are crucial**: research can carry out the scientific, technical and economic monitoring of regional initiatives.



Hydrogen Valleys: catalysts for collaboration and competition

- Lessons learnt can enable the collection of techno-economic values on performance, availability and costs;
- This will create confidence on hydrogen solutions for investors and decision-makers;
- Awareness on what is working properly and what should be improved with additional research and development efforts;
- Hydrogen Valleys will provide information on the required workforce, advising on the training efforts for skilled workers.



Hydrogen Valleys

The European Declaration

- A joint declaration on Hydrogen Valleys was signed in Brussels on 1 March
- 50 Hydrogen valleys, at least 1 in each EU member country
- 6 PRIORITY ACTIONS:
 1. Strengthen the research and innovation agenda to accelerate the development of the Hydrogen Valleys
 2. Continuous investment in research and innovation of hydrogen technologies such as the Clean Hydrogen Partnership
 3. Collaboration to maximize the impact of funding
 4. Promote knowledge sharing and accelerate the development of new initiatives
 5. Stimulate the development of educational and training programs to build skills
 6. Consider the development of H₂ valleys as an element for the global development of the hydrogen economy



A ROADMAP ON EU HYDROGEN VALLEY WILL BE RELEASED BY EC

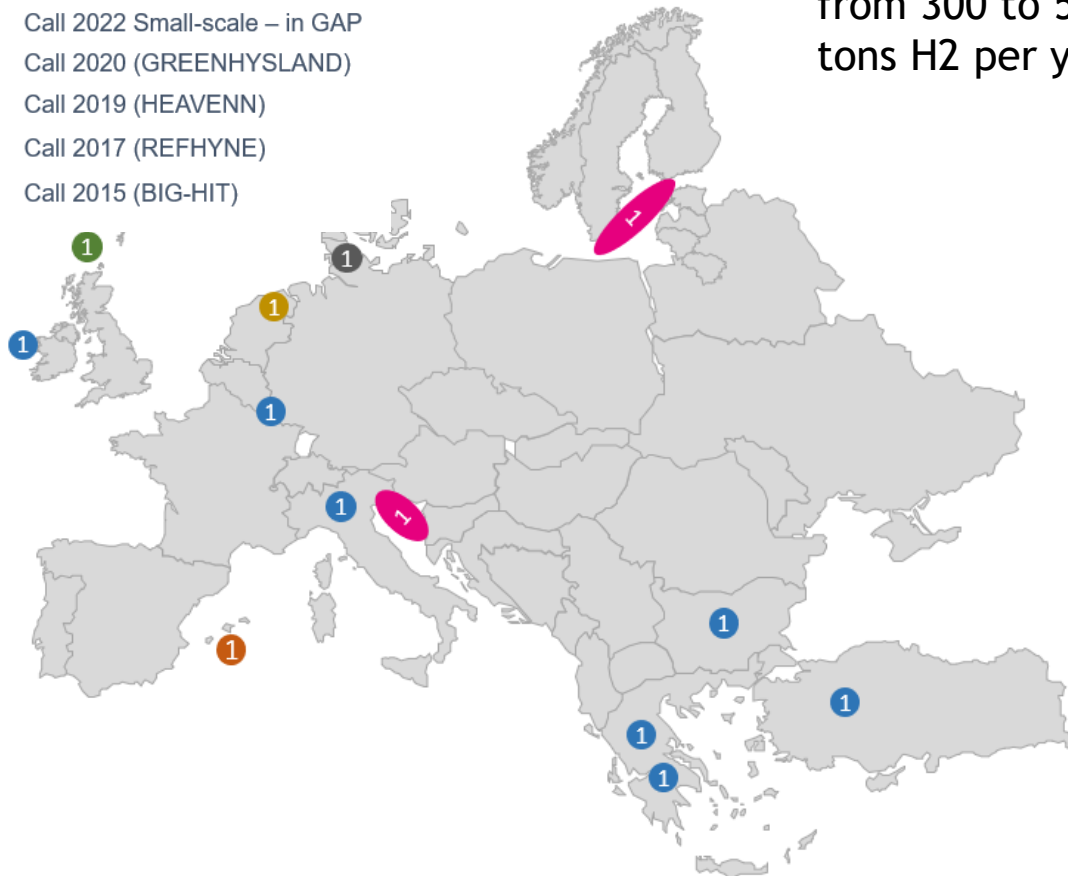
Hydrogen Valleys

Clean Hydrogen Partnership

Running projects (including those under GAP):

- Call 2022 Large-scale – in GAP
- Call 2022 Small-scale – in GAP
- Call 2020 (GREENHYSLAND)
- Call 2019 (HEAVENN)
- Call 2017 (REFHYNE)
- Call 2015 (BIG-HIT)

from 300 to 5,000
tons H₂ per year



Clean Hydrogen Partnership

154.44 MEUR of support

- 33 MEUR Main Call 2022
- 23.4 MEUR residuals from Call 2022,
- 49 MEUR RePowerEU Call 2022
- 38 MEUR Main Call 2023
- 11 MEUR RePowerEU AWP 2023

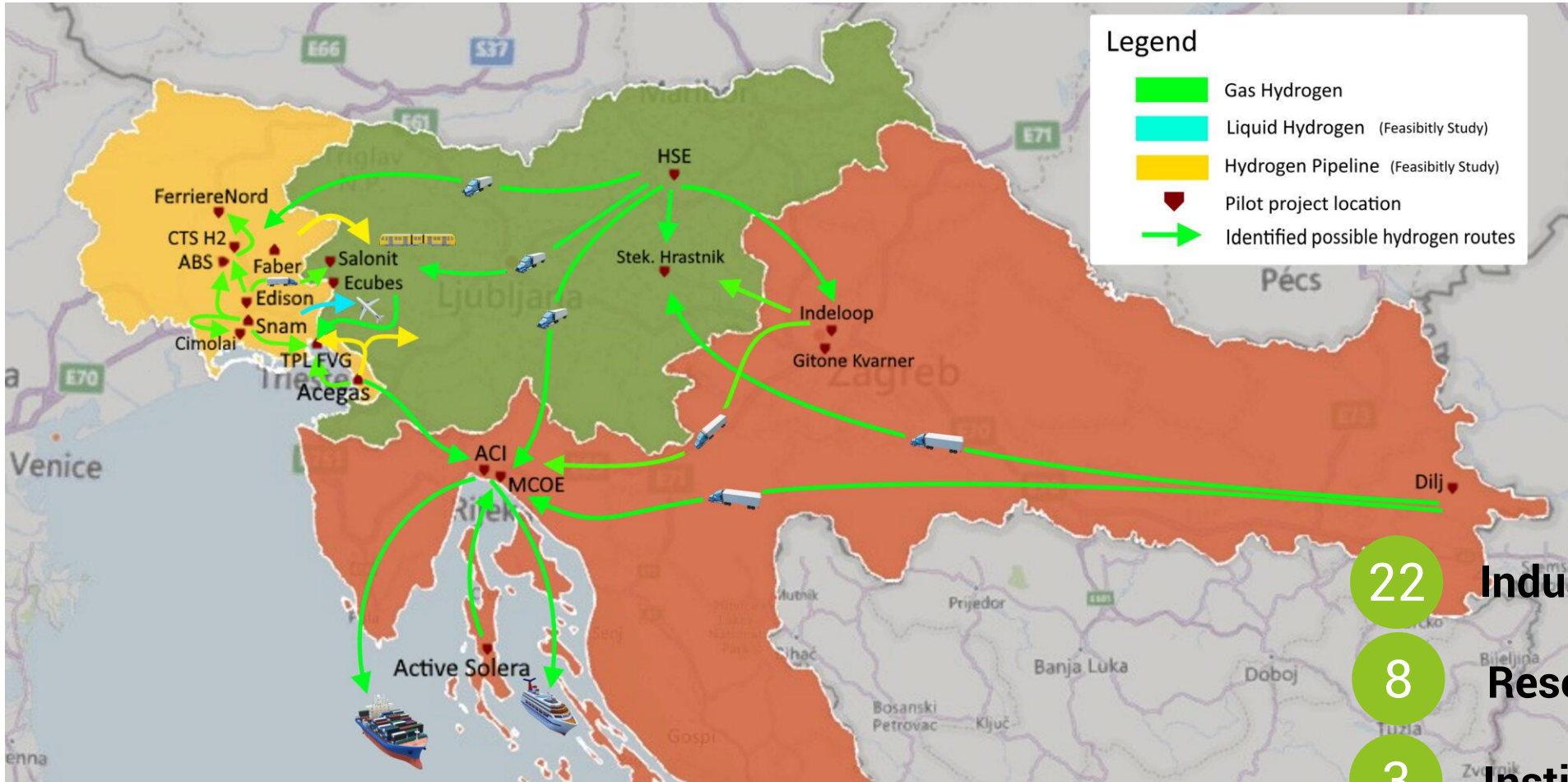
EU Commission priorities

- Support the realization of 50 Hydrogen Valleys within 2030
- Assign an additional budget of 200 M€ to the Clean Hydrogen Partnership calls
- Publish (end 2023) an EU ROADPMAP on Hydrogen Valleys

Testbeds/Pilot Projects ecosystem

18

Pilot / Test Beds



FVG – Italy
Croatia
Slovenia

strong level of
business and
social interaction

area
of 84.769 sq.Km

about 7.2 million
inhabitants

22

Industrial Partners

8

Research Partners

3

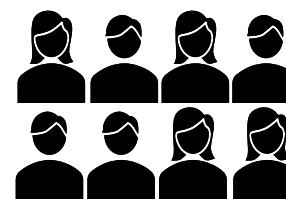
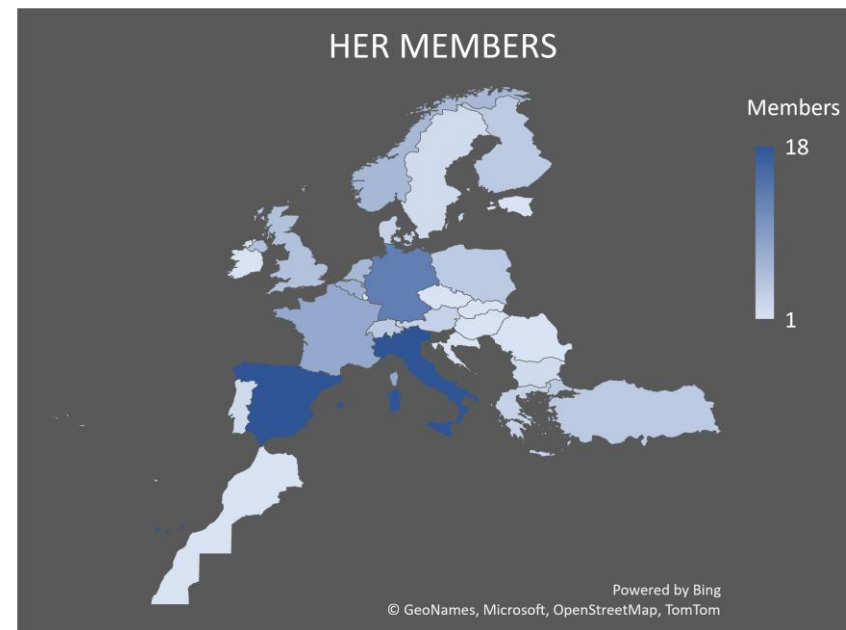
Institutional Partners

Hydrogen Europe Research at a glance

We represent the European Hydrogen Scientific Community with **150 members** in **29 countries**.



76 Higher education establishments
74 Research organisations



800+ scientists
involved in defining priorities
for the FCH sector

Our vision and mission

Hydrogen Europe Research aims to contribute to the achievement of carbon neutrality by strengthening the European hydrogen industry and ensuring high-level research in Europe. We actively support Research Institutes and Universities involved in the development of a new industrial ecosystem based on hydrogen.

Our mission is based on **4 pillars** with **4 active Working Groups (2 starting September 2023)**

RESEARCH

Supporting the excellence of European research on hydrogen and fuel cells – low Technology Readiness Level (TRL) research is still needed to develop the next generations of materials, components and products.

INFRASTRUCTURES

Enabling Research & Technology Infrastructures to scale up and speed up innovation – development of RIs and TIs is essential to bringing new technologies into the market.

SUSTAINABLE DEVELOPMENT

Ensuring sustainable development standards for a clean hydrogen ecosystem – evaluation of the carbon and environmental footprint related to the production, distribution, and usage of hydrogen is fundamental.

EDUCATION

Developing education and trainings to provide a skilled workforce for the European hydrogen economy – an educational framework should be a priority of European and national policies.



Hydrogen Europe
Research



Thank you
for your
support!