Clean Hydrogen Partnership

From Innovation to Industrial Competitiveness in the EU Hydrogen Sector



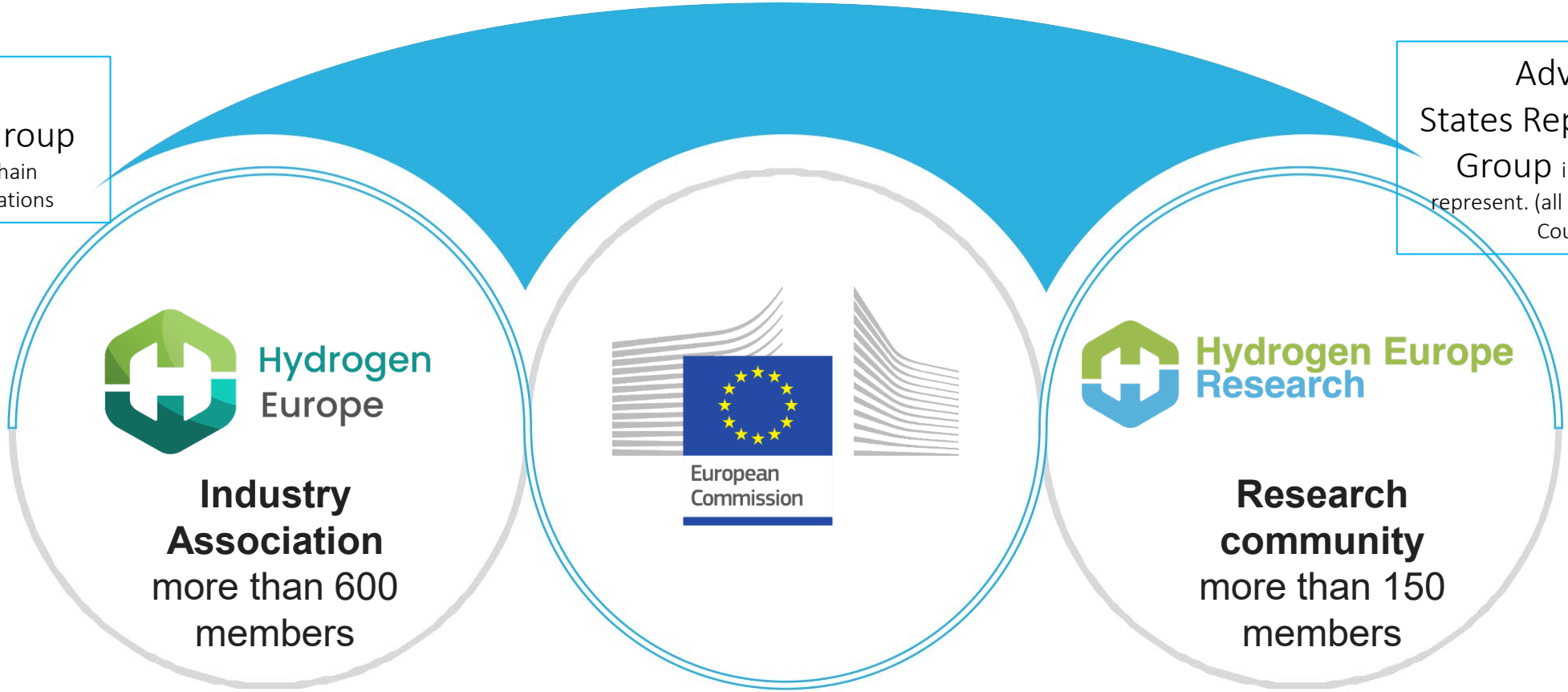
EUROPEAN PARTNERSHIP

Clean Hydrogen Joint Undertaking

EU Institutional Public-Private Partnership (IPPP)

Advisory:
Stakeholder Group
incl all H2 supply chain stakeholders, associations

Advisory:
States Representative Group incl 36 countries represent. (all EU and Associated Countries)



1 billion EURO from Horizon Europe* to implement R&I activities and facilitate the transition to a greener EU society through the development of hydrogen technologies

**** additional 200 million EURO for Hydrogen valleys (under RePowerEU)***

Co-funded by the European Union

Clean Hydrogen Partnership

Almost two decades of the Joint Undertaking

From **research and innovation** to delivering solutions in the market

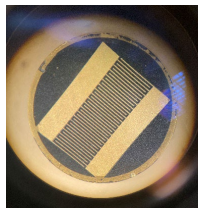










Large scale field trials

Next generation of products

Manufacturing

Large scale field trials

Next generation of cells and stack

Small scale field demonstrations

Early PoC fuel cell

Degradation and lifetime

Materials

Component improvements







New applications

Hydrogen Valleys





Developing new business cases

End users strongly present in projects

Industries, regions, cities



Research and Industry working together

Early research

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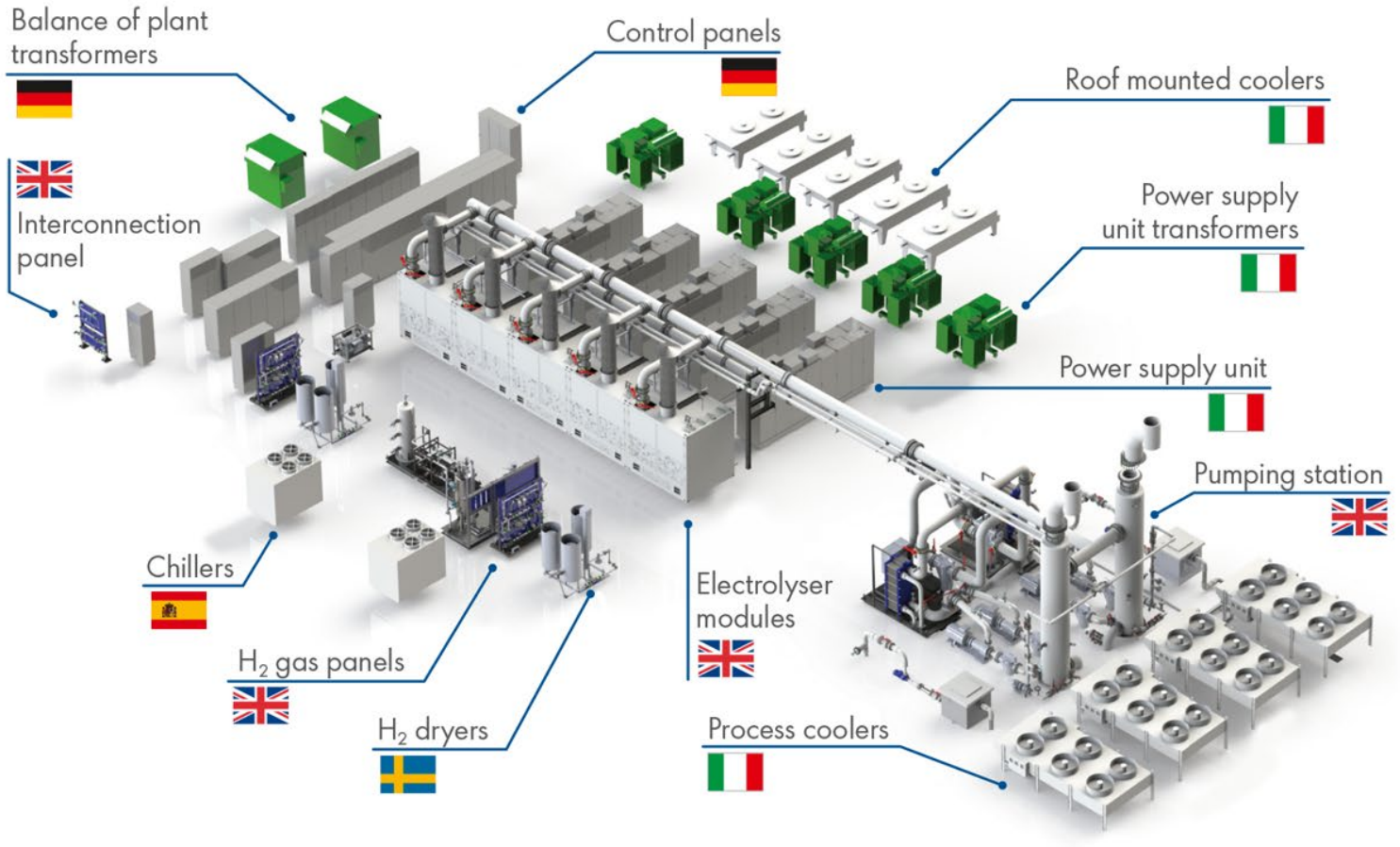
100% EU-made components in REFHYNE project

(first 10 MW PEM-electrolyser in Europe, at Cologne/DE Shell refinery)

Building Europe's largest PEM-Electrolyser

REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE

- 10 MW
- Up to 1,300 tons production capacity
- The first large-scale water electrolyser integrated in a refinery
- Stepping stone and reference for the 100MW class



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Other JU-specific activities to support the sector

Additional activities are necessary to fulfil the JU objectives and **support the sector, along the grants R&I funding**



- **Tenders/Studies** for feedback to policy and sectoral roadmaps
- Developing **synergies** with other partnerships and programmes incl **H2Valleys initiative**
- **Pre-Normative activities** for Regulations, Codes and Standards
- European Hydrogen **Safety Panel** (of experts)
- European Hydrogen **Sustainability** and Circularity Panel (of experts)
- **Knowledge** management (Observatory)
- Competitiveness e.g. SMEs, Start-ups
- **International** Cooperation (MI, IPHE, NEDO)
- Communication activities

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Continuous and stable support to Startups/SMEs –

Scaling up the EU hydrogen market… along the technology)

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438 Number of SME beneficiaries

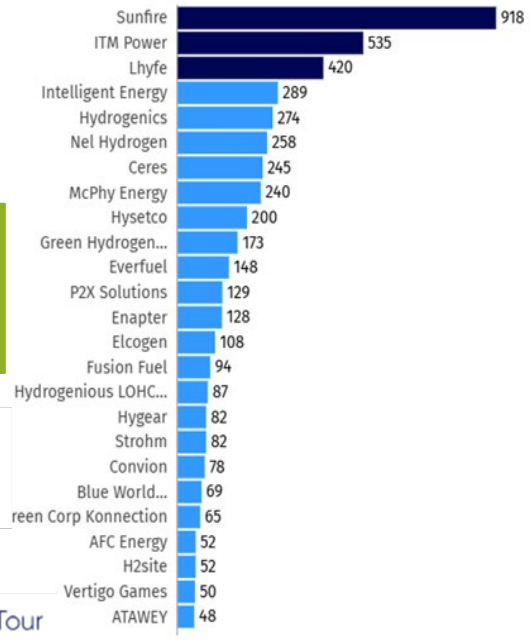
€ 424.9 M JU funding to SME

84 SMEs raised € 5.18 B

Leverage of **12x** the amount committed by the Clean Hydrogen Partnership

€ 61.8 M Average amount raised per company

Top SMEs by amount raised (M€)



R&I supported by the Clean Hydrogen Partnership

Provides pipeline of **validated technologies and solutions within industry** (incl SMEs), ready to be scaled up and deployed

Large-scale industrial implementation → **Member States investments in factories, pilot lines etc**

Next step: CLEAN HYDROGEN STARTUP HUB

TENDER PUBLISHED → *aiming at accelerating and* ***accompanying the "translation" of research into investable start-ups, building the basis for scaling startups by connecting investment to hydrogen innovation,*** *with corporates as key enablers, and building and consolidating European Hydrogen Innovation Corridors.*

From beneficiaries in our projects to IPCEI funding:

IPCEI Hy2Use
- Everfuel
- P2X Solutions

IPCEI Hy2Move
- Hydrogène de France

IPCEI Hy2Tech
- Advent
- Elcogen
- Sunfire
- 1s1 Energy

IPCEI Hy2Infra
- Lhyfe
- Fusion Fuel
- Hydrogenious

Working with Regions and Hydrogen Valleys - an evolving concept and priority

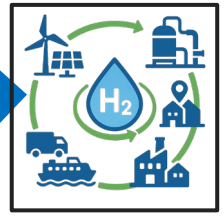
Clean Hydrogen Partnership



July 2020
European Hydrogen Strategy

May 2022
REPowerEU Plan

June 2024
European Hydrogen Valley Roadmap



FCH JU - Regions initiative (2016-2018)

PDA I 2020

PDA II 2022

H2Valleys facility 2025

EUROPEAN HYDROGEN VALLEYS PARTNERSHIP

REPowerEU
+200 MEUR



AWP 2015

BIGHIT

AWP 2019

HEAVENN

AWP 2020

AWP 2022

AWP 2023

AWP 2024

AWP 2025

AWP 2026

Status

27 H2 Valleys proj/grants funded (**338 M€** JU funds/1.6 b€ total costs)

+ 1 grant under signature

+15 PDAs
(ended -10.3 b€ investments project pipeline)

+13 PDAs
(ongoing)

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What next?

From **EU technology leadership** to **EU market leadership!!!**

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Draghi Report in 2024:

Innovation is key to competitiveness and the JUs could play an important role



- **Fostering Innovation Leadership** – Enabling Europe to stay at the forefront of technological advancements.
- **Bridging Innovation Gaps** – Accelerating the journey from research to market deployment.
- **Scaling Up Industrial Capacity** – Facilitating large-scale deployment of critical technologies.
- **Boosting Strategic Autonomy** – Reducing dependency and enhancing EU industrial resilience.
- **Mobilizing Public-Private Synergies** – Leveraging investments to drive industrial transformation.

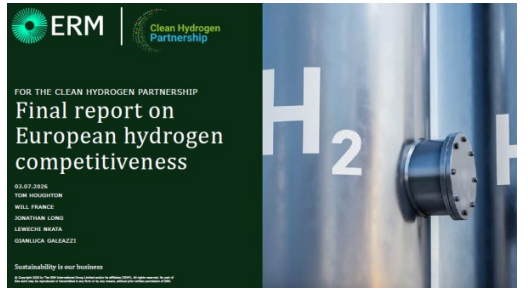
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Work ongoing on setting up R&I Priorities in the next decade

Driving EU Innovation and Competitiveness in the Hydrogen Sector

- **(Funding) Synergies Strategy** - 2026 and beyond – report published
- EU **Hydrogen Competitiveness and the Role of Innovation** – report published
- Strategic Research and Innovation Priorities, **SRIP** - ongoing study
- Strategy Advice to the Clean Hydrogen Joint Undertaking on **partnership legal framework and its operation** – ongoing study







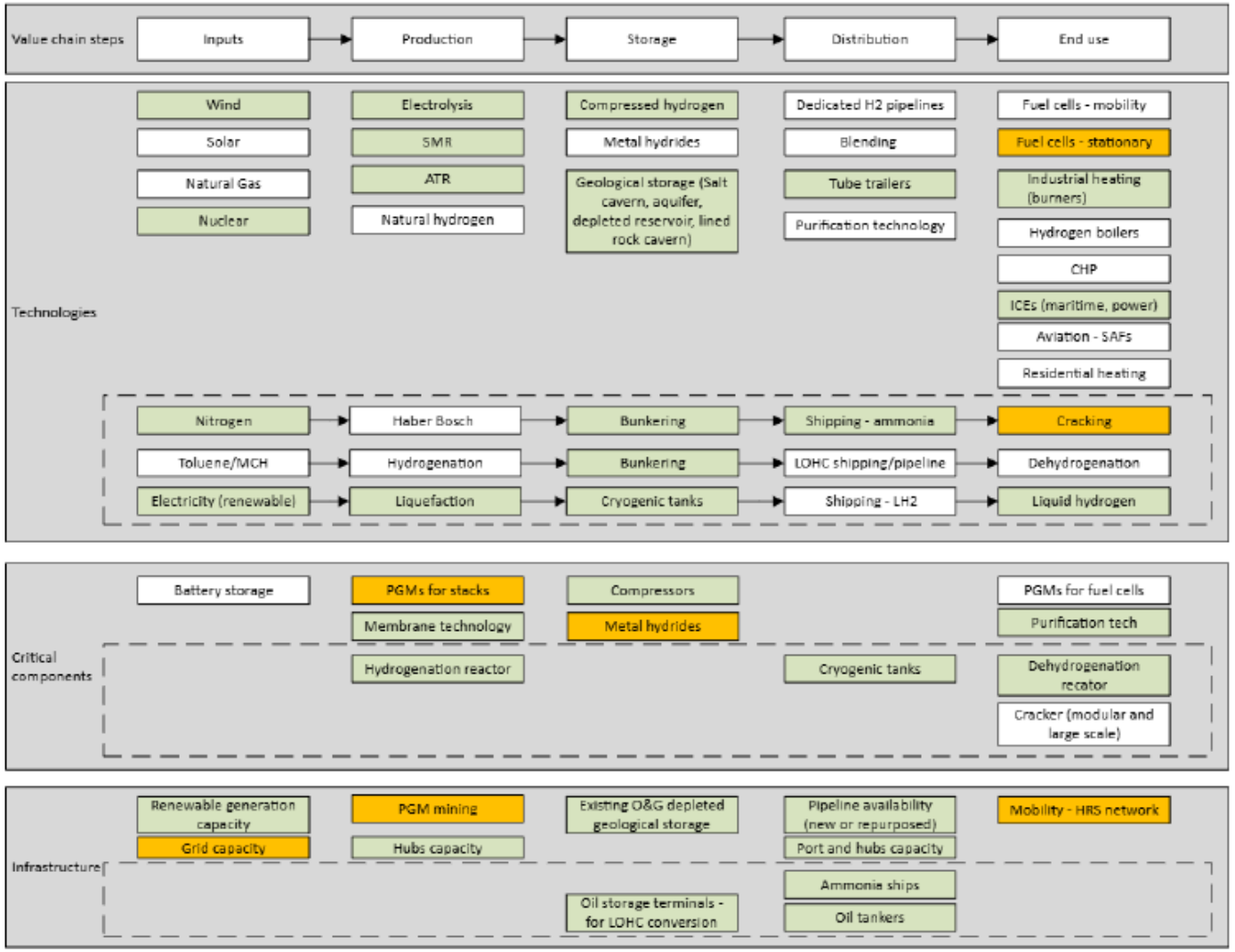
Hydrogen and derivative end-uses and applications

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A granular view of the hydrogen value chain

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Europe is active across the value chain with strong technology and wide involvement in infrastructure development



Key:

- Actively competing/targeting as part of strategy
- Active but with limited focus
- Limited or no activity
- Indicating value chain relationships

What is at stake?



Strengths

- **Leadership in electrolysers and infrastructure tech**
- Strong patent position
- Focus on quality, reliability, **sustainability, safety**



Opportunities

- **Approx 1M jobs by 2030**
- Potential global hub for renewable H_2
- Supportive EU policy framework



Weaknesses

- Dependence on critical raw materials
- **Higher production costs vs competitors**
- Regulatory and permitting complexity



Threats

- Risk of losing tech leadership (PV, batteries precedent)
- **Delays in industrial scale-up**
- Lack of global champions

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Seven (7) Priority areas with highest impact on competitiveness

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A competitive, resilient European H_2 industry & ecosystem



Manufacturing at scale



Electrolytic H_2 production



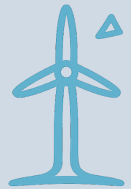
Enabling H_2 carriers & supply chains



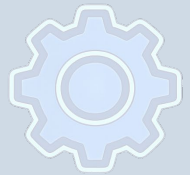
Supporting H_2 Ecosystems



Demand & market uptake



Access to competitive energy



Other enablers e.g. skills, support to start-ups

Manufacturing	EU technologies & value chains	Market creation and scale-up	Framework conditions

WHAT remains to be done?

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1 R&I REMAINS ESSENTIAL

Industrialisation cannot be done without innovation!

- Continue **early-TRL funding for strategic technologies** and preserve the pipeline of future solutions.
- Further **improve technology performance, efficiency, durability and cost.**
- **De-risk emerging technologies** before commercial deployment and maintain European technology leadership.
- Use R&I to **address new system-level challenges** as technologies move into real-world deployment.

R&I remains a necessary foundation for future competitiveness.

2 THE JU REMAINS ESSENTIAL

And its role needs to evolve with the maturity of the sector…

- Preserve the ability to **align public objectives with industry expertise**, investment and delivery.
- **Connect R&I and demonstration** more systematically **with scale-up and commercial deployment.**
- Strengthen **links with demand creation**, infrastructure, finance and industrial policy.
- Adapt **partnership models and instruments** as market maturity and **project risks** evolve.

The JU model should evolve around its proven R&I core — and complement it.

The challenge is to connect the main R&I role of JU more effectively with the conditions required for industrial scale-up and market deployment.

Source: ERM, primarily slide 112 — condensed for management presentation.

End-uses that likely rely on hydrogen and derivatives replacing fossil-based energy and feedstocks for full decarbonisation are now well identified

These are applications that cannot be electrified and that will therefore continue to require material input (molecules as opposed to electrons) as fuel or feedstock, be it with a switch to alternative materials such a hydrogen, ammonia, or methanol

Hydrogen and derivative end-uses and applications
(numbered in order of expected implementation at scale)

Transport (EU-T)	Feedstock for industry (EU-F)	Industrial heat (EU-H)	24/7 renewable electricity (EU-E)
1. H_2 for production of conventional fuel and biofuel 2. Aviation 3. Maritime transport 4. Long haul heavy-duty road transport Other(1): Rail transport, Off-highway mobile machinery (incl. ports and mining), Drones	1. Ammonia for fertilisers and chemicals 2. H_2 for steel 3. Feedstock for HVCs (2) and other chemicals (e.g. methanol to olefins) Other(1): H_2 for chemical recycling	1. e-methane for high temperature heat 2. H_2 for high-temperature industrial furnaces / fuel systems	1. Dispatchable renewable power (e.g. from long term storage, or from electrolyser demand-response) Other(1): Continuous power supply in off-grid systems ; Shore power for ships at berth

(1) Other applications having a less prominent role in terms of volume

(2) "high-value chemicals": ethylene, propylene, butadiene, benzene, toluene and xylenes (olefins)

- *3,2 GW of electrolyser capacity is under construction or past FID in Europe today.*
- *The targets set by the EU regulatory framework towards climate neutrality require deployment of hydrogen and derivatives at a scale of 1-3 Mt H_2eq/y or more for each end-use above by 2035-2040.*

The decarbonisation of end-uses requires the deployment of new value chains combining new technology bricks

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	Molecule	New end-use technology	New delivery systems	New production systems
End-uses: Transport (EU-T)	• **H_2 for refineries and biofuel production** • **SAF for aviation** • **H_2 for HD road transport, coastal shipping, aviation** • **Methane, Methanol, NH_3, DME for shipping**	SC-7: **H_2 refuelling systems (HRS, bunkering, airport fueling)** EU-T: **Onboard vehicle technologies (gaseous and liquid H_2)** • Onboard H_2 storage (compressed or cryogenic tanks) • Fuel cells and combustion engines adapted to new fuels • Site-specific safety, metering and transfer systems	SC-4: **European H_2 transport grid** incl. **geological storage** and compression SC-5: **H_2 distribution/collection networks**	SC-1: **Renewable and Low Carbon H_2 production, incl. compression** SC-2: **H_2 liquefaction and H_2 above ground storage** SC-3: **Derivative synthesis** (methane, ammonia, methanol, kerosene, diesel, DME) incl. bio/non-bio hybrid processes
Feedstock for industry (EU-F)	• **NH_3 for fertilizers** • **H_2 for steel** • **Methanol & naphtha for chemicals**	EU-F: **Feedstocks for industry** • New industrial processes (e.g. steel from H_2 DRI, chemicals from methanol)		
Industrial heat (EU-H)	• **Methane** • **H_2**	EU-H: **Heat from sustainable fuels** • H_2 burners, boilers, and combustion systems • Kiln/furnace integration interfaces • Industrial safety, metering and control systems	SC-6: **H2 carriers** • Ammonia cracking • LOHC dehydrogenation • MeOH/DME steam reforming with CO_2 back-shipping	
24/7 renewable electricity (EU-E)	• **H_2** (from LT storage) • **NH_3** (imported) to substitute NG based dispatchable capacity	EU-E: **24/7 renewable electricity** • H_2 or NH_3 (fuel flexible) turbines • Stationary fuel cells • Power system integration (grid balancing, off-grid supply)		

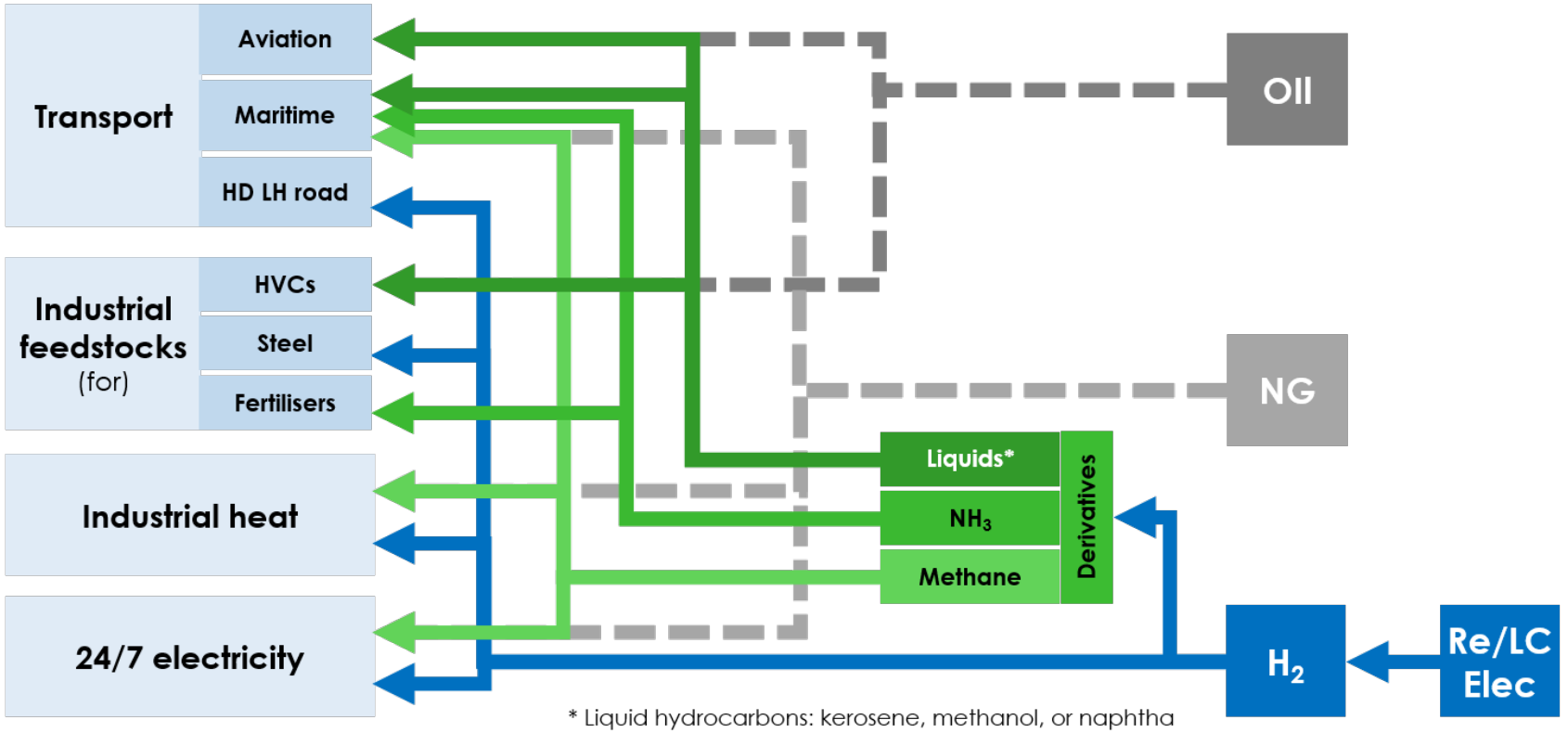
EU: End Use ***SC: Supply Chain***

A renewed and coherent EU-wide R&I & Deployment agenda: from individual technologies to complete hydrogen value chains

Despite significant progress in recent years, the hydrogen sector and its technologies need to mature and scale-up further

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The challenge is to deploy complete value chains, not isolated technologies



* Liquid hydrocarbons: kerosene, methanol, or naphtha

Simplified depiction of the new clean molecule value chains that need to be deployed for decarbonisation of the identified end-uses. The dotted lines represent existing transport infrastructure used for supply of the clean molecules. (HD LH road: long-haul heavy-duty road transport, NG: natural gas, Re/LC Elec: Renewable or Low carbon electricity).

Note: Infrastructure for supply of fossil fuels and feedstocks that is not used for supply of the designated clean molecules is not shown.

Further advances are needed inc. but not only on

- performance, cost competitiveness, durability, efficiency, sustainability, material availability, recyclability and manufacturability
- continued scale-up towards GW-scale deployment.
- Greater operational flexibility and better integration into real-world applications and markets are also essential.

Overarching R&I framing and prioritisation rationale based on two-track approach for tech development

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Leverage Europe's systemic strengths **(1) to accelerate complete clean molecule value chains** while **(2) developing the next generation of integrated technologies and systems** supporting EU industrial competitiveness and resilience

Track 1: accelerate complete decarbonised molecule value chains

- **Deploy high-TRL technology-based bricks in complete value chains at meaningful scale**.
- Prioritize deployment-oriented R&I to address technology bankability, reliability/ availability, manufacturability, integration, standardization, repeatability and safety.
- Performance-oriented R&I inside mature bricks should support deployment

Track 2: develop the next generation of integrated technologies and systems

- Prioritise **mid-/low-TRL R&I that tackles intrinsic limitations of today's solutions or unlocks deeper integration**.
- Target significant gains in efficiency, resource use, cost, resilience and whole-system performance.
- Develop technologies that can eventually be integrated into the complete systems established through Track 1.

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Additionally, Manufacturing Innovation: enabling industrial scale-up and deployment

Design technologies for manufacturing, while developing the industrial capabilities to produce and deploy them at competitive cost.

SCALE-UP



Larger-capacity systems and components

Develop equipment, tooling and processes to produce, assemble and qualify larger components, stacks, modules and systems.

SCALE-OUT



Replicate proven units and modules

Automation, higher yield and material efficiency. Modular designs, standardised interfaces and qualified alternatives.

DEPLOYMENT

Prepare in the factory, simplify work on site

Factory-tested and pre-commissioned modules. Design for maintenance, replacement, repair, refurbishment and recycling.

QUALITY THROUGHOUT: in-line monitoring, factory testing and digital traceability

Product designs, production, quality assurance and installation must mature together, aligned with market introduction plans and feedback from operation.

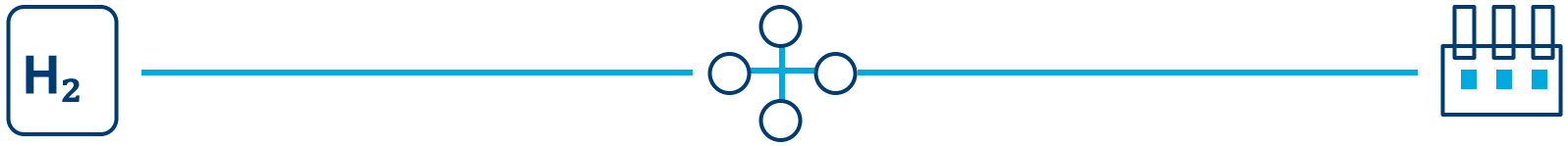
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AND enabling Deployment at scale: preparing investment-ready and commercially viable end-to-end value-chains including H2Valleys

Reinforce Hydrogen Valleys as a framework for coordinating interdependent investments around anchor demand.

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Hydrogen and derivatives — **Infrastructure** — **Multiple end uses**

Anchor demand aligns production, delivery and use

Project-readiness gap

Technical, permitting, commercial and financing work is not ready for FID.

Targeted pre-FID DEVEX support

Business-case gap

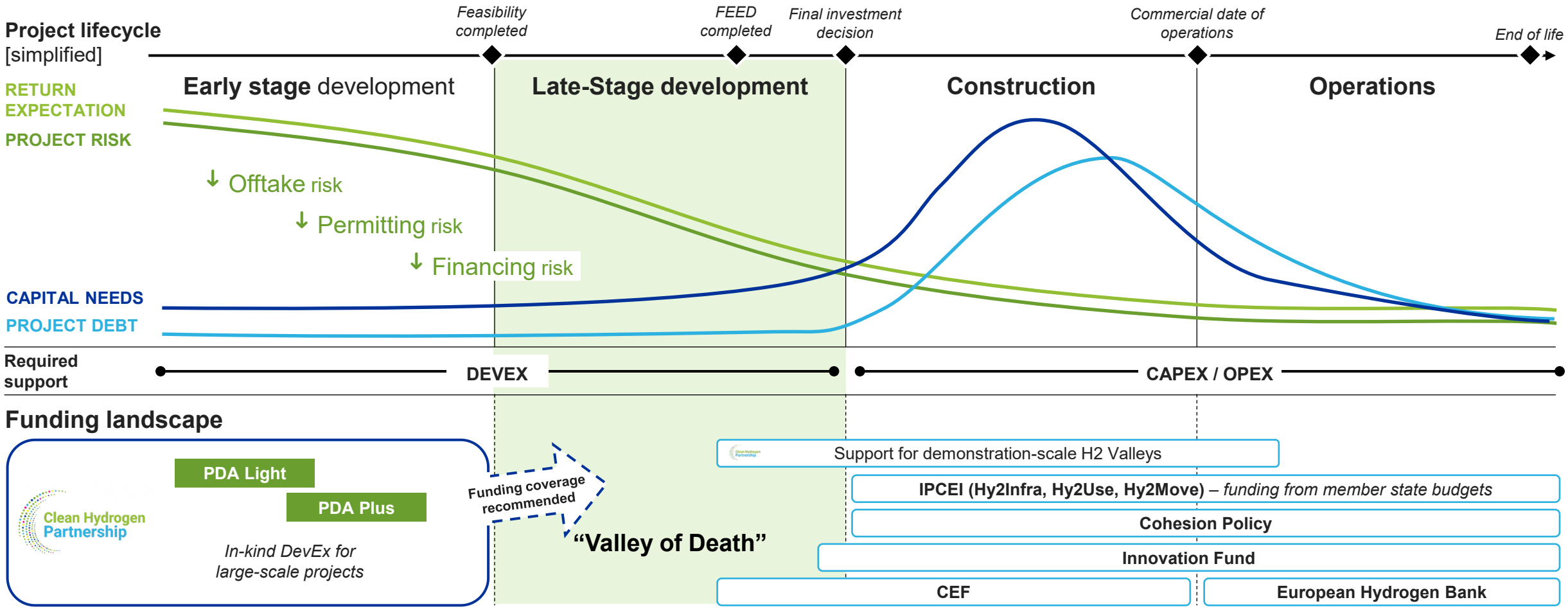
Production and delivery costs exceed offtakers' willingness to pay.

CAPEX / OPEX support

Assess maturity, commercial viability and implementation risks before allocating deployment support.

DEVEX phase is crucial to prepare high-quality, investment-ready projects, which can absorb available CAPEX and OPEX deployment support funds

Support options over a H2 Valley's project's lifecycle



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Next MFF - the RISK of inaction:
Europe could lose the value of decades of hydrogen innovation

and Europe's technological strengths may fail to translate into industrial leadership.

R&I - - **Demonstration** - - **Project development** - - **Deployment**

Possible fragmented support would weaken investment certainty and the coordinated scale-up of European companies!



Manufacturing capacity

Competitors capture the industrial scale-up.



Markets

European companies lose commercial opportunities.



Innovation value

Value from European R&I accrues to competitors.

A Joint Undertaking-type partnership provides the long-term commitment and shared governance needed to connect industry (and research) with the public sector throughout this 'investment journey'

Clean Hydrogen Partnership

Thank you!

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For further information
https://www.clean-hydrogen.europa.eu/

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