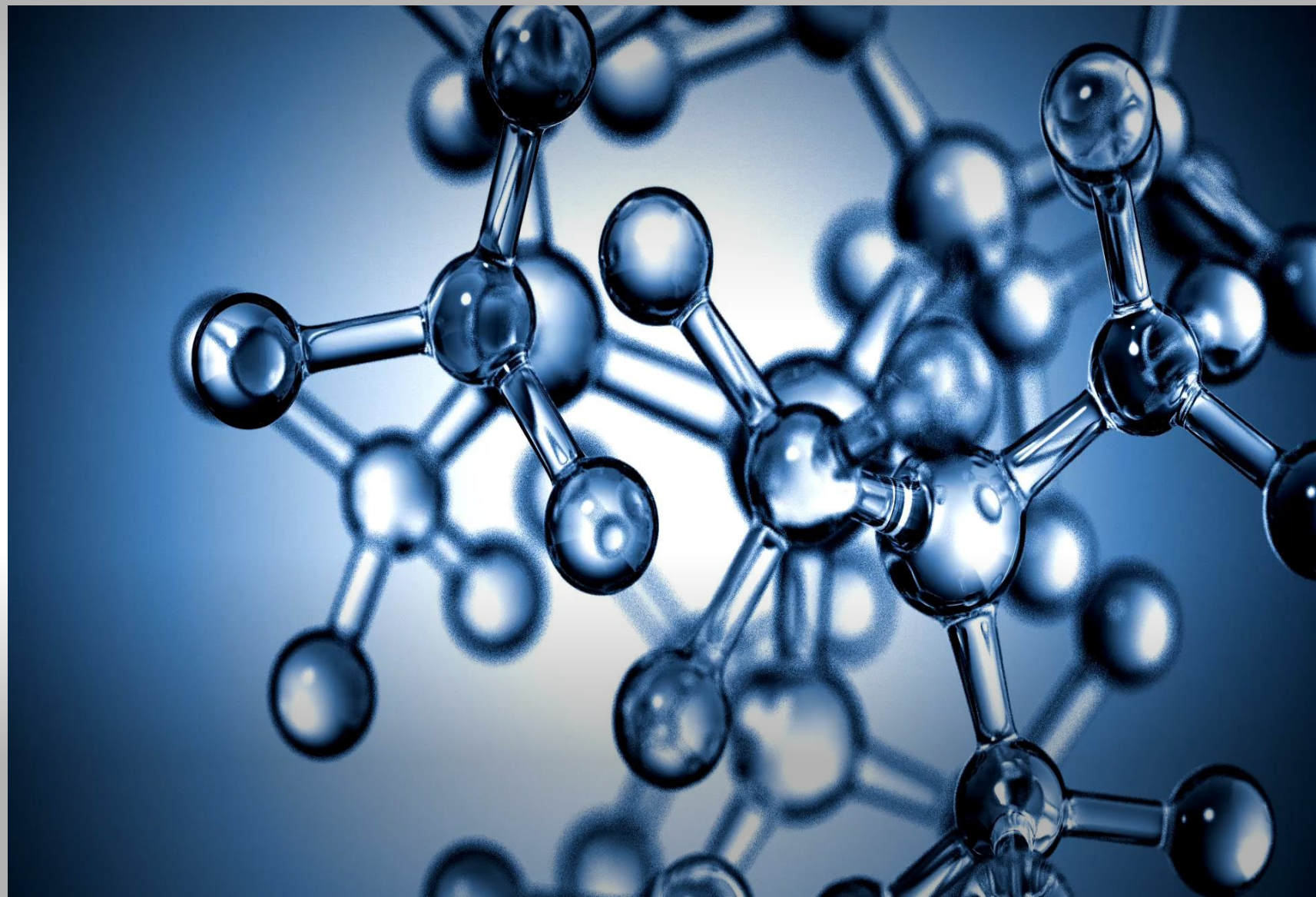
Hydrogen value chains: Reflections on global policies for the Finnish hydrogen economy



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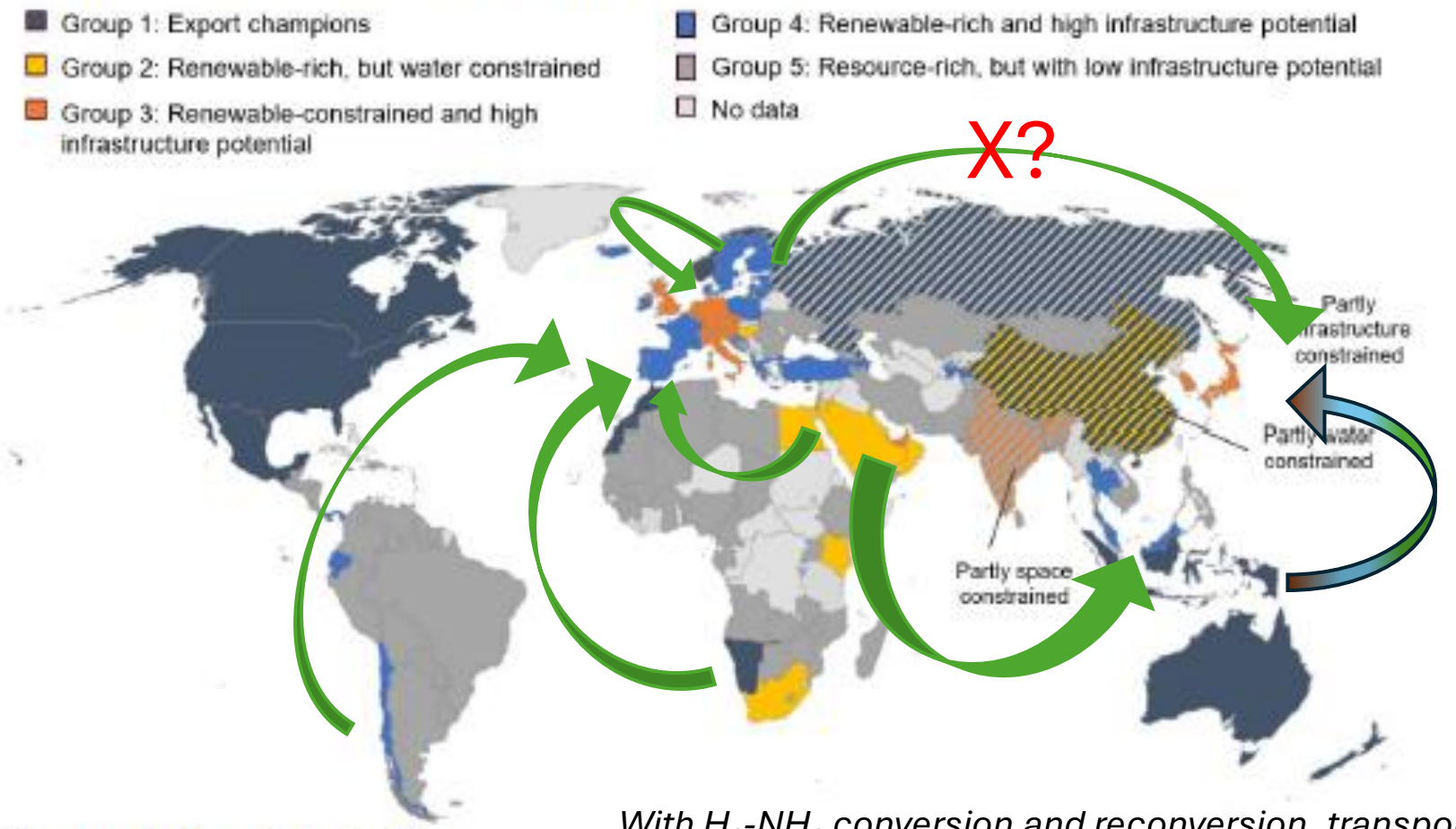
Tampere University/Politics unit
Business Finland HYGCEL consortium

Presentation 22.5.2024 Helsinki

The largest markets for **H2 fuels** produced in Finland will likely be in Europe – for chemicals etc., maybe the same case?

Figure 7 The global renewable hydrogen map



Source: Authors' illustration

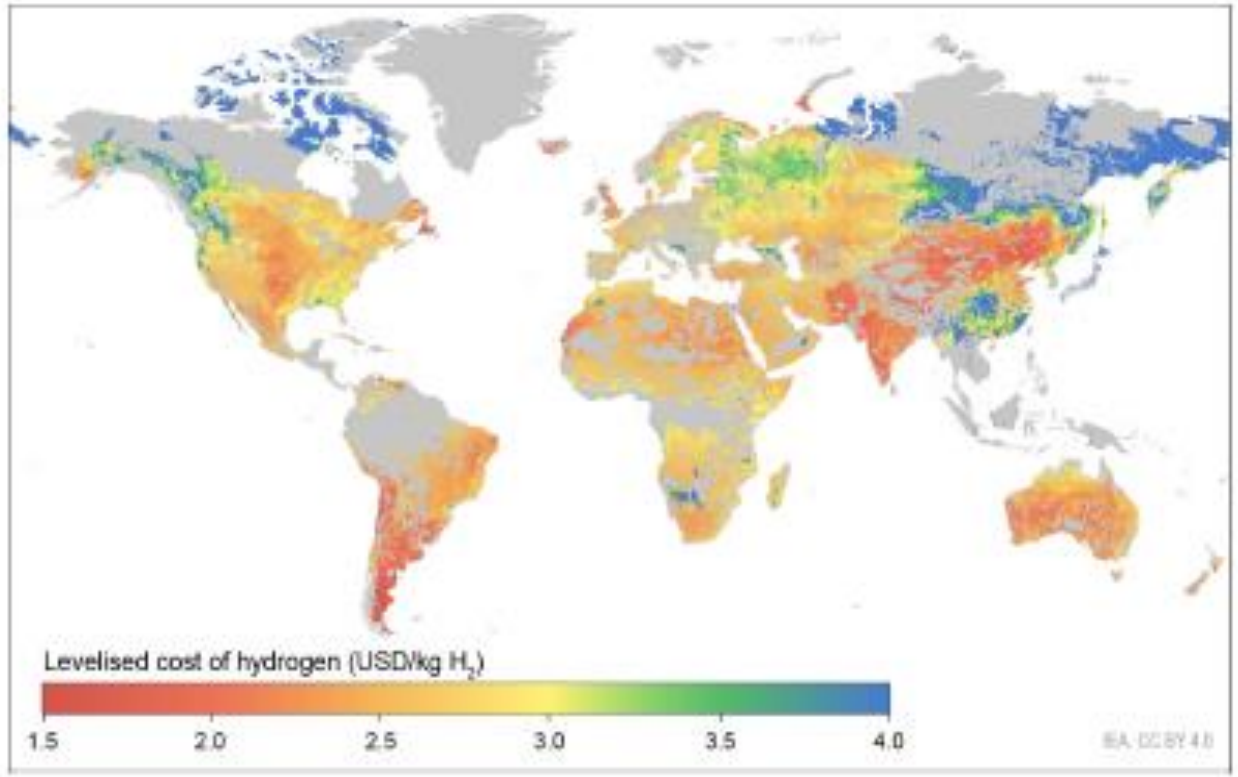
With H_2-NH_3 conversion and reconversion, transport cost can double the price (IEA 2023)

- CHN mostly domestically oriented?
- Large US potential, but uncertainties vis-à-vis exports due to the policies of the next presidential regime and possible domestic instability
- Persian Gulf: affordable CCUS fuel + large renewable H_2 potential
- AUS, IN, ID → Asian markets due to transport cost reasons?
- Northern Sea route unusable
- Finnish fuel exports to Asia uncertain due to transport costs & shrinking global commons character of the Seas
- Southern Europe to be supplied with Northern & sub-Saharan Africa

Source: Pflugman & DeBlasio (2020)

Competition is tough even in Europe both for price and policy reasons – but **competitiveness** has many components (one of them may be **strategic autonomy**!)

Figure 3.13 Hydrogen production costs and share of solar PV from hybrid solar PV and onshore wind systems, 2030



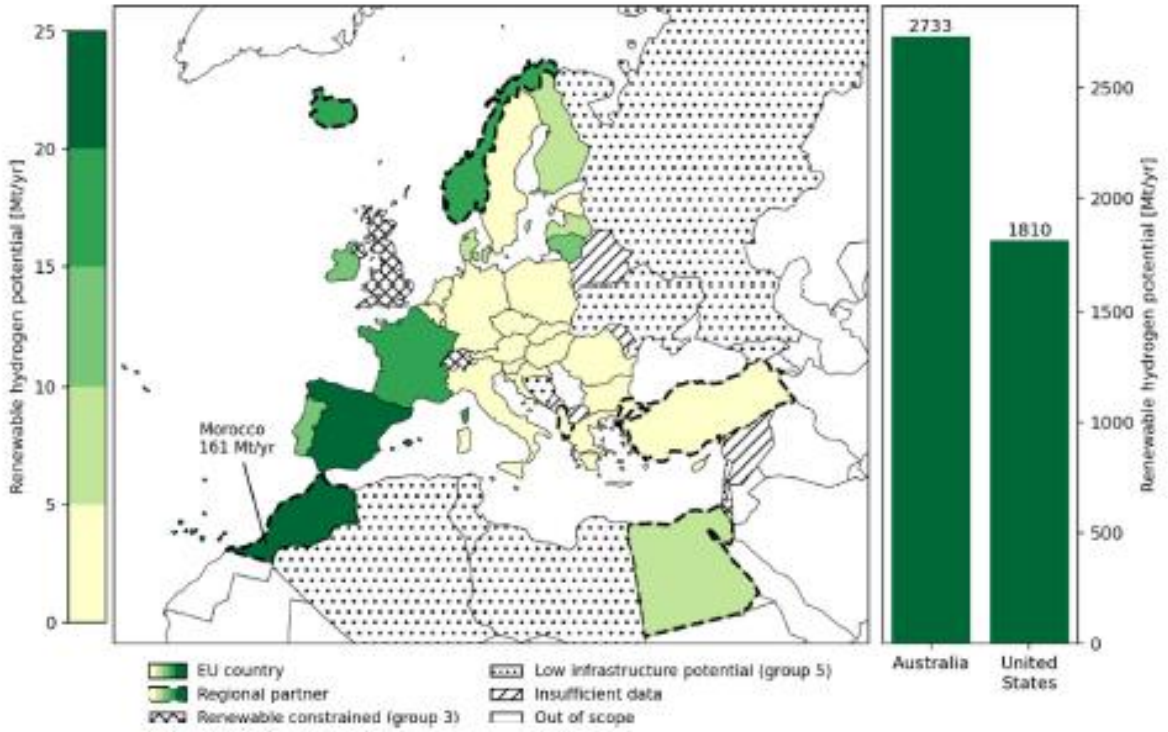


Fig. 1 – Renewable hydrogen potentials by 2050.

- Finnish production globally <u>not</u> among the most price competitive & transport cost to far away markets may be prohibitive
- In Europe, Finnish production competes with Norwegian, Baltic, Spanish, North African, sub-Saharan & Latin American production
- Many potential producer countries have strong policy push & incentives
- Economical pipeline transport ca. 1000-2000km

Finnish H2 fuel production can compete with connectivity & diversified infrastructure

- Poor connectivity to otherwise lucrative Asian markets as Northern searoute and Russian land transit unavailable
- Although only few Finnish projects are operational, those operational in central Europe will not satisfy all demand there
- Finnish ‘project pipeline’ comparable to that of most potential suppliers to Europe
- H2 transport through pipeline & H2 fuel transport via tankers both have vulnerabilties
- Connection to Barents Sea and/or Sweden to address vulnerabilities
- Destinations: UK, BE, NET, DE?

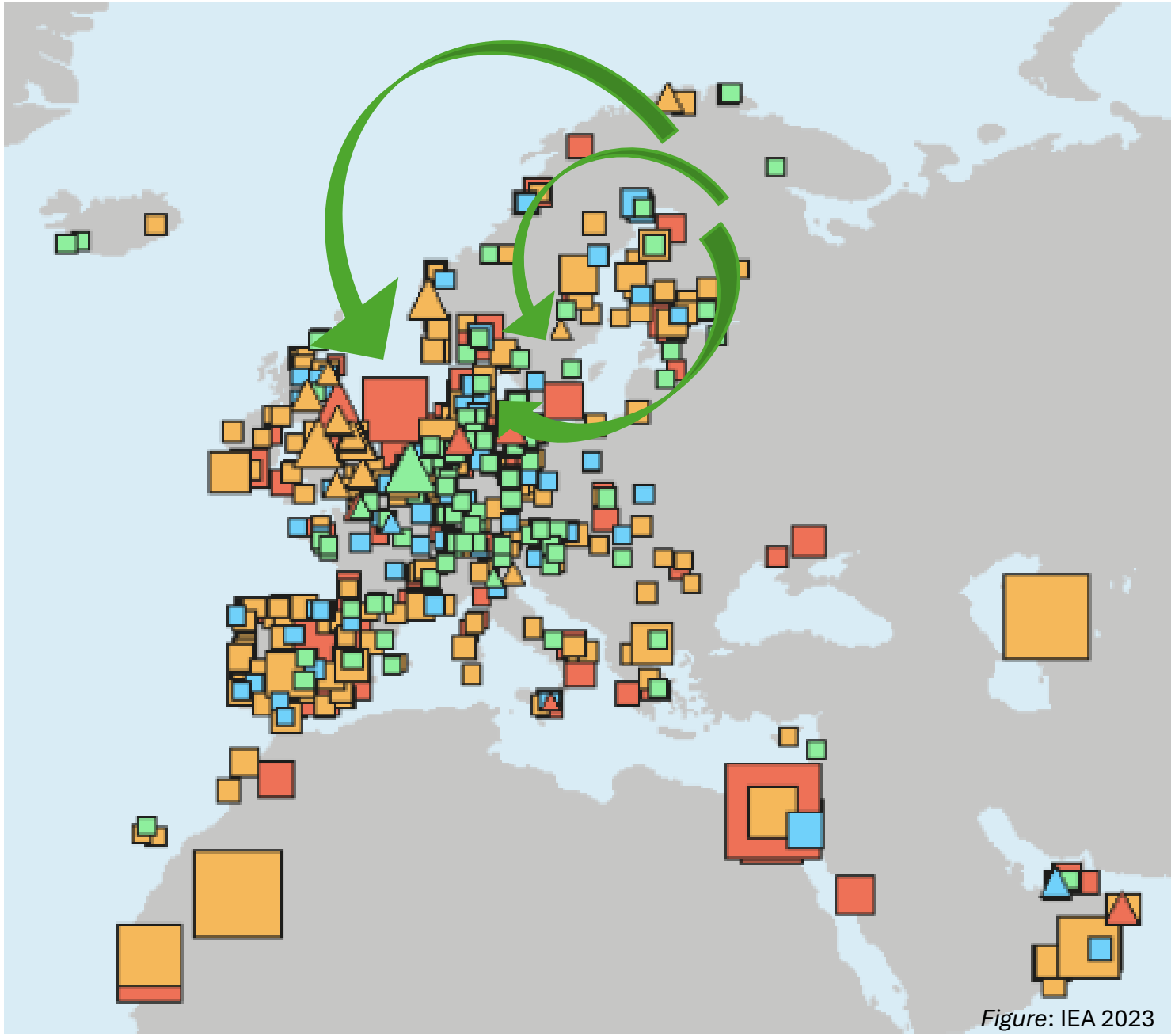
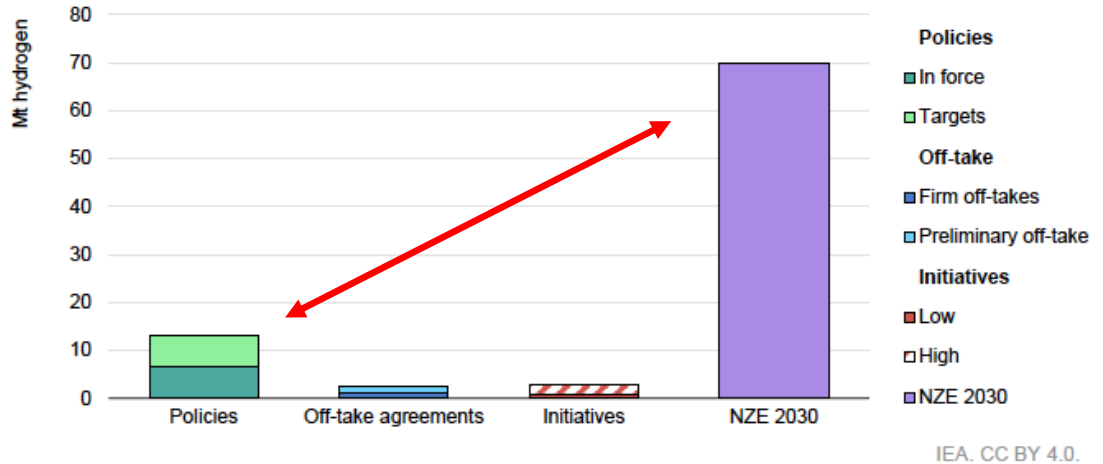


Figure: IEA 2023

What did the Finnish forestry industry once do? It is possible to offshore some production

→ (yet unknown) demand will exist
→ production closer to demand diminished transport cost
→ investment into ‘safe’ (?) allied/NATO countries (USA, JPN, AUS)
→ or to riskier (Namibia? Chile? Morocco? India?)
→ competitive advantage with policies
→ just like RES deployment was kicked off with policies
→ invest in countries with proper policies

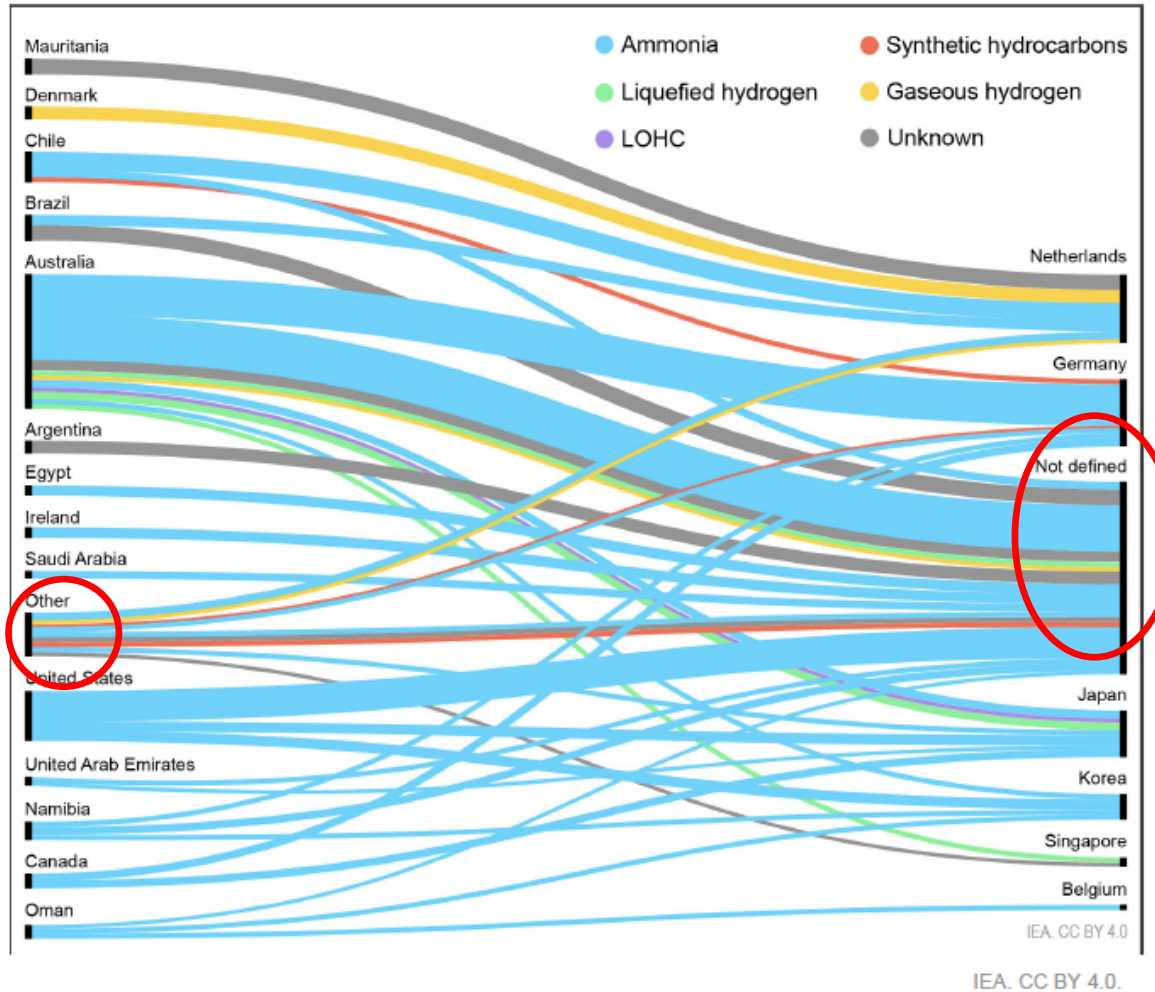
Figure 2.15 Potential demand for low-emission hydrogen from announced policies and targets, private off-take agreements, commitments of international co-operation initiatives and the Net Zero Emissions by 2050 Scenario, 2030



Notes: NZE = Net Zero Emissions by 2050 Scenario. In “Initiatives”, the dashed area corresponds to the range between the most conservative (low) and boldest (high) estimates of the demand that can be generated by international initiatives.

Source: IEA (2023)

Figure 4.3 Potential low-emission hydrogen trade flows based on announcements, 2030



IEA. CC BY 4.0.

Notes: LOHC = liquid organic hydrogen carrier; UAE = United Arab Emirates; Mt = million tonnes. In million tonnes of hydrogen equivalent, only flows larger than 150 kt H_2 equivalent per year are shown.
Source: IEA analysis based on multiple sources, including company announcements.

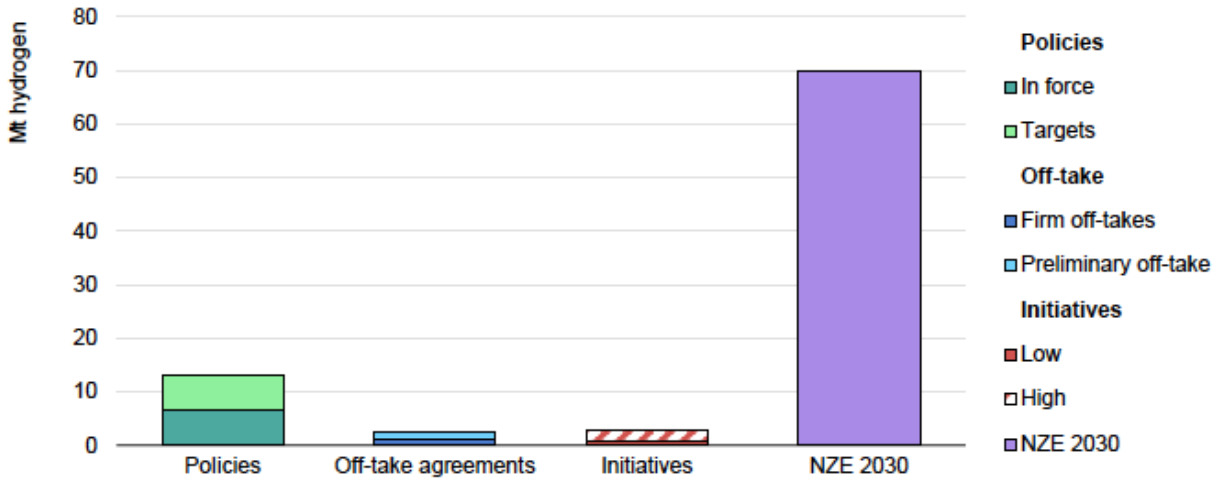
Several trade projects are under development, with Australia, Central and South America, North America and Africa as key exporters, while only a few importing countries have been identified.

Policy push required to create demand

→ redirected fossil fuel subsidies & expenses that so far have went to buying fossil fuels from abroad

→ in 2022, the EU imported energy worth € 604bln…

Figure 2.15 Potential demand for low-emission hydrogen from announced policies and targets, private off-take agreements, commitments of international co-operation initiatives and the Net Zero Emissions by 2050 Scenario, 2030



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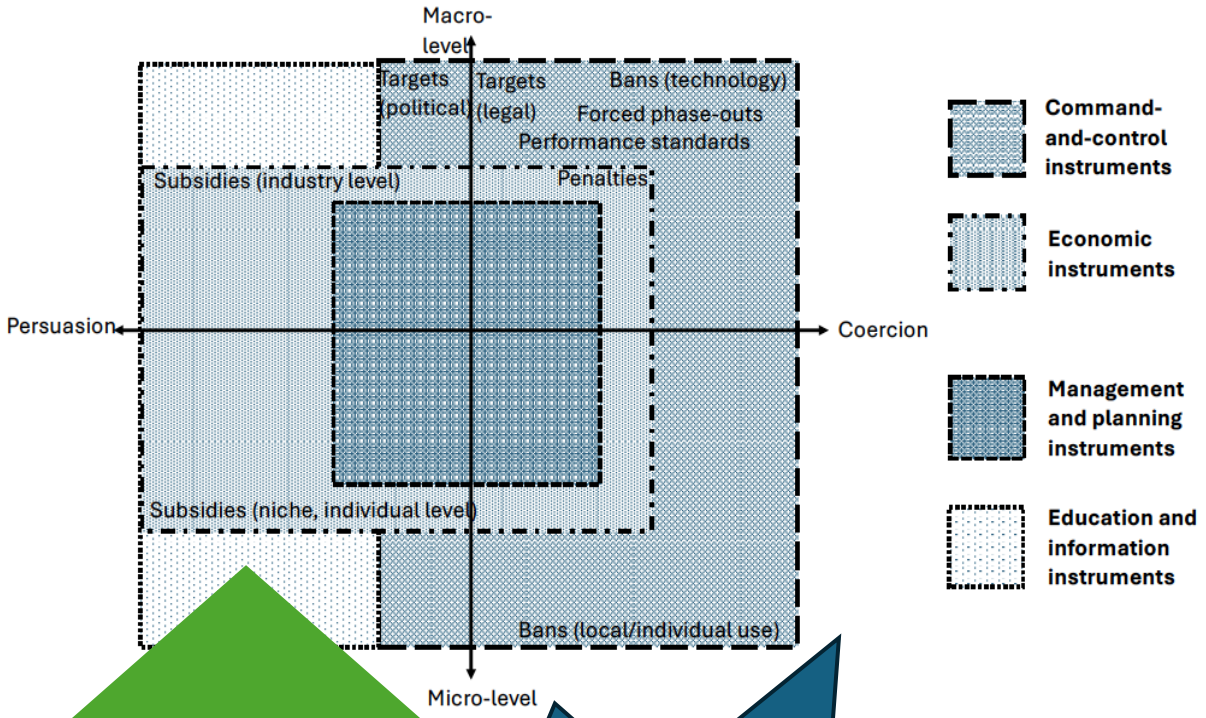


How does one achieve a major transition fast? Analogy from Norway's EV transition → the whole menu of policy instruments in use!

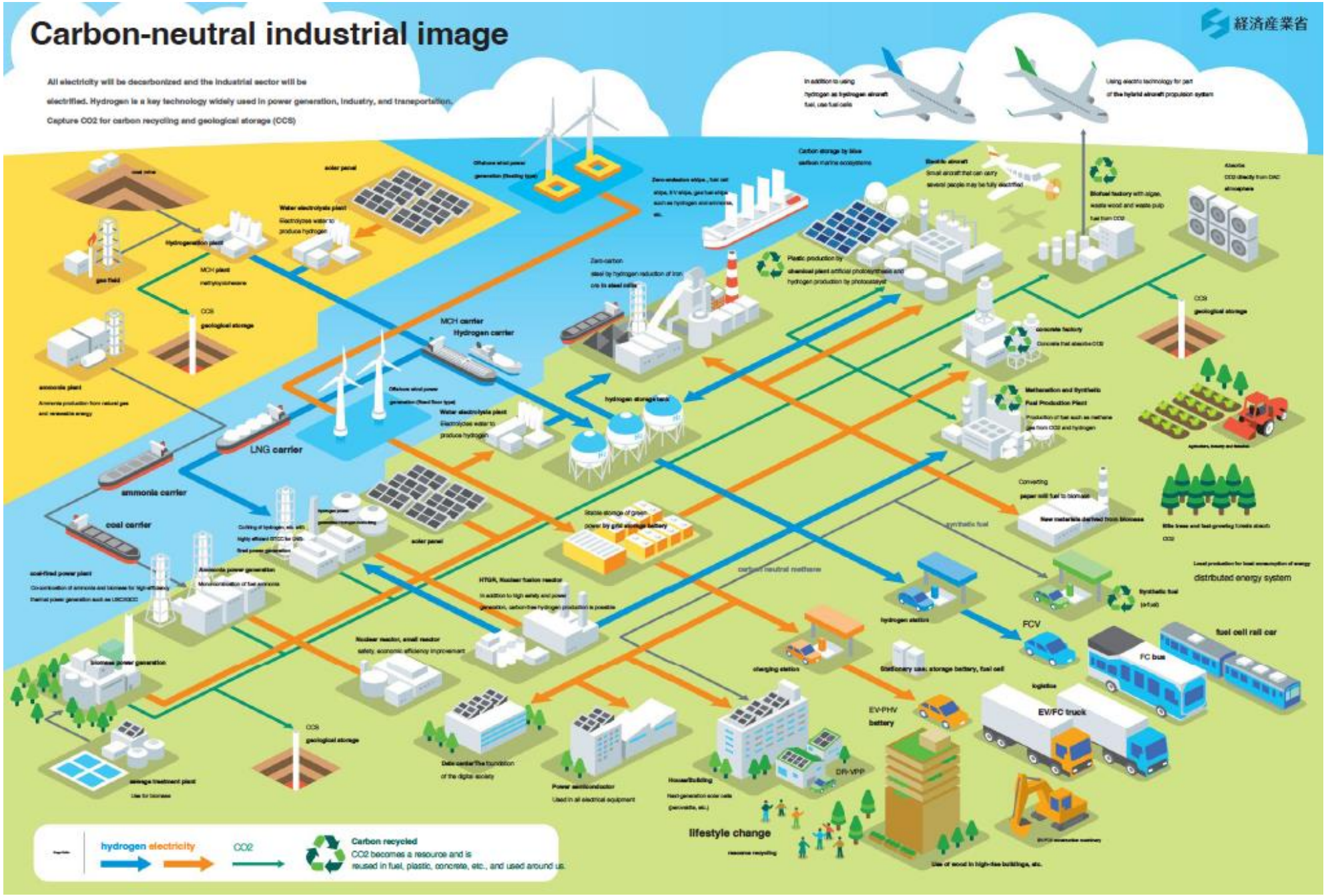
So how does the EU policy mix look like? Gruyere or Maasdam?

Command-and-control	**Example**	**Notes**
Targets		
EU gas and hydrogen package (2023/2024)	42.5% of H2 renewable by 2030 (RFNBO) = 4Mt; 60% 2035	Where is the 2040 target?
	1.2% of aviation fuel renewable H_2 by 2030 (RFNBO) = 92.000t + 460.000t CCUS	The industry's own actions are slow…
	1% road transport fuels renewable H_2 by 2030 (RFNBO) = 360.000t	Hopefully this goes to heavy traffic, but competing solutions exist
Performance standards	RFNBO	Eligibility: 3.4kg of CO_2e/kg H_2
Blending obligation	Natural gas pipeline operators to accept 5% H_2 1.10.2025→ 75% tariff discount for H_2	Primarily targeting industrial sector's emission reductions Hollanti (2026)
Incentives		
Hydrogen Bank	720Me on first round (CfD type), 1.58Mt in 10 years, 7 projects (1 to Finland) → **2Mrd+ €**	+ MS incentives for projects not receiving EU funding, e.g. DE 350M€; EST 39Me
RDI support	Clean Hydrogen Partnership, 190M€ 2024	+ MS 10M€+ projects: BR, NET, DE, DK

What about the competitiors? India's renewable H2, NH3, MeOH boost

Command-and-control	Examples	Notes
Target	'Self-reliant India' scheme (2020)	Energy independence by 2047
Performance standard	Green Hydrogen Standard for India (2023)	Eligible RES incl. biomass; < 2.0 $kgCO_2e/kg$ of H_2 (12m average); methodology TBA
Incentives		
Production subsidy	USD 25mln →5 Mt of 'renewable' hydrogen by 2030 (with 125GW RES capacity additions)	May reach 10 Mt/yr incl. exports
Competitive bidding scheme, 2.2bln USD	Subsidy for electrolyser development	Part of SIGHT programme
Competitive bidding scheme, 2.2bln USD	Subsidy for RES based H_2 production	Part of SIGHT; USD 0.64/kg) for 1st year, USD 0.51/k) for 2nd year; USD 0.38/Kg) for 3rd year
Waiver	Electricity transmission charge waiver	Until 2030/2036
Management instruments	Manufacturing zones for green H_2	Spatial planning policy
	H2 safety certification programme	
Sources: e.g. IEA (2023); Pal et al. (2024); Government of India (2023)	H2 fuel quality control system	

Japan’s hydrogen society vision proposed to do it a bit differently



Some key leftovers from Japan's Hydrogen Society vision, on top of impressive H_2 supply chain development

Transport – *heavy competition with other technologies*

6427 FCV

FC bus deployment
106 FC buses

FC train demonstration

FC train

FC Truck development

ISUZU HONDA The Power of Dreams
HINO TOYOTA

FC Truck

District & residential heating + CHP → *best applied where?*

Stationary Fuel Cells at home

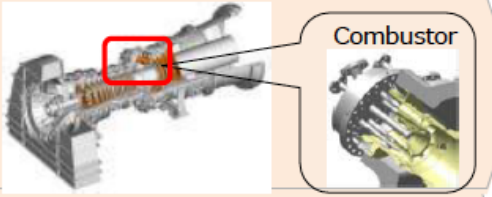
FC CHP* for home use: More than 400,000 units installed

Sources: METI (2021, 2022)

R&D for large-scale thermal power generation (500 MW class)

Development of technology for hydrogen co-firing in existing large-scale thermal power plants, **achieving a hydrogen co-firing rate of 20% by 2018.**

Technology development for hydrogen single fuel power generation is in progress from 2020.



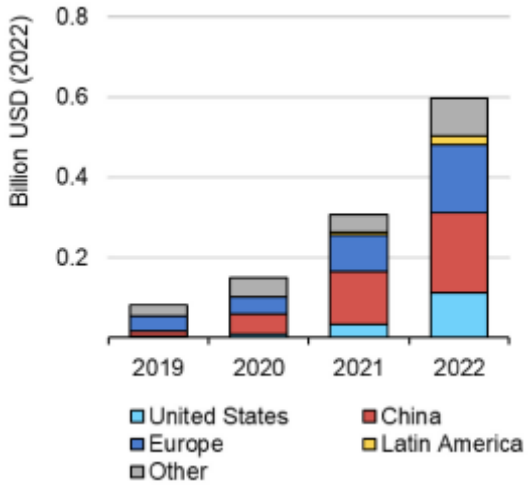
R&D for cogeneration for supplying heat and electricity (1MW class)

We have developed a technology that can freely co-fired hydrogen with natural gas from 0 to 100%.
In 2018, we will be the first in the world to achieve combined heat and power supply to urban areas using hydrogen exclusively.

From 2019, technology development for high-efficiency dedicated **hydrogen single fuel power generation** is in progress.

Hydrogen power generation facility (hydrogen CGS) constructed on Port Island in Kobe City

What about the global competition in electrolyser manufacturing?



Electrolyser investments, 2021-22

Sources: IEA (2023); METI (2021, 2022)

Selected active hydrogen R&D programmes

Country	Programme	Funding and duration
Australia	ARENA's R&D Programme CSIRO Hydrogen Mission	AUD 22 mln (~USD 15 mln) – 5 yr AUD 68 mln (~USD 47 mln) – 5 yr
European Union	Clean Hydrogen for Europe	EUR 1 bln (~USD 1. bln) – 10 yr
France	PEPR Hydrogène	EUR 80 mln (~USD 91 mln) – 8 yr
Germany	National Innovation Programme for Hydrogen and Fuel Cell Technology	EUR >250 mln (~USD 285 mln) – 10 yr
	Wasserstoff-Leitprojekte	EUR 700 mln (~USD 800 mln) – n.a.
Japan	NEDO innovation programmes	JPY 699 bln (~USD 6.5 bln) – 10 yr
Spain	Misiones CDTI	EUR 105 mln (~USD 120 mln) – 3 yr
United Kingdom	Low Carbon Hydrogen Supply	GBP 93 mln (~USD 119 mln) – n.a.
United States	H2@Scale M²FCT – H2New Consortia DOE Hydrogen Program	USD 104 mln – 2 yr USD 100 mln – 5 yr USD 285 m/yr

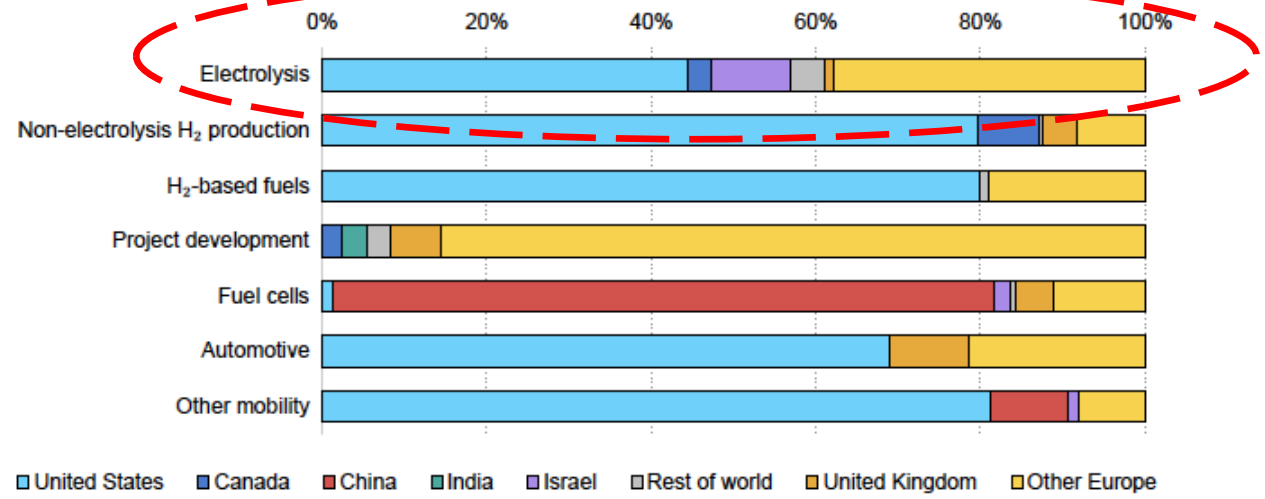
→ Japan invests some 450mln USD public money for electrolysers to bring cost to 1/6!

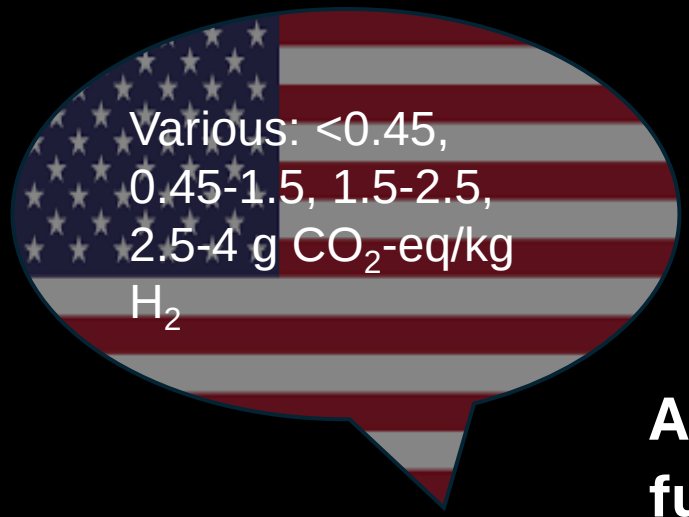
GI Fund Project② : Scaling up Electrolysers

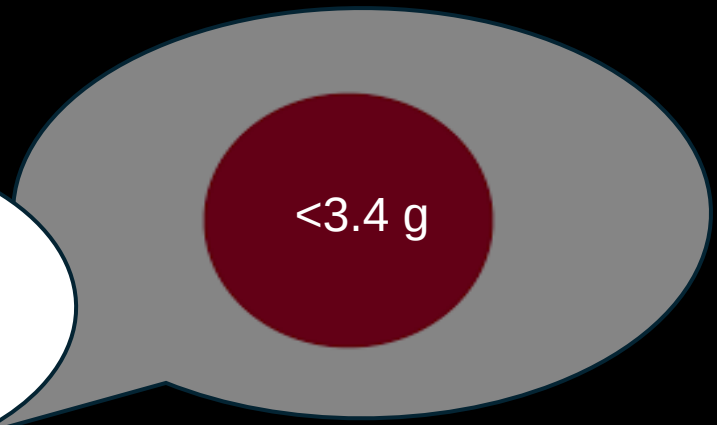
- To further reduce the cost of electrolysers, Japanese government will support demonstration projects for 1) scaling up electrolysers, 2) implementing superior components and 3) system optimization with several demands(**~70 Billion Yen**)
- The goal of this project is to establish a strong technological base to attain the cost of electrolyer **(up to 1/6 of the current system cost)**

→ But USA & Europe lead investment in electrolyser start-ups

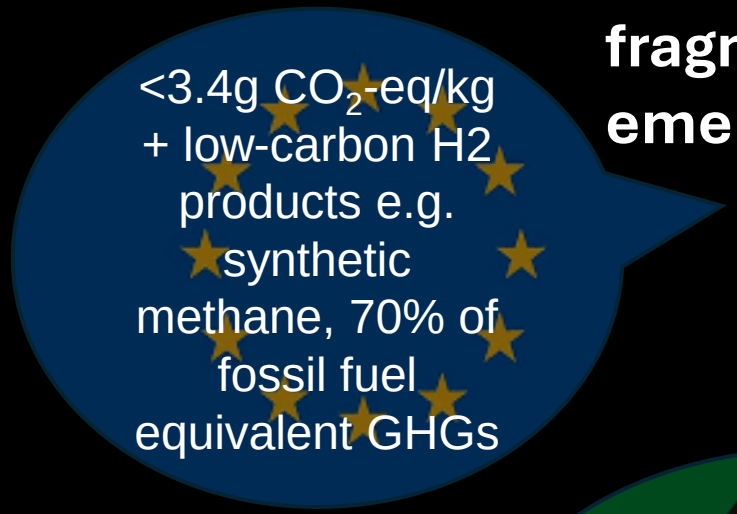
Figure 5.6. Early- and growth-stage equity investment in energy start-ups in hydrogen-related areas by region, 2018-2022

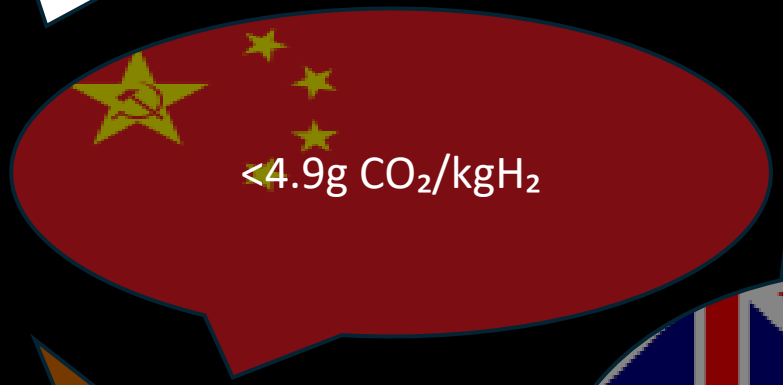


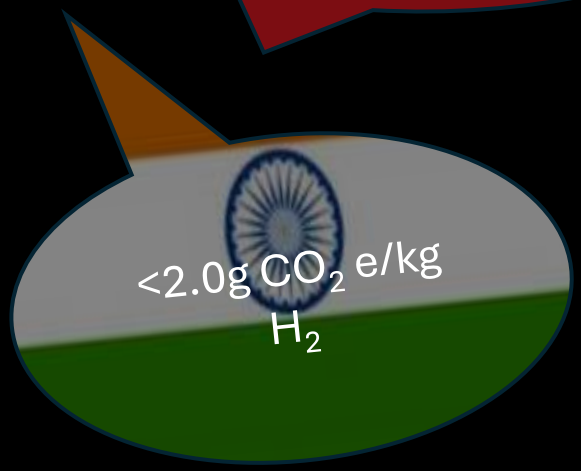




A 'global' hydrogen fuel market – fragmentation emerging?







A ‘global’ policy landscape?

- Not so much in terms of actual ‘global’ policies yet but predominantly national + EU-based
- Some international standardisation efforts
  - European Clean Hydrogen Alliance (standardisation)
  - European Hydrogen Safety Panel, ISO (work on fuelling stations & protocols)
  - SAE International [USA] (hydrogen refuelling stations)
  - International Electrotechnical Commission (standards on performance testing in fuel cell/battery systems in excavators + power-to-methane, fuel cells in trucks)
- Several ‘agent’ organisations & platforms working on knowledge accumulation, sharing & dissemination

Where is Finland?

- Even though Finnish H_2 fuel production will not be the cheapest, strategic autonomy policies & friend-shoring to create opportunities within NATO/EU
- But Finland’s own H2 policies are not much to be seen…
- Some risks in transition period CCUS solutions based on natural gas extraction
- And in CO_2 in methanol solutions → how long will biological origin CO_2 be considered climate neutral?
- **For a value-added, resilient niche, invest in ammonia + SWE/NO transport connection?**

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