HYDROGEN PRODUCTION, STORAGE AND TRANSPORT FOR E-FUEL PRODUCTION

Marcel Weeda

Vice-chair HTCP

Building blocks for e-fuel production Workshop Event

Hydrogen TCP

In a nuthsell

34 **Members**

23 Member Countries
9 Sponsors
European Commission + UNIDO

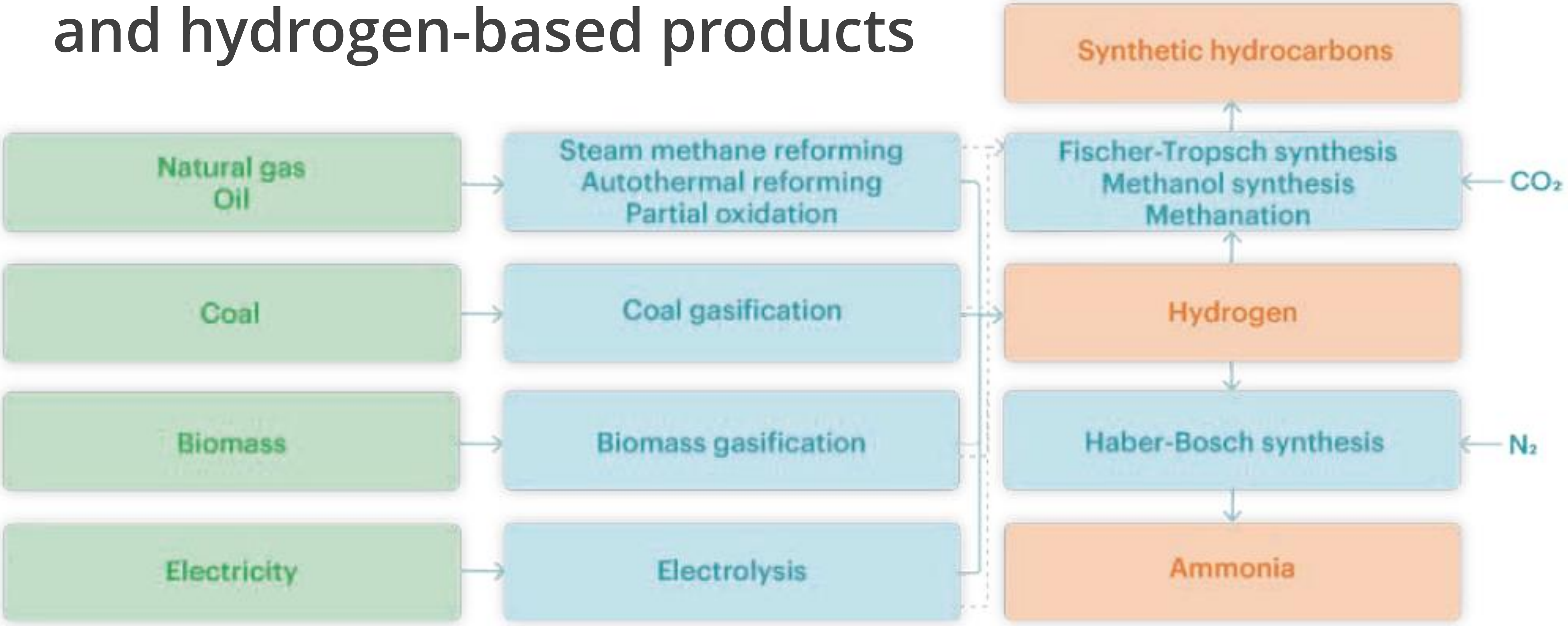
40+ **Tasks**

5 Ongoing
39 Finished
≅ **8** in definition

250+ **Experts involved**

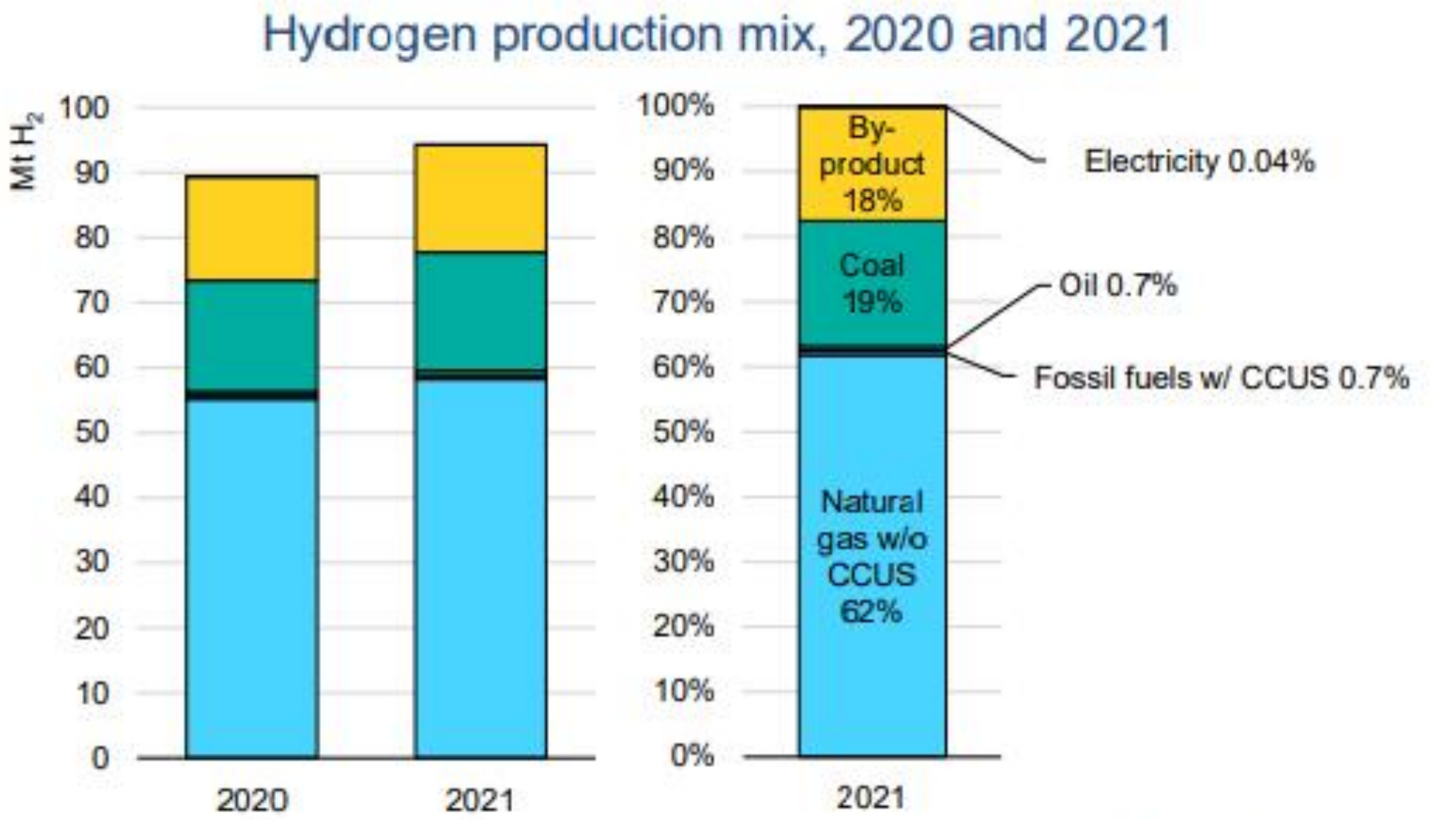
In collaborative research on hydrogen and hydrogen technologies

Main pathways for producing Hydrogen and hydrogen-based products



Source: The Future of Hydrogen, IEA 2019

Today's hydrogen production



Note: CCUS = carbon capture, utilisation and storage.

Potential renewable hydrogen pathways

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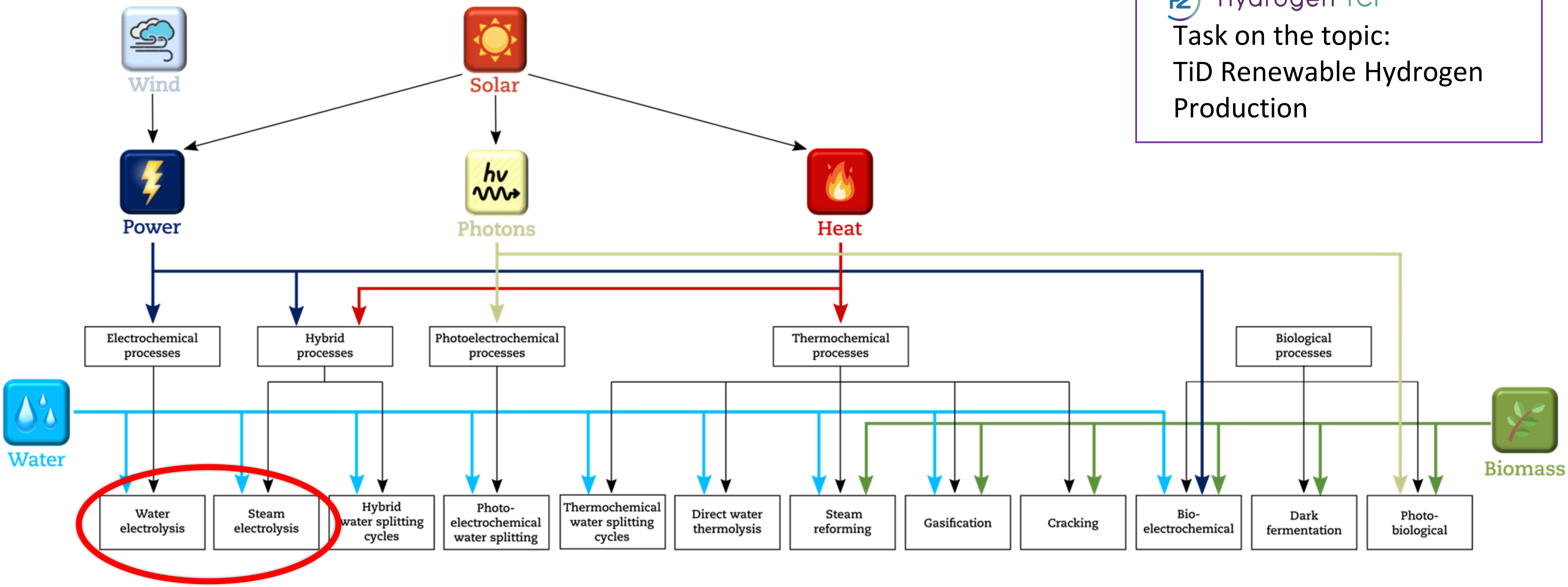
Task on the topic:
TiD Renewable Hydrogen
Production



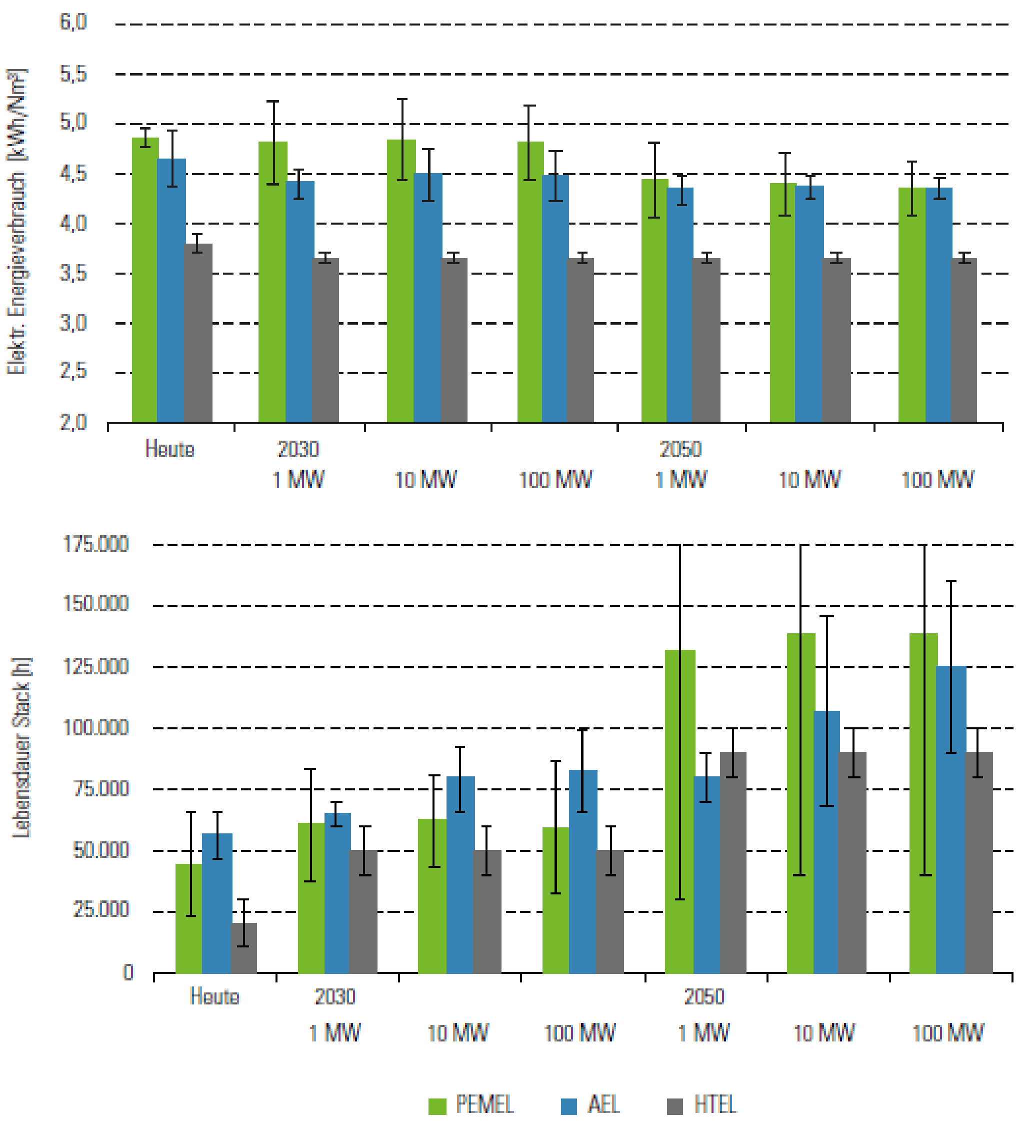
Various types of electrolysis

- Alkaline electrolysis (AEL)
- Proton exchange membrane (PEMEL)
- Solid oxide electrolysis (SOE)
- Anion exchange membrane electrolysis (AEMEL)

	Alkaline electrolyser			PEM electrolyser			SOEC electrolyser		
	Today	2030	Long term	Today	2030	Long-term	Today	2030	Long term
Electrical efficiency (%, LHV)	63–70	65–71	70–80	56–60	63–68	67–74	74–81	77–84	77–90
Operating pressure (bar)	1–30			30–80			1		
Operating temperature (°C)	60–80			50–80			650 – 1 000		
Stack lifetime (operating hours)	60 000 – 90 000	90 000 – 100 000	100 000 – 150 000	30 000 – 90 000	60 000 – 90 000	100 000 – 150 000	10 000 – 30 000	40 000 – 60 000	75 000 – 100 00
CAPEX (USD/kW_e)	500 – 1400	400 – 850	200 – 700	1 100 – 1 800	650 – 1 500	200 – 900	2 800 – 5 600	800 – 2 800	500 – 1 000

Source: The Future of Hydrogen, IEA 2019

Source: Studie IndWEDe, NOW 2018



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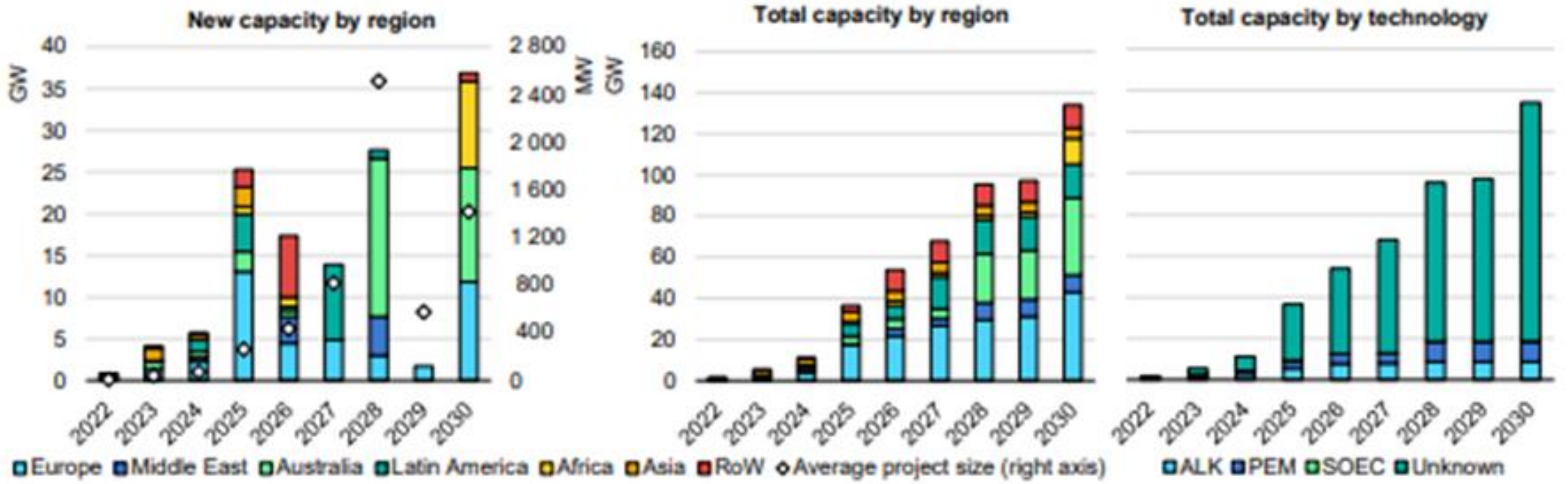
Potential growth global electrolyser capacity by 2030, based on current project pipeline



Notes: RoW = rest of world; ALK = alkaline electrolyser; PEM = proton exchange membrane electrolyser; SOEC = solid oxide electrolyser. Only projects with a disclosed start year for operation are included. Projects at very early stages of development, such as those in which only a co-operation agreement among stakeholders has been announced, are not included

Source: IEA Hydrogen Projects Database (2022).

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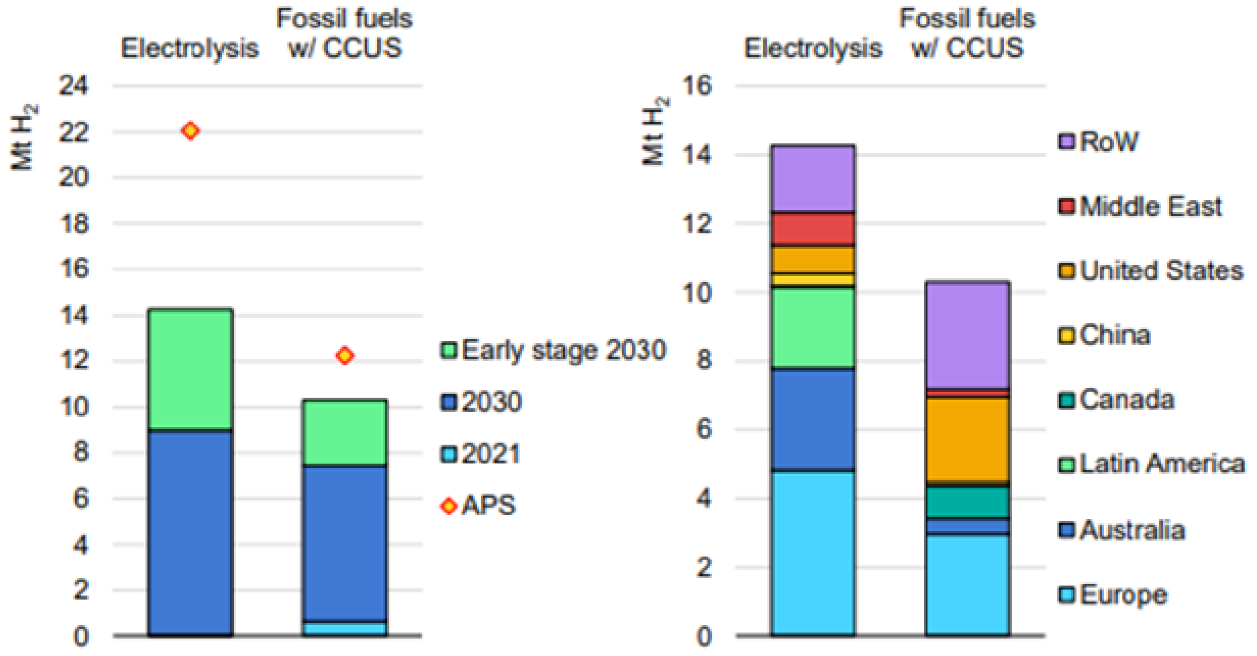
Potential growth low-carbon hydrogen production by 2030, based on current project pipeline

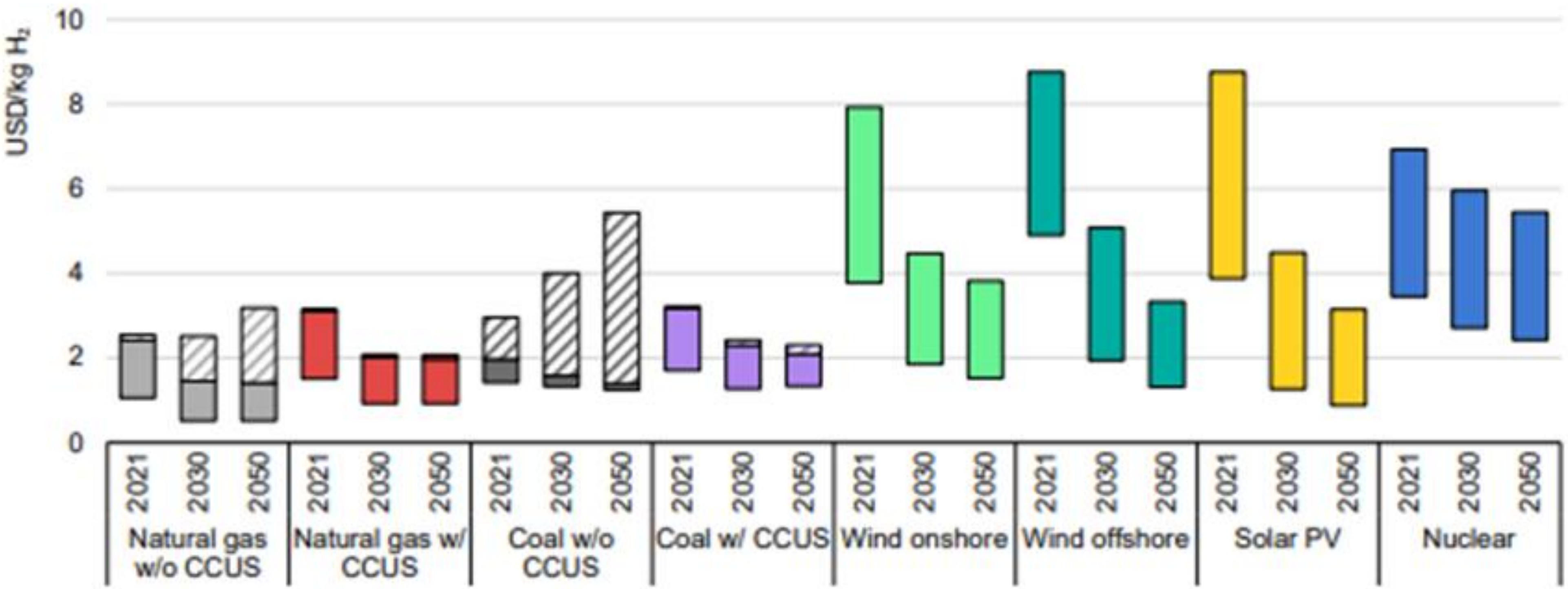
- Note: current hydrogen production about 90 Mt/a



Notes: RoW = rest of world; APS = Announced Pledges Scenario. In the left figure, the blue columns for 2020 and 2030 refer to projects at advanced planning stages. The right figure includes both projects at advanced planning and early planning stages. Only projects with a disclosed start year for operation are included.
Source: IEA, Hydrogen Projects Database (2022).

Indication cost (reductions) hydrogen

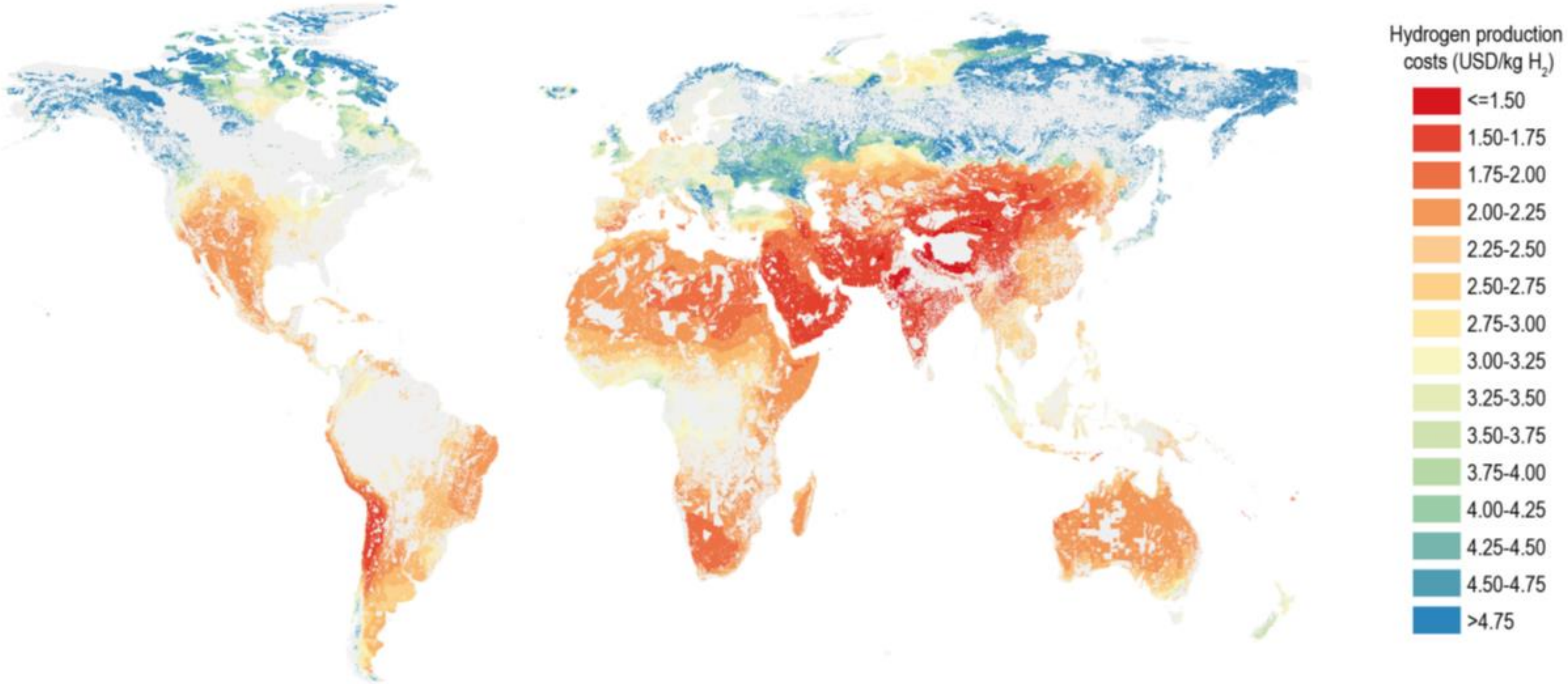
Levelised cost of hydrogen production by technology in 2021 and in the Net Zero Emissions by 2050 Scenario, 2030 and 2050



Notes: Ranges of production cost estimates reflect regional variations in costs and renewable resource conditions. The dashed areas reflect the CO_2 price impact, based on CO_2 prices ranging from USD 15/tonne CO_2 to USD 140/tonne CO_2 between regions in 2030 and USD 55/ tonne CO_2 to USD 250/ tonne CO_2 in 2050.

Sources: Based on data from McKinsey & Company and the Hydrogen Council; Council; IRENA (2020); IEA GHG (2014); IEA GHG (2017); E4Tech (2015); Kawasaki Heavy Industries; Element Energy (2018).

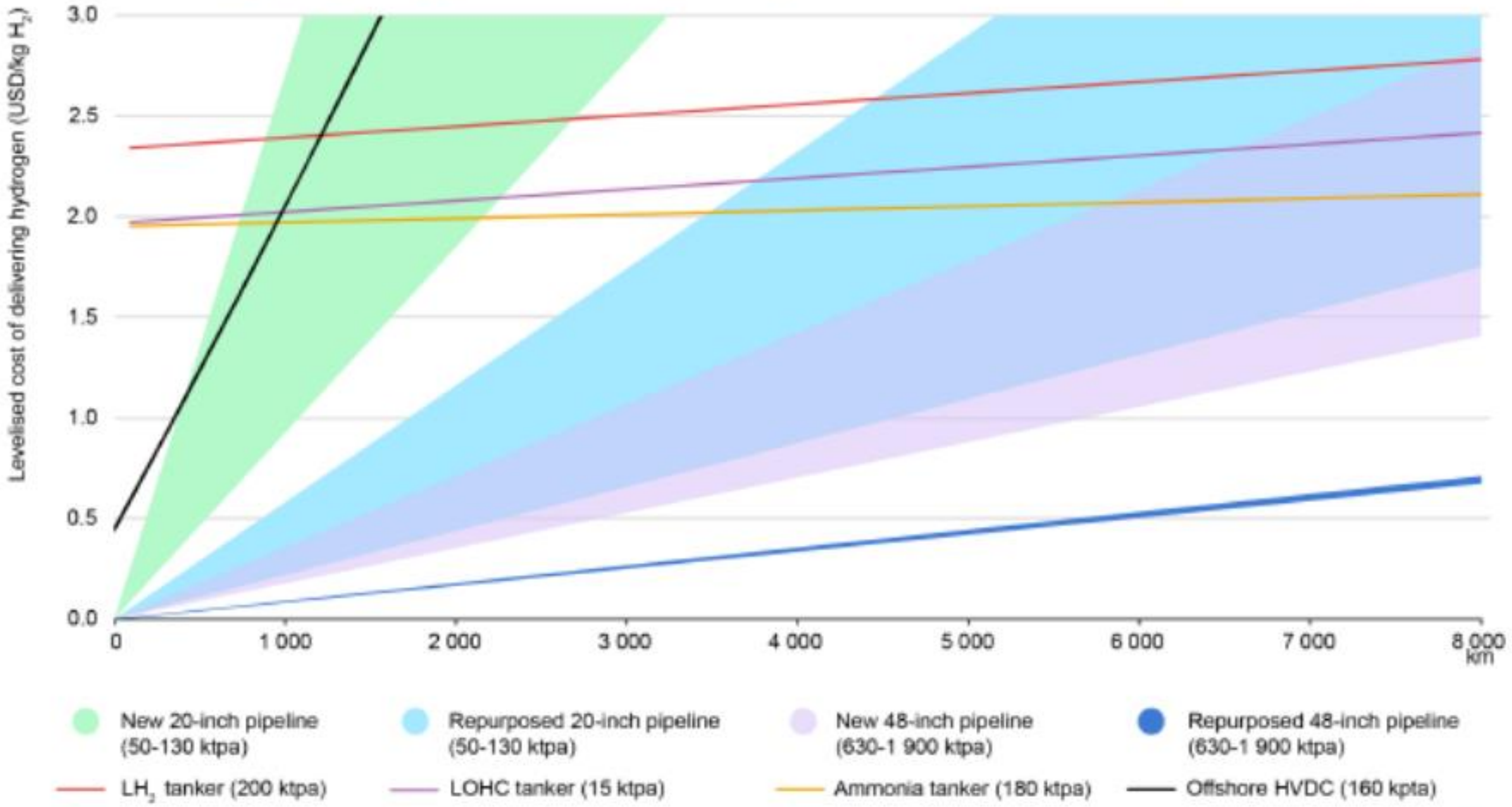
Production cost hybrid solar-PV and wind



Source: Global Hydrogen Review, IEA,2022

Modes and cost of hydrogen transport/delivery

Levelised costs of delivering hydrogen by pipeline and by ship as LH_2, LOHC and ammonia carriers, and electricity transmission, 2030



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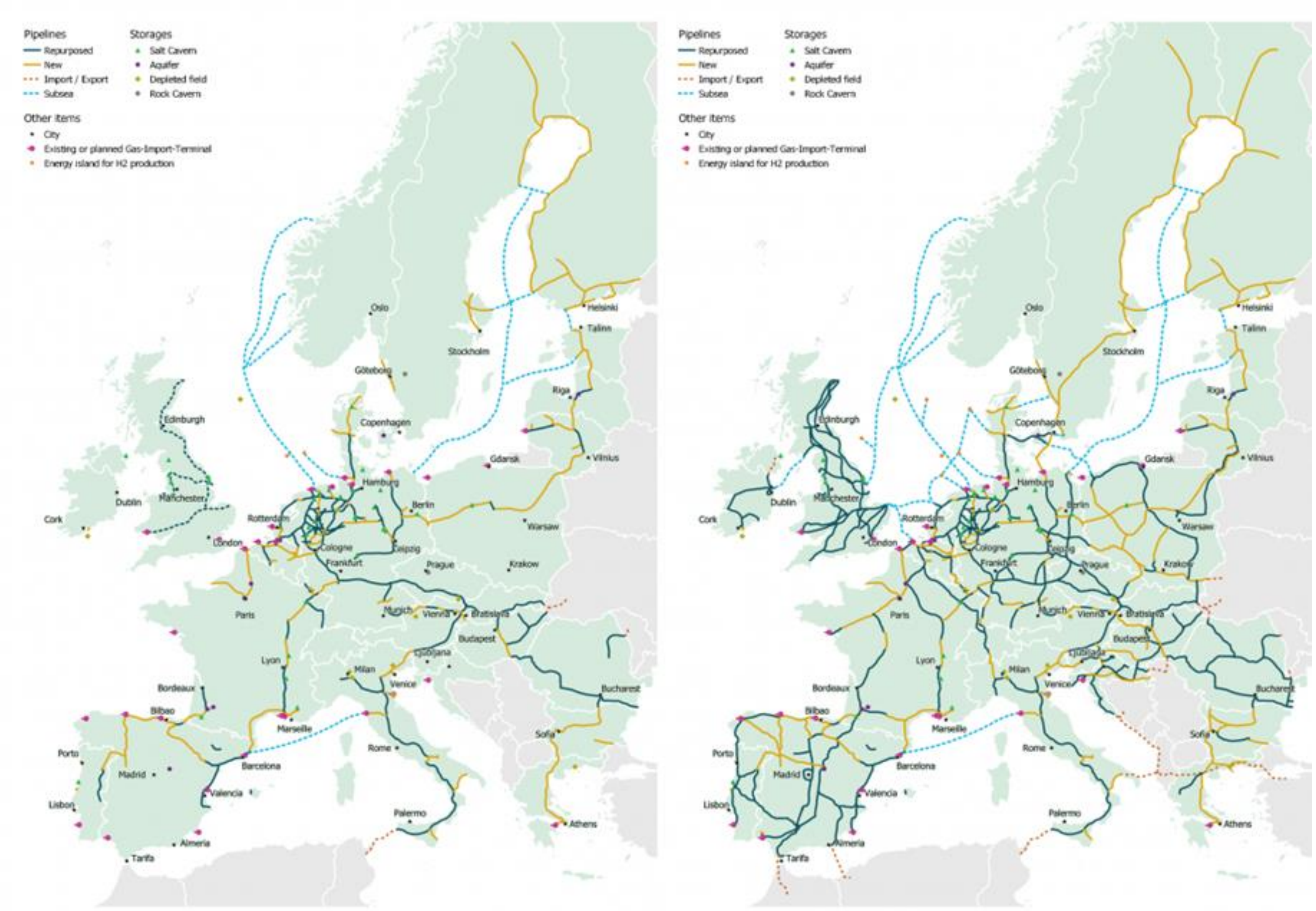
Task on the topic:
TiD International
Hydrogen Supply Chains

Source: Global Hydrogen Review, IEA,2022

European hydrogen backbone development

- EU H2 backbone network proposed by gas infrastructure companies (EHB/news)
- Currently, 31 European gas infrastructure companies in the partnership



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Hydrogen infrastructure development: the case of the Netherlands

- Conversion of natural gas infra to hydrogen, including large-scale storage (e.g. salt caverns): [HyWay27]

Phase 1: ready 2025 – 2026: large industrial clusters on the coast + the connection to storage

Phase 2: ready 2027 - 2028

Phase 3: ready no later than 2030, other routes

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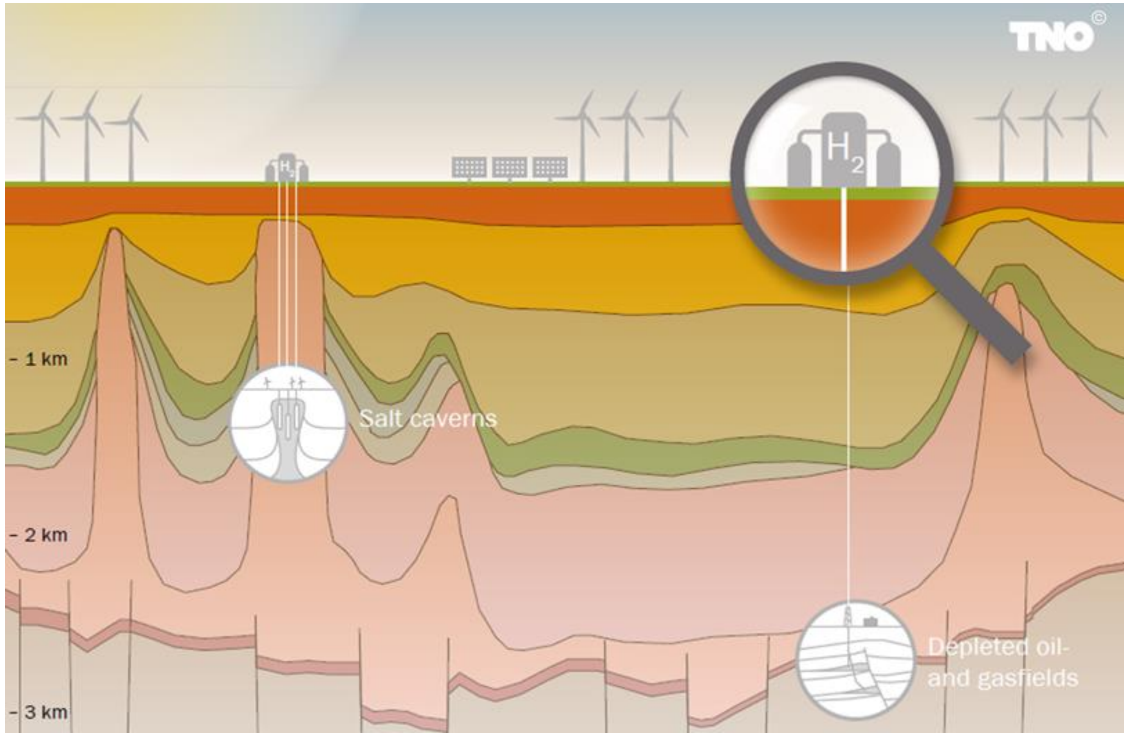
Hydrogen storage

Compressed gaseous

Liquid hydrogen



Underground hydrogen storage (UHS)

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Underground geological storage of hydrogen

	Salt cavern	Depleted gas field	Saline aquifer	Lined hard-rock cavern
Specific investment	Medium	Low	Low	High
Levelised cost of storage	Low	Medium	Medium	Medium
Cushion gas*	25-35%	45-60%	50-70%	10-20%
Capacity	Medium	Large	Large	Small
Annual cycles	Multiple	Few	Few	Multiple
Geographic availability	Limited	Variable	Variable	Abundant

* The volume of gas required as permanent inventory in a storage facility to maintain sufficient pressure to meet withdrawal demands at a high rate, even at low storage levels.

Source: Energy Technology Perspectives 2023, IEA 2023

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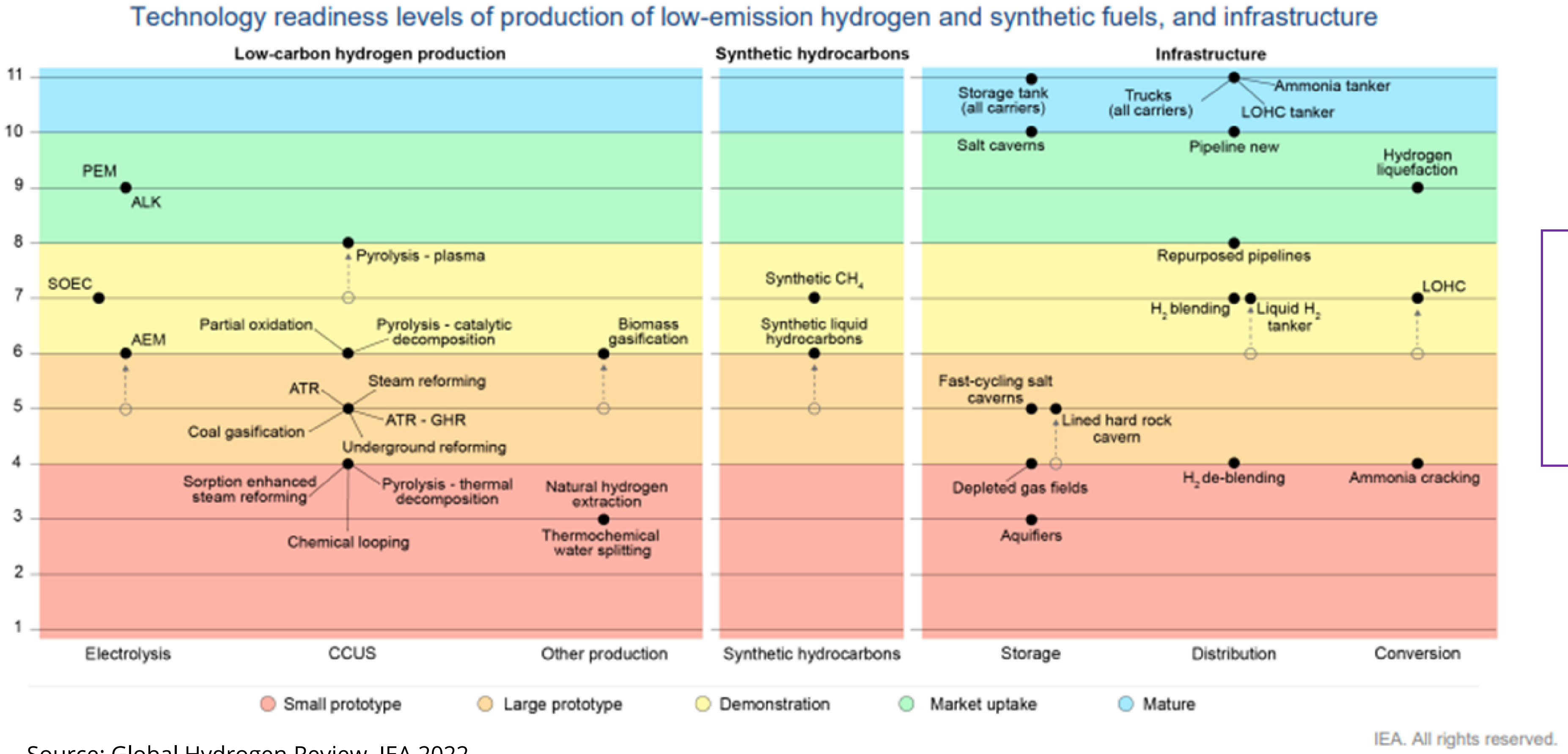
Task on the topic:
Task42 – Underground Hydrogen Storage

Hydrogen technology TRL assessment



Source: Global Hydrogen Review, IEA 2022

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TRL assessment for IEA in collaboration with other TCP's

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Thank You!