Hydrogen Valleys

Insights on Global Hydrogen Project Development with a Special Focus on H_2 Mobility

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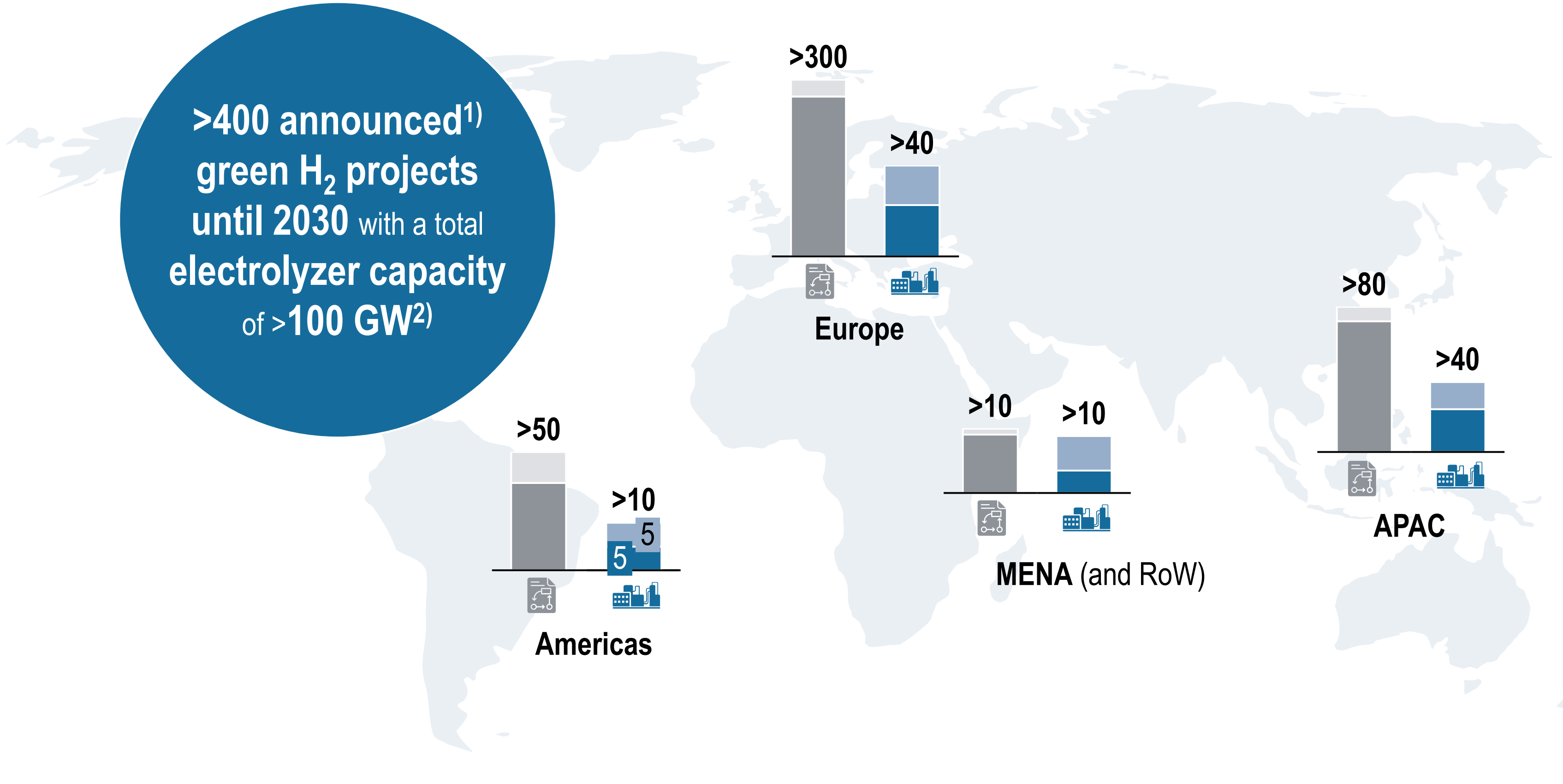
Are we arriving at the "age of projects" or "real assets" in the emerging New Hydrogen Economy? Indeed, a lot is happening



Announced mature projects [#] | Announced early stage projects [#]
Mature project capacity [GW electrolysis] | Early stage project capacity [GW electrolysis]

Clear trends and highlights

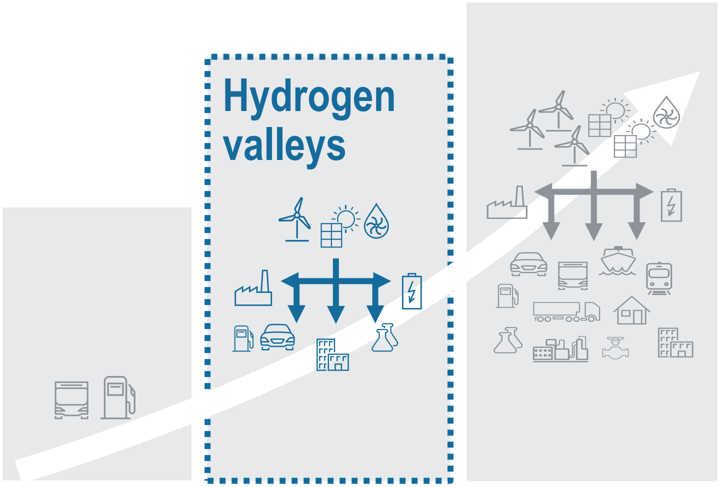
- **"More":** announced green H2 projects tripled over the past 12 months
- **"Bigger":** scale matters, more GW-scale projects out of ultra-low LCoH countries
- **"Actual FIDs?"** Still largely pending, in the absence of critical (regulatory) enablers
- **"Better together":** Strong integration along the hydrogen value chain – need for partnerships, de-risking

1) As of October 2021, incl. early-stage projects; 2) Announced Green H_2 project at early stage, e.g at concept design or press announcement stage;
3) Green H_2 projects that are at the feasibility study, design stage, FID, under construction, commissioned or operational
Source: IEA, Roland Berger H2 Project Database

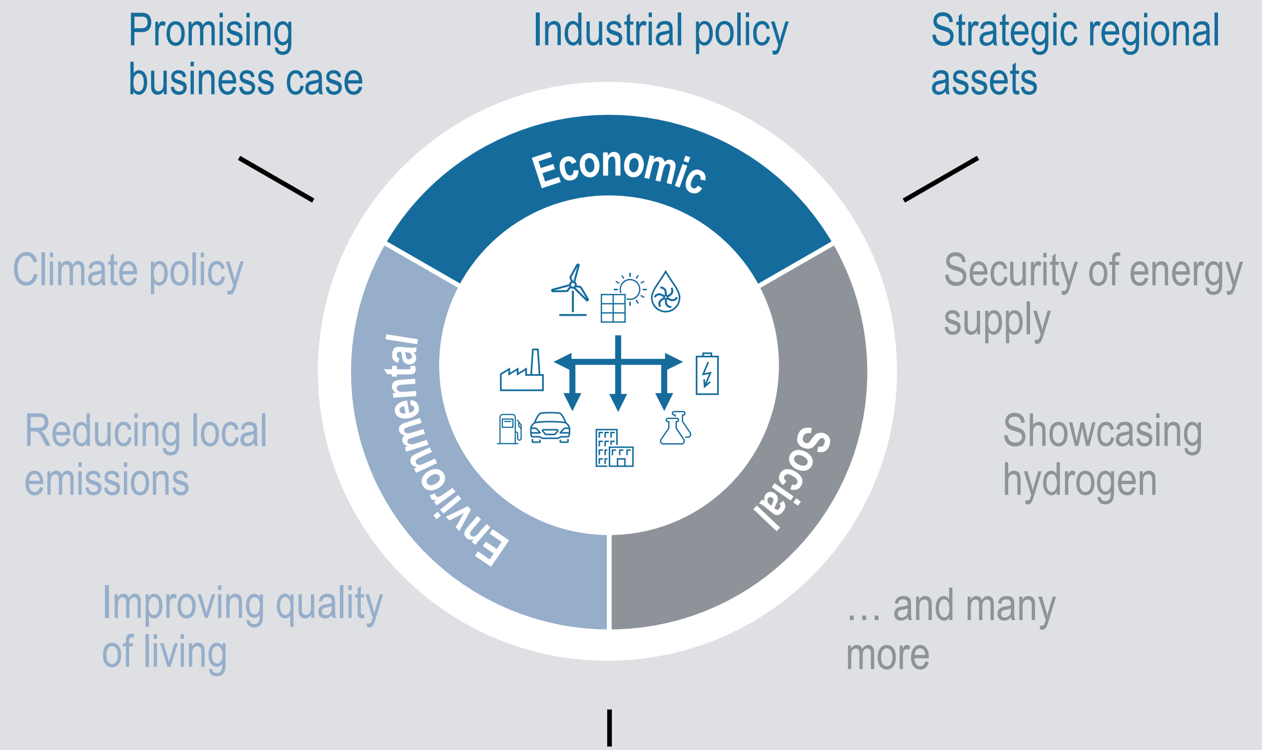
The first projects: Coined and conceptualized in Europe, "Hydrogen Valleys" are seen as local market makers for clean hydrogen

Hydrogen Valleys …

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



… and what drives them



Source: FCH JU, Inycom, Roland Berger

"Hydrogen Valleys" have become a global phenomenon – Many projects with at least a partial focus on hydrogen mobility

A fast-growing landscape of Hydrogen Valleys…

Netherlands
> HEAVENN
> Hydrogen Delta
> H2 proposition Zuid-Holland/Rotterdam
> Hydrogen Valley Port of Amsterdam

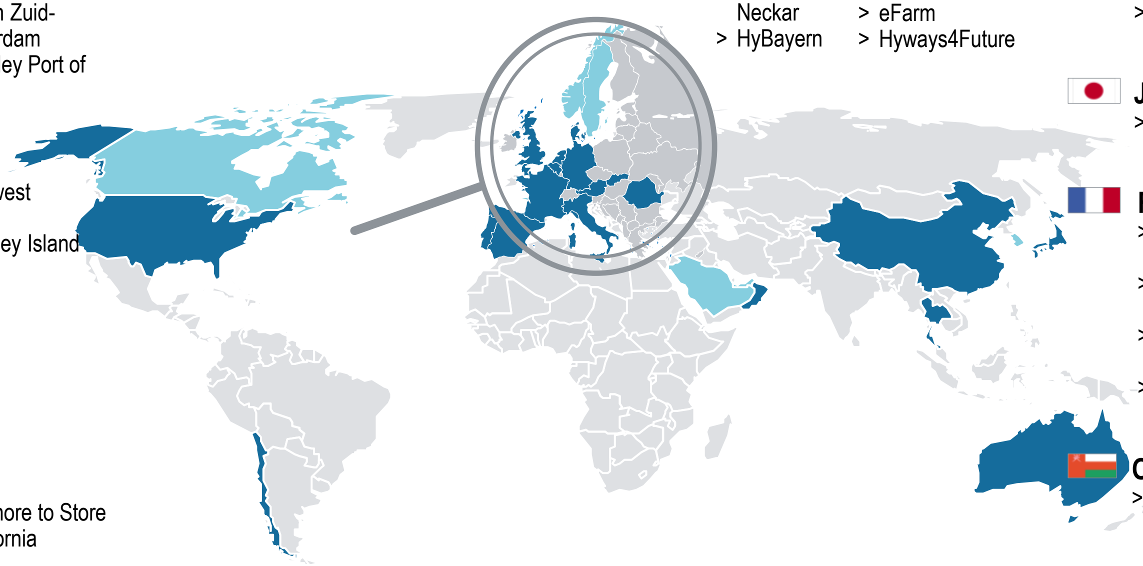
EU IPCEI
> Blue Danube
> Black Horse
> Green Crane (West)
> Green Octopus

Germany
> H2Rivers/ H2Rhein-Neckar
> HyBayern
> Norddeutsches Reallabor
> eFarm
> Hyways4Future

China
> Pearl River Delta (Foshan)
> Beijing-Zhangjiakou
> Rugao

Japan
> FH2R Fukushima

United Kingdom
> HyNet Northwest England
> BIG HIT Orkney Island



France
> Zero emission valley Auvergne-Rhône-Alpes
> Normandy Hydrogen Deployment Plan
> Hydrogen Territory Bourgogne Franche Comté
> CEOG, French Guiana

Chile
> Hydrogen Facility Initiative

USA
> ACES, Utah
> Port of LA, Shore to Store Project, California

Oman
> Green Hydrogen and Chemicals Oman

Spain
> Green Hysland Mallorca
> Basque Hydrogen Corridor (BH2C)

Denmark
> HyBalance

Thailand
> Phi Suea House

Italy
> South Tyrolean hydrogen valley

Austria
> WIVA P&G

Australia
> Neoen Crystal Brook Energy Park
> Eyre Peninsula Gateway

Countries with hydrogen valleys on the platform

Additional countries with major hydrogen valley activity where outreach is ongoing

… featured on the platform www.H2v.eu

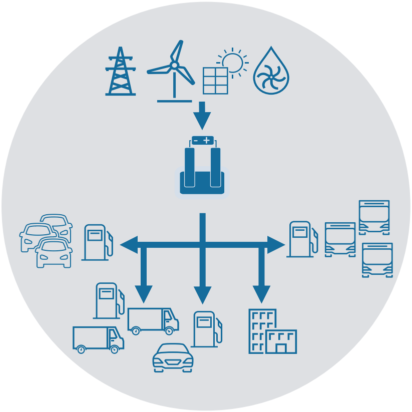
- More than **85% with mobility end-uses** (buses, trucks, cars)
- More than **95% with green H2** production as part of projects (average H2 production cost of 5-6 EUR/kg)
- Largely, there are **commercial structures in place already** (albeit vast majority still with public funding support)

Source: FCH JU, Inycom, Roland Berger

As integrated projects, the Valleys are as diverse as the sources and uses of hydrogen – We see 3 common archetypes

Archetype 1:

Local, small-scale & mobility-focused

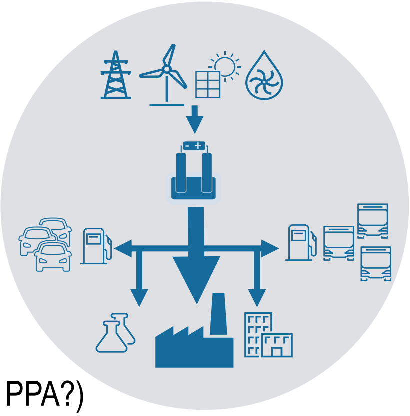


- **Local** (green) H_2 production
- **Serving mobility applications:** fleets of buses, trucks with (semi-)captive HRS
- Mostly **led by public-private initiatives,** often with long-term experience in H2
- Mostly located in Europe

Key challenges: Multitude of stakeholders involved (high complexity against comparatively low H2 volumes)

Archetype 2:

Local, medium-scale & industry-focused

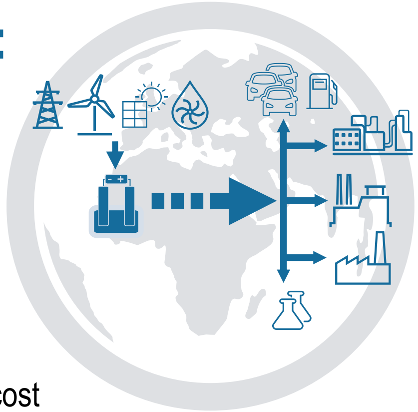


- **Local** (green) H_2 production (grid, PPA?)
- Centered **around 1-2 large industrial off-takers** (e.g., refineries, fertilizer production) as "anchor-load", mobility off-taker as potential add-on
- Mostly **led by private sector**

Key challenges: Regulatory requirements (e.g., additionality), seamless integration with industrial processes, expansion limits

Archetype 3:

Larger-scale, international & export-focused



- **Large-scale projects** with low-cost (green) H_2 derivative production from dedicated RES
- **Aiming to connect supply and demand globally,** often phased implementation with initial phase for local / on-site offtake (industry, mobility)
- Mostly **led by private or large sovereign investors**

Key challenges: Regulatory enablers for long-term offtake commitments, technology at scale, transport solutions

Closed, regional ecosystems of H2 **production** ("scale"), **transport/storage** ("shared infrastructure") and **offtake** ("pooling demand") – increasingly underpinned by **long-term commercial arrangements**

Source: FCH JU, Inycom, Roland Berger

Looking at Archetype #1 (H2 mobility projects) especially in Europe, several key success factors become clear

1 Business Case: Sizing of fleets and HRS

- Go captive
- Start big enough
- High HRS utilization!

2 Business Case: Holistic project derisking

- Tight web of long-term contracts
- Project financing?

3 Operations: Availability vs. vehicle cost

- Performance, performance, performance!
- Effective service

4 Execution: HRS engineering and permitting

- Key barrier, quickly on the critical path
- Collaborative approach

5 Execution: EPC and O&M of HRS, H_2 sales

- Partners make the difference
- Tailored business models

6 Public support: Funding and financing

- Strong potential in the short term
- Decreasing opportunities?

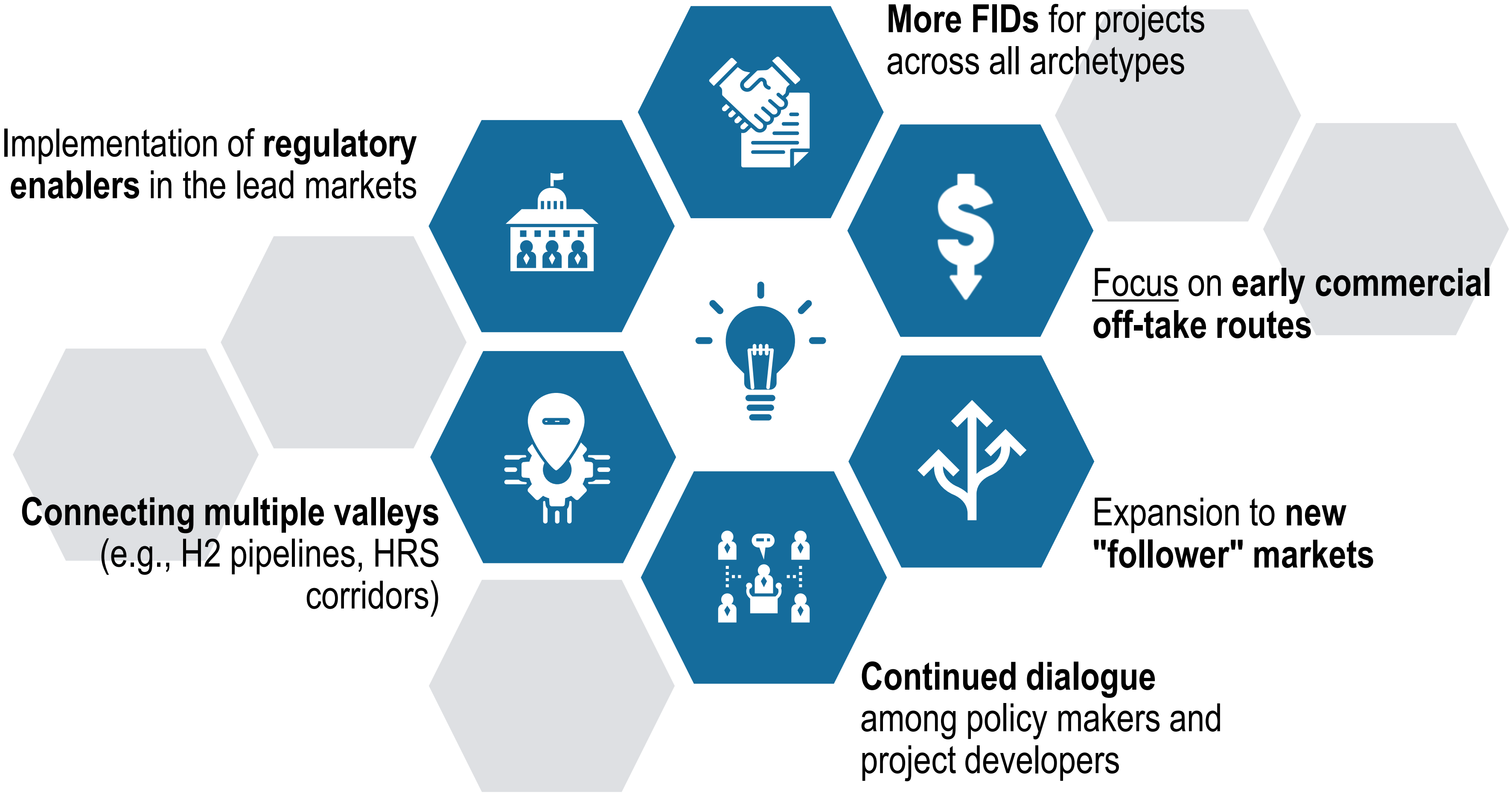
Key success factors in H_2 mobility projects

Source: Roland Berger

So what's next for Hydrogen Valleys?
A packed agenda to sustain and expand the momentum

Short-term agenda for Hydrogen Valleys:

Priorities, needs and key steps ahead



Source: FCH JU, Inycom, Roland Berger

Thank you for your attention, check out the platform and the report. And don't hesitate to get in touch!

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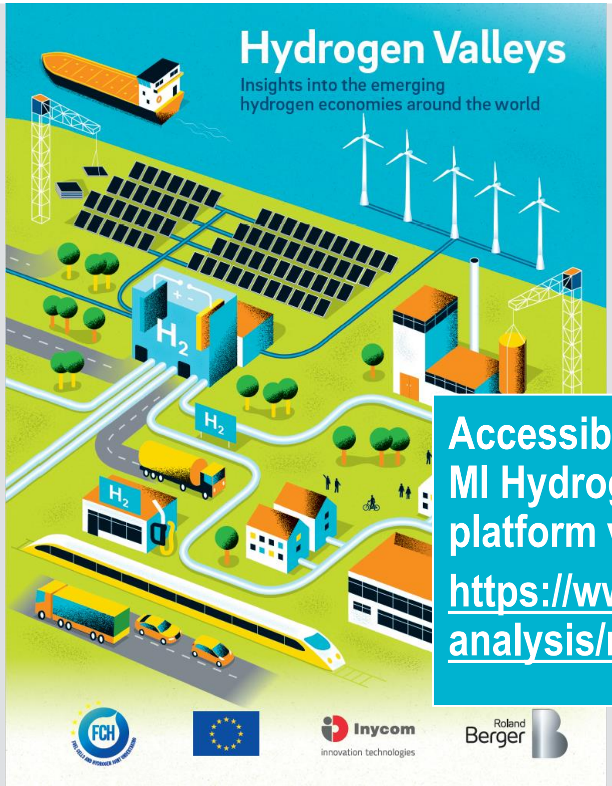
www.rolandberger.com/en/Insights/Global-Topics/Hydrogen/

More information available in the report



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Accessible on the MI Hydrogen Valley platform via:
https://www.h2v.eu/analysis/reports

Source: FCH JU, Inycom, Roland Berger

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