An isometric illustration of a hydrogen valley ecosystem. It shows a network of hydrogen production, distribution, and consumption. Production includes wind farms, solar panels, and industrial plants. Distribution is shown via pipelines, trucks, and a train. Consumption includes industrial facilities, residential buildings, and hydrogen refueling stations. A large white cloud is in the top left. A sign with 'www.h2v.eu' is visible in the lower right.

The state of play of Hydrogen Valleys in Europe

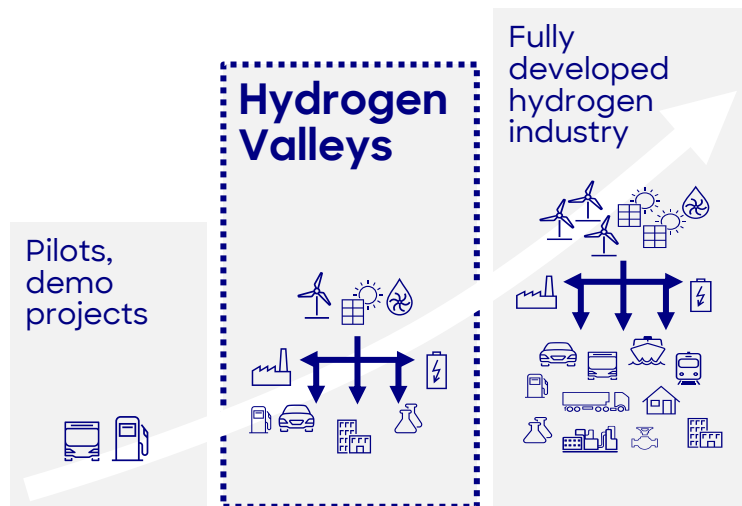
Markus Kaufmann
Partner, Roland Berger
EU Hydrogen Research Days
Brussels, November 15, 2023



"Hydrogen Valleys" are local market makers for clean hydrogen – Integrated infrastructure projects along the full value chain

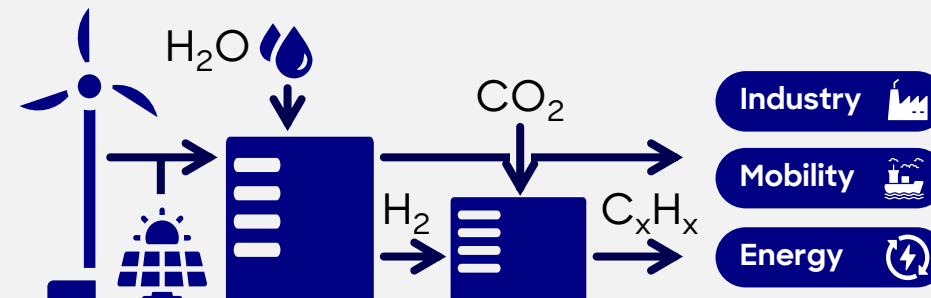
Hydrogen Valleys ...

- Next-generation H2 market development
- Integrated (and larger-scale) projects covering more and more of the value chain – "mini hydrogen economies"



... and what they're made of

- **Large-scale joint investment** (> EUR 10 m and up to multi-bn EUR)
- **Full hydrogen value chain coverage**
 - Centralized clean hydrogen production (*de facto* mostly green H2)
 - Shared infrastructure (e.g., pipelines, refueling stations)
 - Multiple end-uses (e.g., steel industry, fuel cell trucks)
- **Clear regional scope** (e.g., around a major port)
- increasingly underpinned by **long-term commercial arrangements**



Bringing global knowledge sharing and collaboration together: The Hydrogen Valley Platform

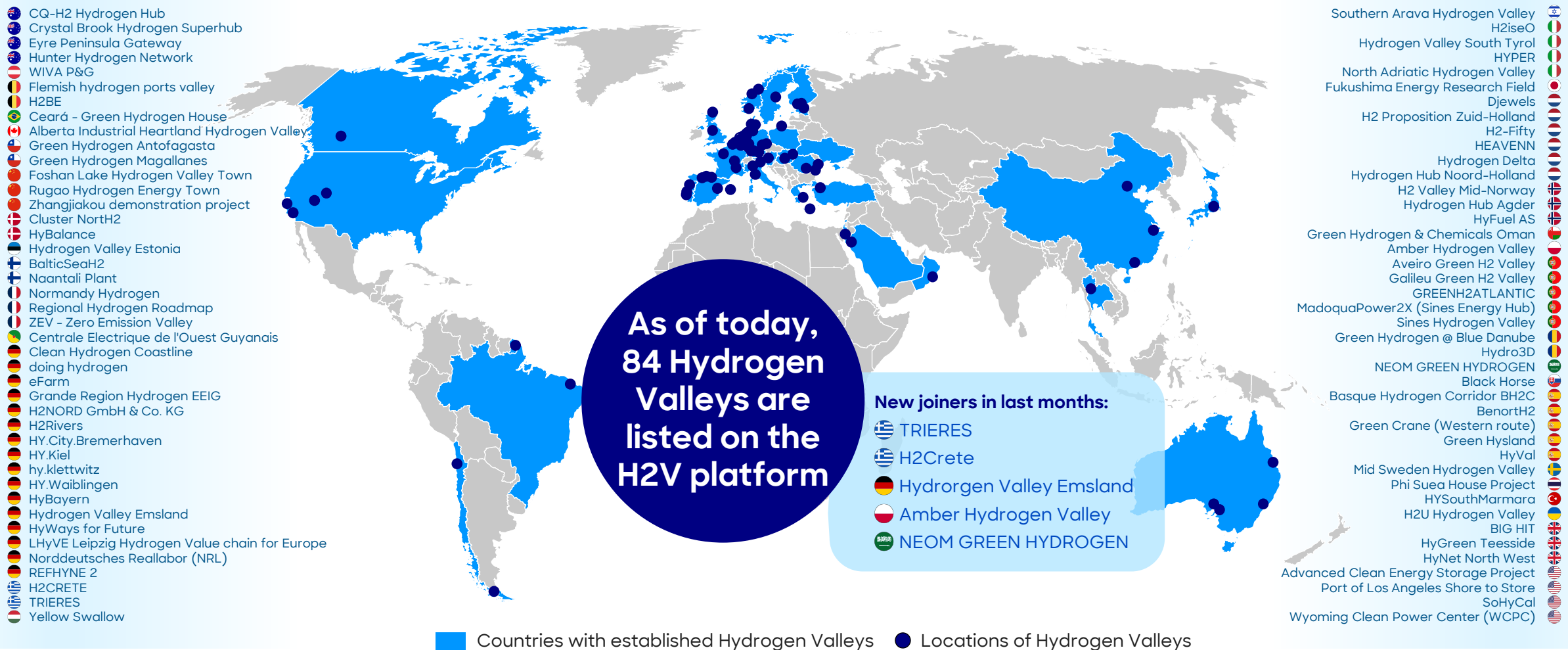


Key elements of the platform

- World map of Hydrogen Valleys
- Individual Hydrogen Valley profiles
- Data, analysis, visualization
 - Insights: value chain, technologies, stakeholders, capacities, cost, funding & financing, challenges & success factors, etc.
 - Best practices for project development
- Toolbox for project development
 - Other global hydrogen platforms and databases
 - Reference studies and reports
- Hydrogen Valley members area

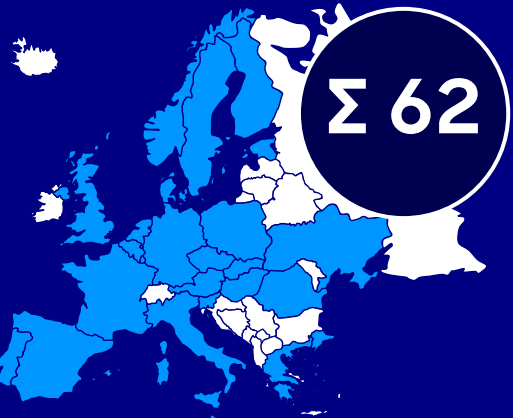
www.H2V.eu

Coined and conceptualized in Europe, Hydrogen Valleys have become a truly global phenomenon



In 2021, there were 22 European Hydrogen Valleys on the MI H2 Valley platform – Today, we can map more than 60 such integrated projects

Europe



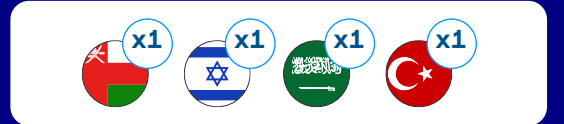
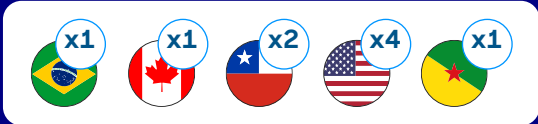
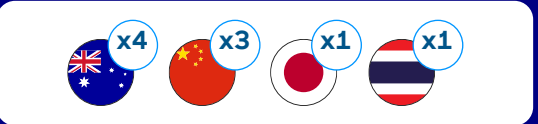
Asia-Pacific



Americas

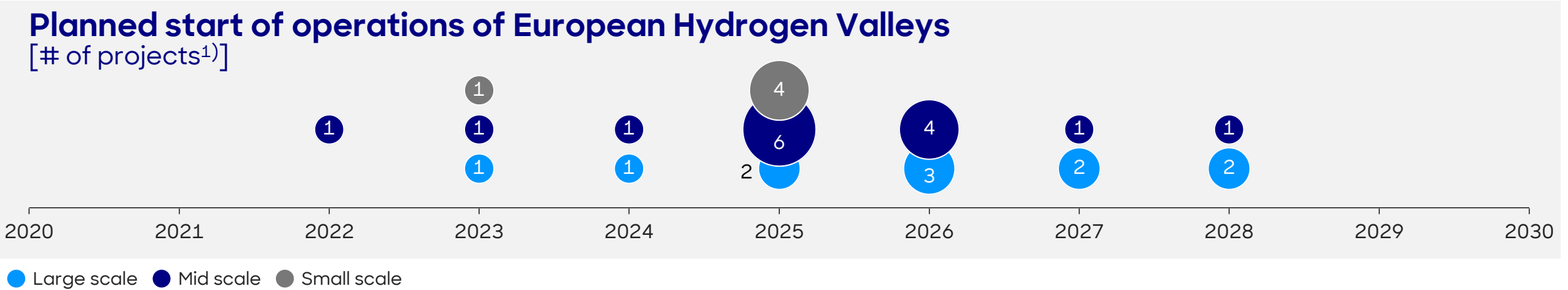
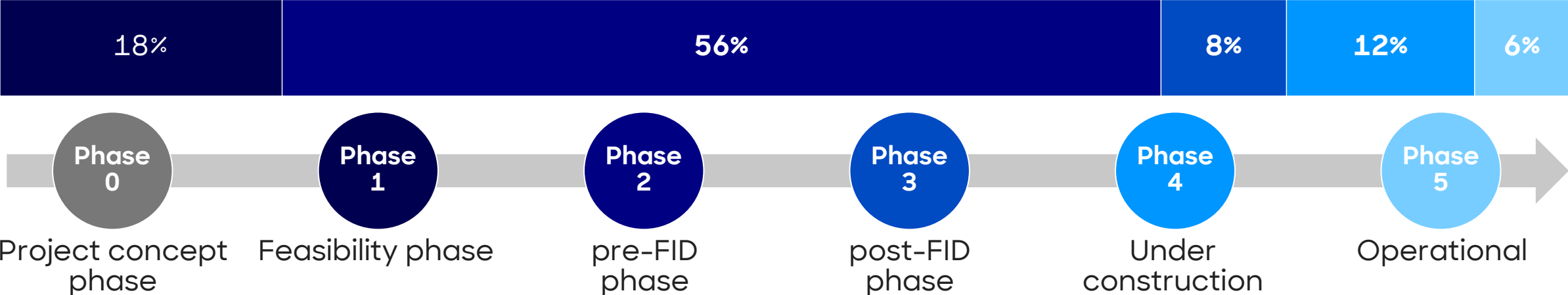


Middle East & Africa



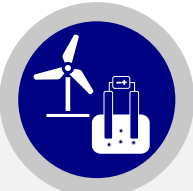
Note: Only considering Hydrogen Valleys participating in the Mission Innovation Hydrogen Valley Platform

European Valleys are still "early stage" as of today - About 3/4 of projects under development have yet to take a final investment decision



Note: Small scale: Investment < EUR 50 m; Mid scale: Investment EUR 50 - 500 m; Large scale: Investment > EUR 500 m; 1) n = 38

The European Valleys focus on green hydrogen for various end-uses in mobility, industry, and energy sectors

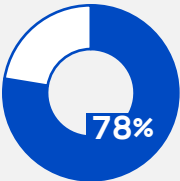


Upstream

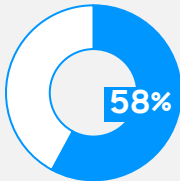
~ **15 mt**
annual green
hydrogen production
volume¹⁾

Electrolyzer technologies

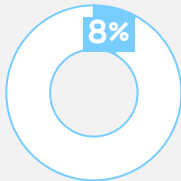
PEM



Alkaline



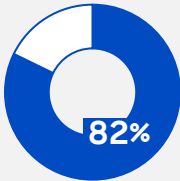
Other



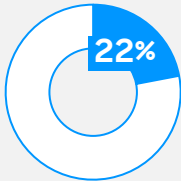
Midstream

Storage (mainly compr. gas. H₂)

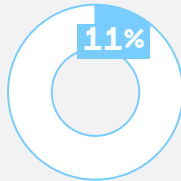
Tanks



Caverns

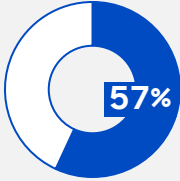


Other

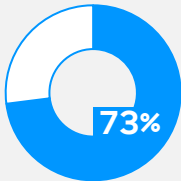


Transportation

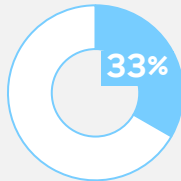
Pipelines



Trucks



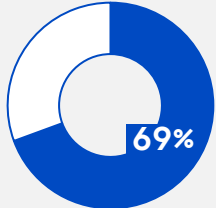
Vessels



Downstream

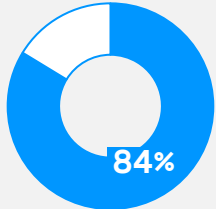
Industrial off-takers

(esp. chemical industry, refineries and steel)



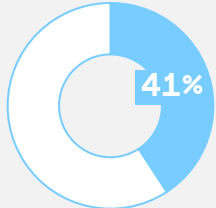
Mobility end uses

(mainly buses, trucks and cars)



Energy end uses

(esp. grid injection and gas-fired power plants)



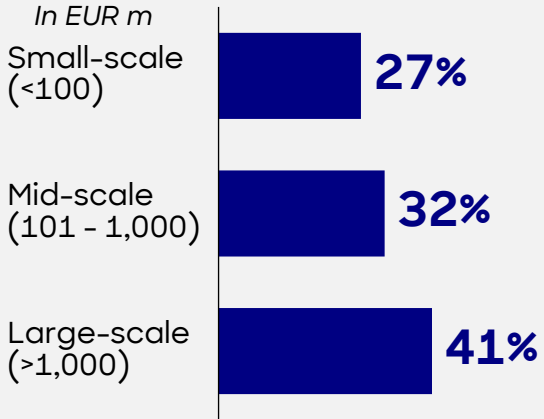
1) After reaching maximum build-out stage

With EUR 85+ bn planned investment, European Hydrogen Valleys are on a path to competitiveness with fossil H₂



Investment

> EUR 85 bn total investment¹⁾



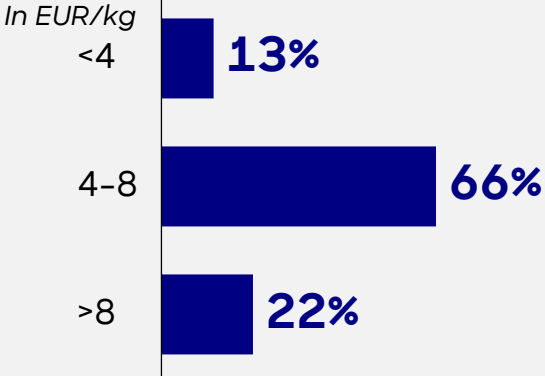
...tend to be mobility focused

...tend to be industry/energy focused



Hydrogen cost

Ø 6.2 EUR/kg hydrogen cost



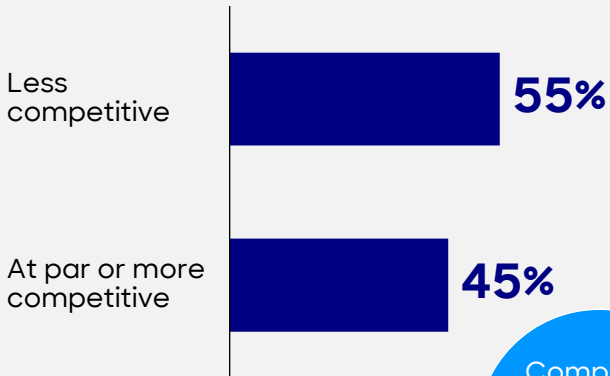
...tend to be larger-scale projects

...tend to be smaller-scale projects



Competitiveness

... growing commercial confidence

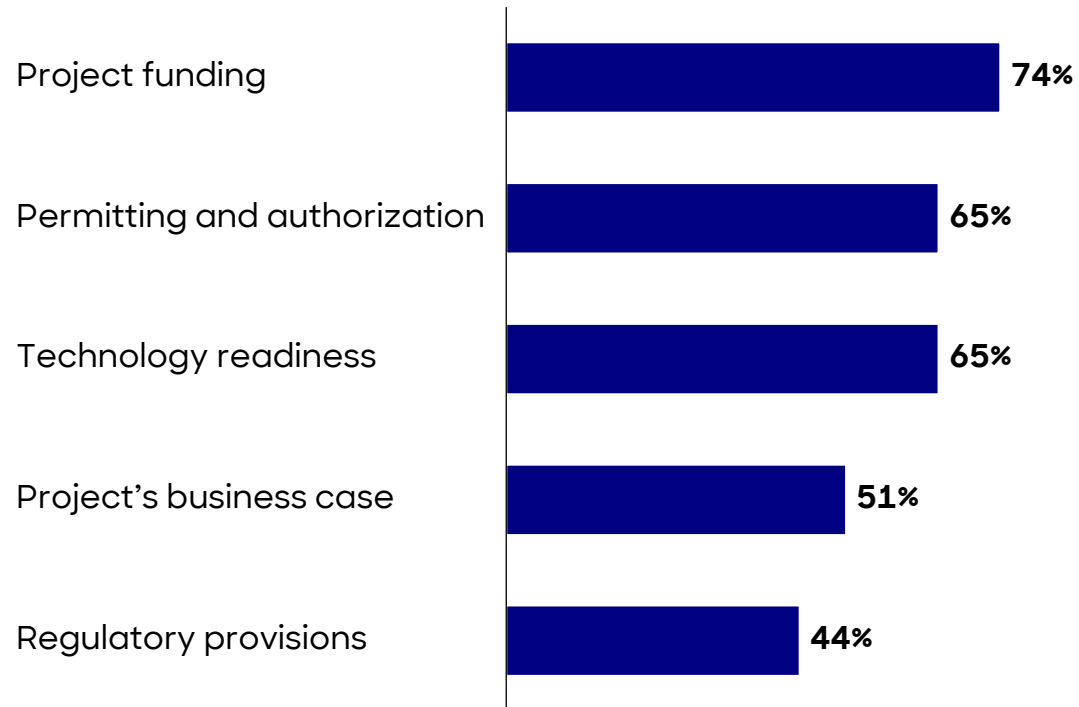


Compared to conventional offering, as per developers' own assessment

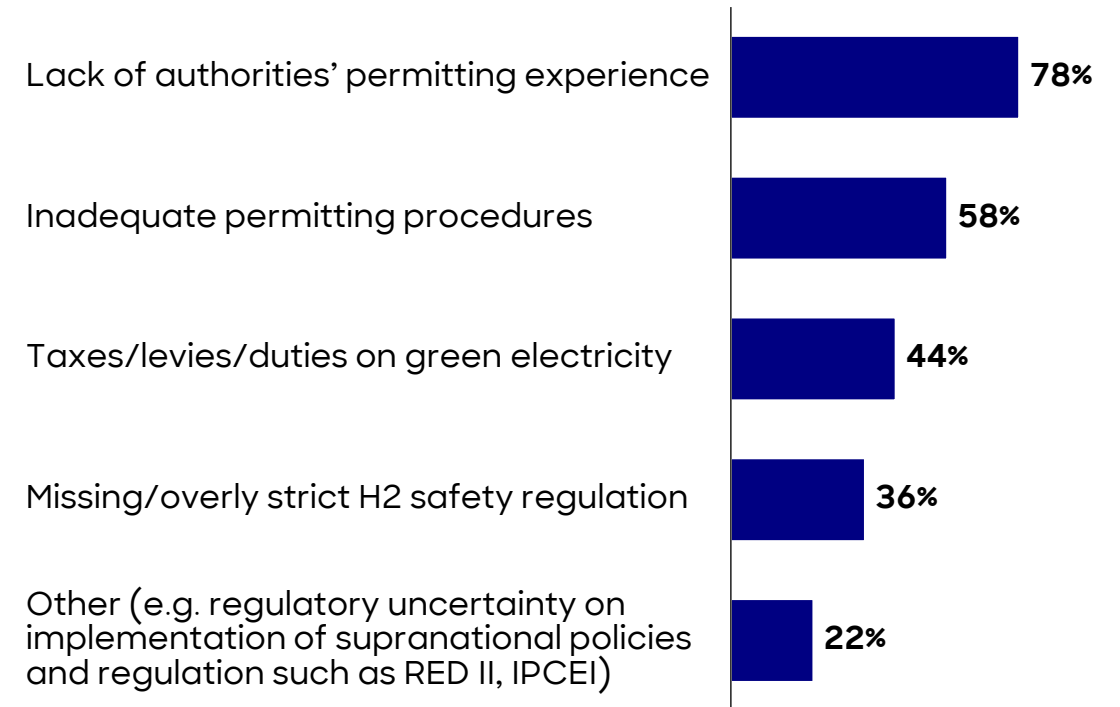
1) European Projects

European developers face common challenges, especially concerning funding and regulations → ... addressed in recent workshops

Top overall challenges when developing Hydrogen Valleys in Europe¹⁾



Most significant regulatory hurdles when developing Hydrogen Valleys in Europe¹⁾



1) Top 5 answers from survey; multiple answers possible

The key success factors for Hydrogen Valley development can be broadly classified into project structuring and project financing success factors

Top overall success factors when developing Hydrogen Valleys¹



Two broad categories of success factors:

Project structuring factors:

Related to project execution, value chain integration, and de-risking of project progress



Project financing factors:

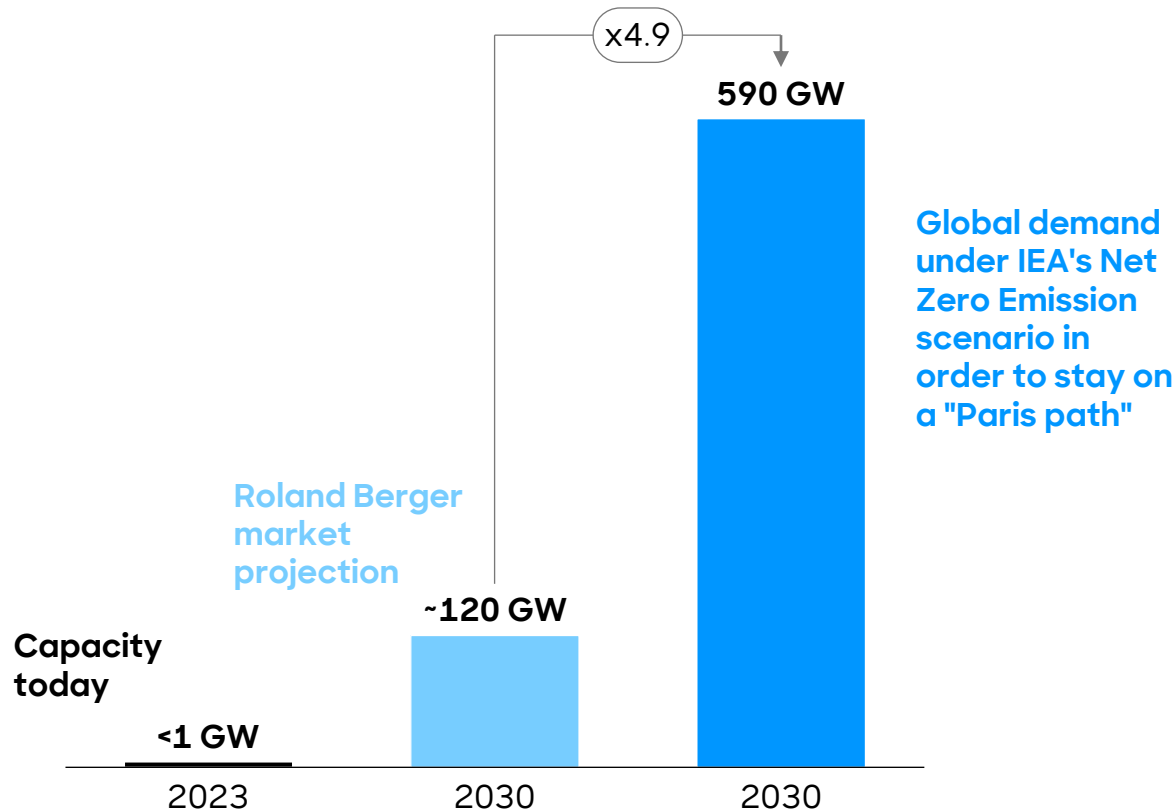
Related to securing non-recourse project financing, bankable offtake agreements, price formula, etc.



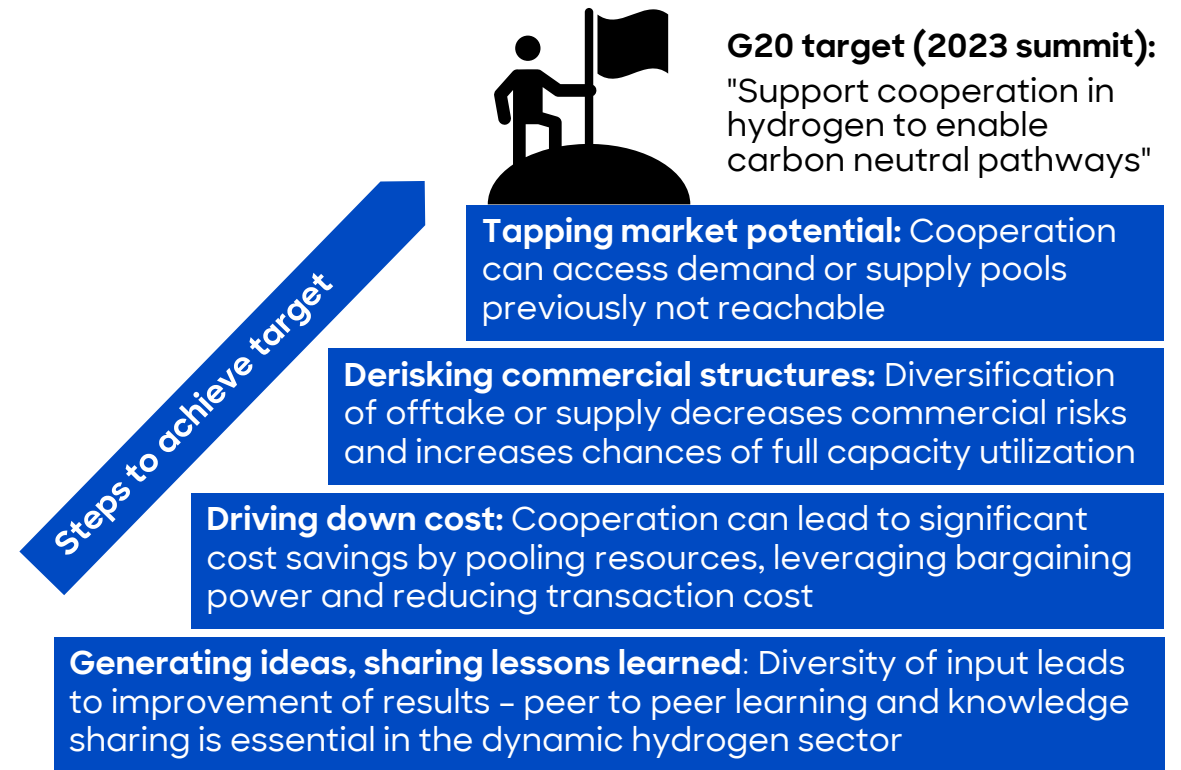
1) Top 5 answers from survey; multiple answers possible

The hydrogen market needs inter-project collaboration to get to the necessary next levels of project scale and volume uptake

Global green H2 production capacity by 2030 [GW]



To reach needed volumes, cooperation must be leveraged



Infra. driven cooperation centers on asset dev. and infrastructure sharing, while project dev. collaboration facilitates knowledge sharing and joint interests

Infrastructure-driven cooperation



- Cooperation in the area of building, operating and managing assets
- Key cases: sharing mid-stream transportation and storage infrastructure or refueling networks
- It can help to make the market more liquid, diversify risk and allow access to new demand or supply centers

Examples

- Use of hydrogen import terminals to connect Hydrogen Valleys
- Operation of hydrogen pipelines between Valleys
- Sharing assets producing renewable energy (e.g., wind or solar)
- Sharing vehicles for hydrogen transport

Project development cooperation



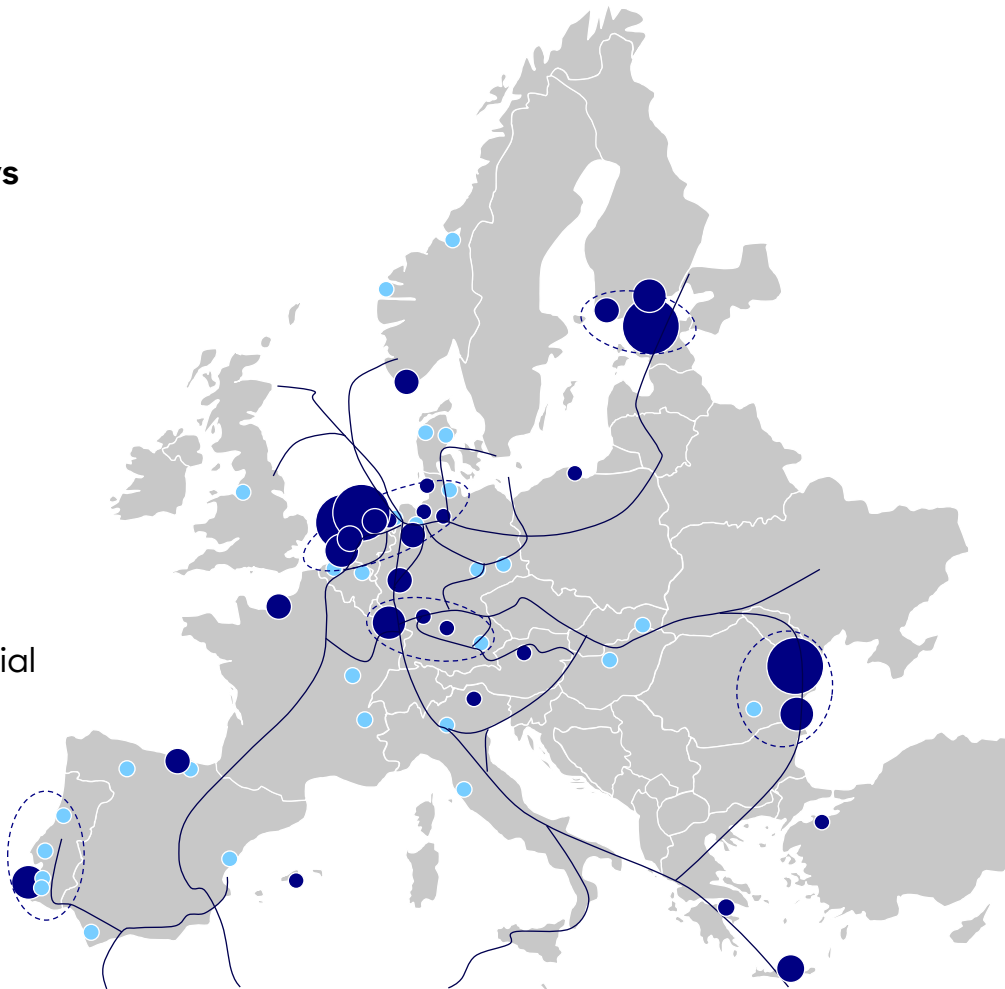
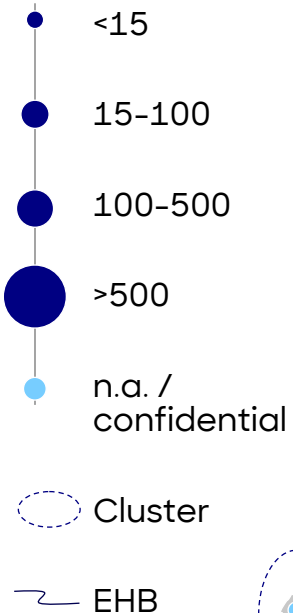
- Various collaborative activities aimed at achieving a common goal through their individual project
- Sharing knowledge, ideas and experiences from one hydrogen valley to the other
- Pooling resources, increasing bargaining power

Examples

- Joint workshops and trainings
- Joint procurement
- Best practice sharing
- Consortium building to combine resources and expertise








Mapping the European Hydrogen Backbone (EHB) plans across the European valley landscape shows the huge potential for linking Valleys with pipelines

Centers of production Hydrogen Valleys (H2 tpd)



European Hydrogen Backbone: Key facts



 Objective:	Development of a dedicated hydrogen pipeline transport network across European countries to enable large-scale transport and use of hydrogen
 Initiators:	European Hydrogen Backbone initiative; group of 31 EU gas Transmission System Operators
 COD:	2040 (final stage of pipeline construction / upgrade)
 Length:	53,000 km by 2040 (accelerated EHB vision)
 Required invest:	EUR 80-143 bn (60% repurposing, 40% new)
 Countries covered:	28 countries
 Approach:	2030: Initial pipeline network of 28,000 km 2035: Extended pipeline network 2040: Mature pipeline network of 53,000 km

Our next steps: updating data, EU Hydrogen Week, additional workshops, final report / global study



Next steps

- Data updates, tracking project progress (2023)
 - European Hydrogen Week (2023)
 - Additional workshops for Valley developers and policy makers (2024)
 - Final report / global study on hydrogen valleys (2024)
- ... and of course: adding additional Hydrogen Valleys to the community

www.H2V.eu

Your contact at Roland Berger



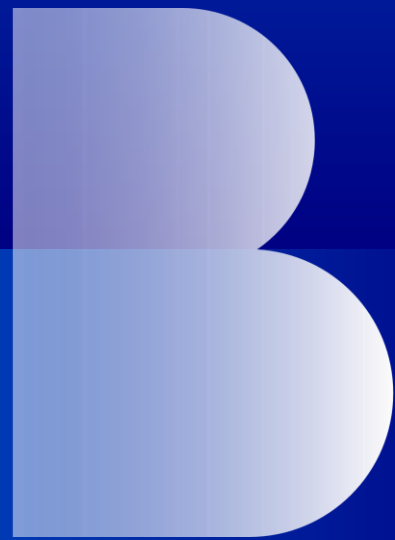
**Markus
Kaufmann**

Partner

Roland Berger GmbH

Am Sandtorkai 41 | 20457
Hamburg | Germany

markus.kaufmann@rolandberger.com



Roland
Berger