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Pipelines vs. ships for EU hydrogen imports

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Background

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Motivation…

1. EU is **targeting 20mt** clean hydrogen by 2030
2. 50/50 split domestic vs. imports means ~**6mt** hydrogen imports p.a
3. Imports require new value chains & infrastructure, with opportunity cost in buildout

What are some of the risks/opportunities to consider given Europe's position?

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Scale and timelines

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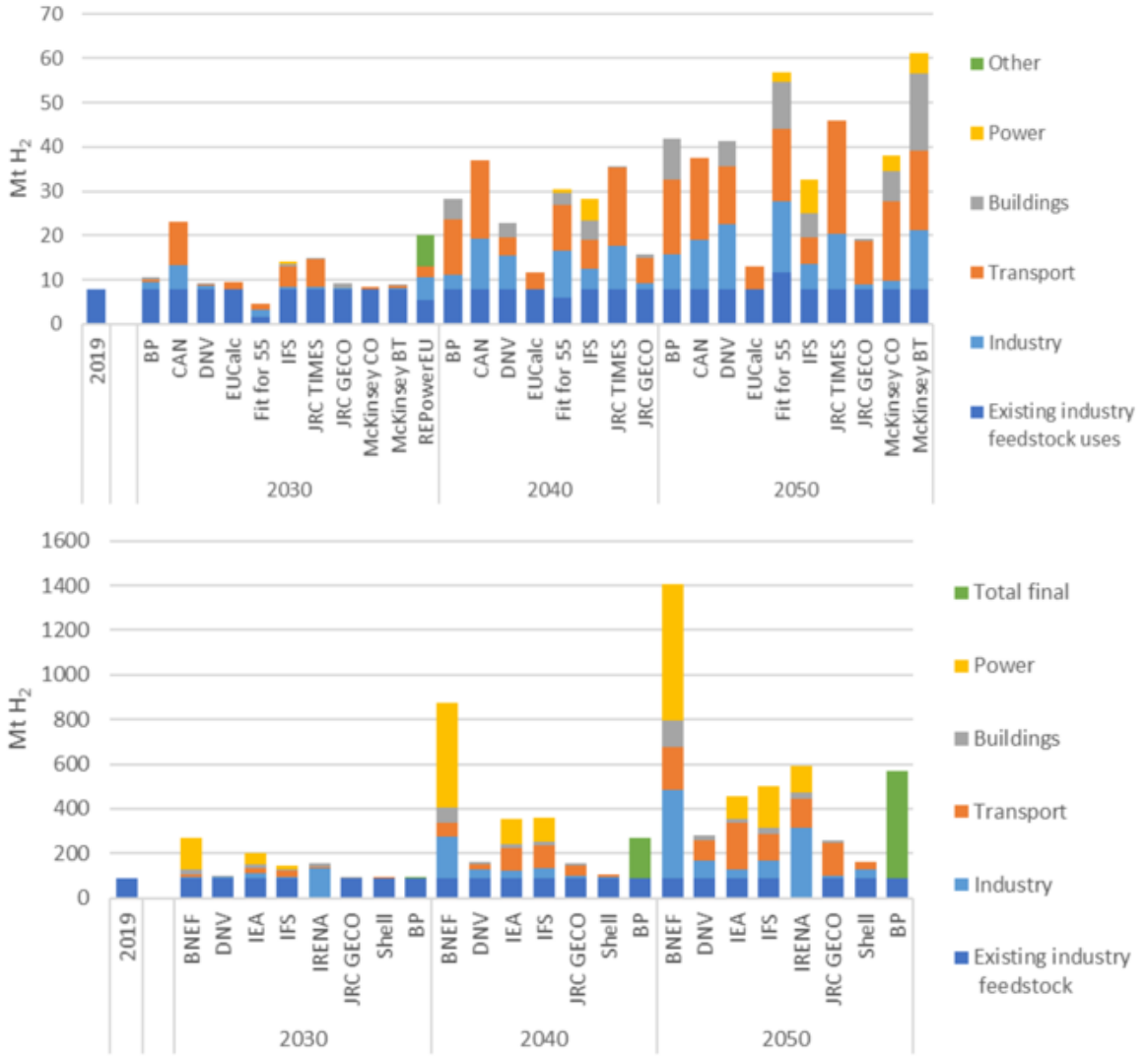
DEMAND: Hydrogen

There are significant unknowns, but EU projected demand is;

- 12mt in 2030
- 26mt in 2040
- 40mt in 2050

Import options?

- Pipeline
- LOHC
- Ammonia
- Liquid hydrogen



Projected EU (top) and global (bottom) hydrogen demand for 2030, 2040, 2050 (JRC, 2022)

Strengths and limitations of infrastructural options

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Economics: Cheapest single tonne

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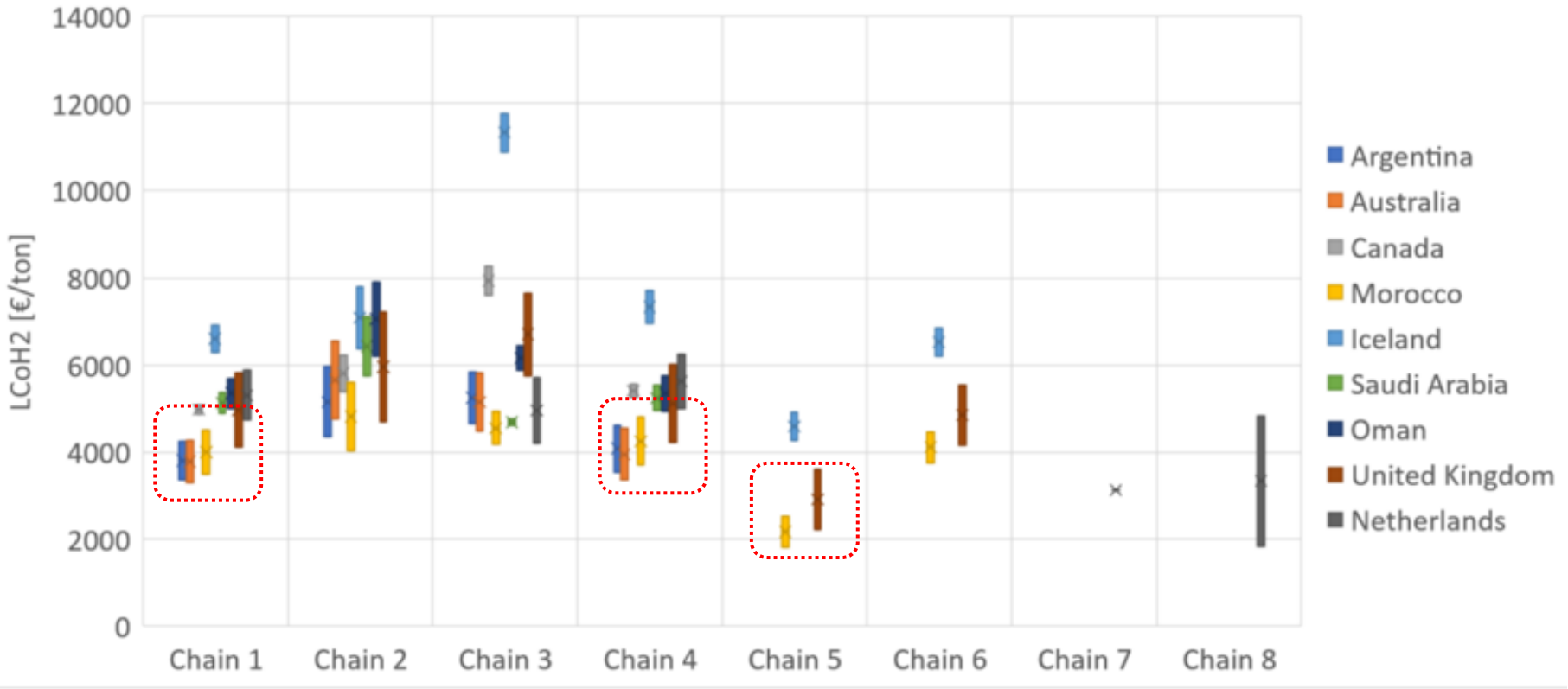
Levelised cost of hydrogen of all chains for all routes in 2030 and 2040 (van der Meulen, et al., 2022)



1 = H2 via NH3
2 = H2 via LH2
3 = H2 via LOHC
4 = H2 via MeOH

5 = H2 via Pipeline (low)
6 = H2 via Pipeline (high)
7 = Domestic LCoH2, green hydrogen (source: 7AD2)
8 = Domestic LCoH2, blue hydrogen (source: 7AD2)

Practicalities: How do ships and pipes compare?

Shipping	
Strengths	**Weaknesses**
• Flexibility in suppliers (security & competitiveness) • High suitability for developing a 'spot market' • Ports are an easy place to make fast industrial innovations • Low marginal cost for increased distance of deliveries	• Complexity of value chains • Lack of clarity on optimal carrier • Difficulty in scaling/capacity • Missing technology and skills • Low compatibility with existing infrastructure • Hydrogen carriers are only 5-18% hydrogen

VS

Pipelines	
Strengths	**Weaknesses**
• Capacity to transport massive volumes at low marginal cost • It is the established practice in hydrogen sector • Simple value chain • Can make use of existing infrastructure • Trade incentive between connected parties	• High CAPEX • Risk of overreliance on a single supplier • Require large volumes to be cost-effective • Not suitable for extremely large distances (>3,000km) • Risk of leaks

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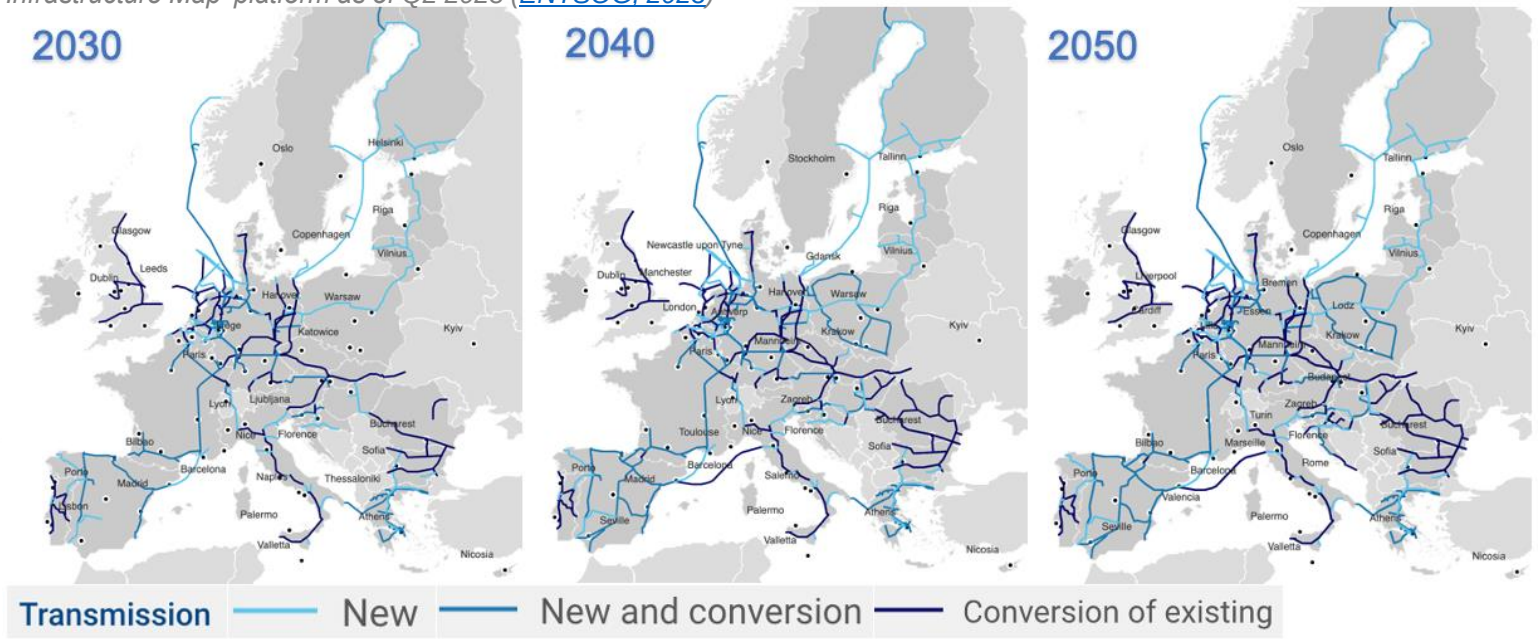
State of play: Projects

- Pipeline projects (right) total transmission capacity of **~30mt/H2/y by 2030**
- Terminal and port projects (left) total import capacity of **<1mt/H2/y by 2030**

Maps of planned hydrogen import terminals (left) and transmission pipelines (right) in Europe and neighbourhood region based on projects submitted to the 'H2 Infrastructure Map' platform as of Q2 2023 (ENTSOG, 2023)



Implications & discussion

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In short…

- Shipping has significant scaling challenges.
  - Carriers **5-18% hydrogen**
  - The **entire global LNG fleet** repurposed to **liquid hydrogen** would deliver just **6.5mt/h2/y**
  - LOHC can scale better using oil infra. but has **value chain bottlenecks**
  - Each carrier needs different infrastructure
- Carriers have a big energy penalty in the **importing** region
  - If Europe is RES poor, this is not a sensible approach
- There is a debate to be had on which are the means to deliver the ***single*** cheapest tonne of hydrogen. But can we afford to pursue all in parallel?
- Pipelines are arguably the technology most capable of delivering the kind of scale of imports targeted within the next 10 years.

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Where now?

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1. Hydrogen for hydrogen, derivatives for derivatives.

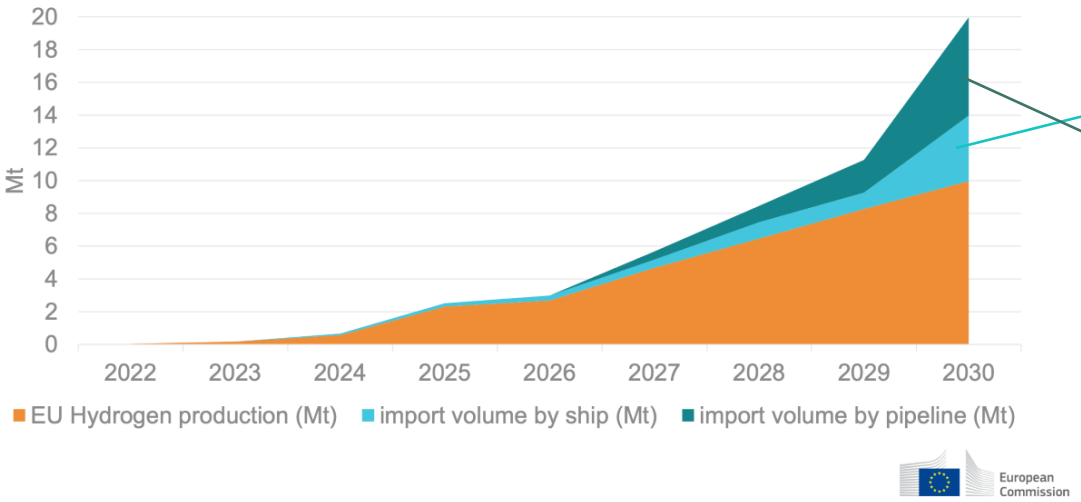
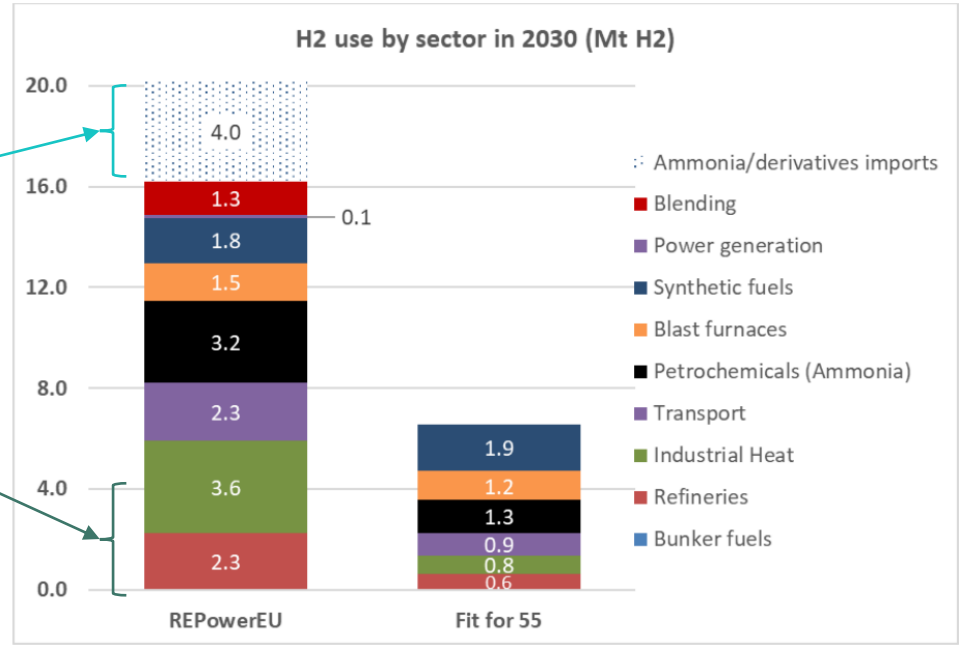


Figure 4: Hydrogen use by sector in 2030



Source: Modelling using PRIMES.

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2. Leverage Europe's competitive advantage in pipelines and let others innovate in shipping.

- Two categories of stakeholders must commit to shipping hydrogen and derivatives:
  - **(i) exporting islands/remote locations,** E.g. Australia, Chile, South Africa,
  - **(ii) importing islands/remote locations**. E.g. South Korea, Japan. **The EU does not fall into these categories.**

- As illustrated previously, the volumes these liquid carriers can currently deliver are so negligible that it will not make the critical difference in guaranteeing Europe's volumes.

- The cost of shipping is anticipated to **drop aggressively from 2030 to 2050**, but with a high range of uncertainty. *Why should Europe take the early risk/pay the innovation and scaling costs?*

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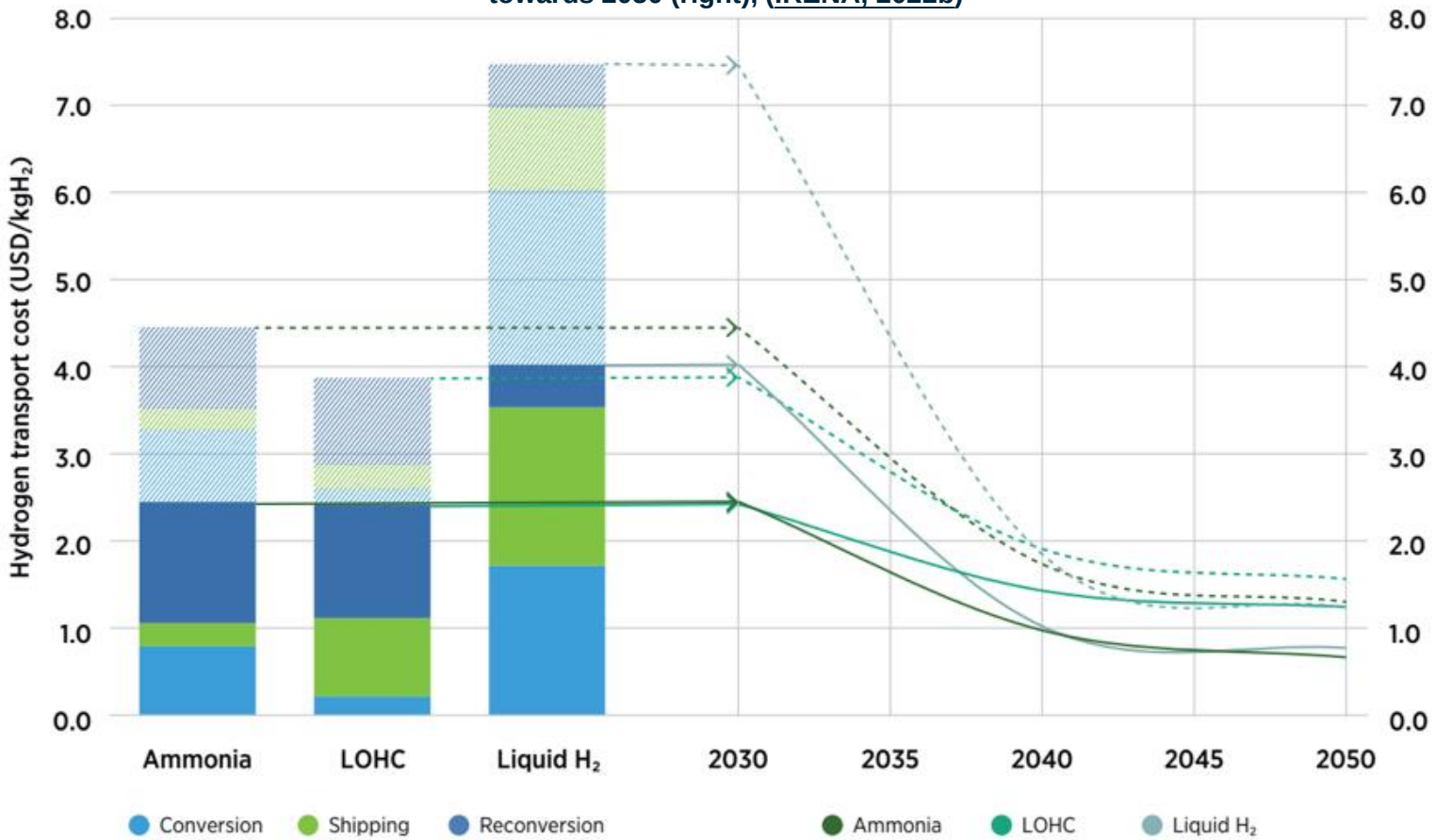
2. Leverage Europe's competitive advantage in pipelines and let others innovate in shipping.

Transport cost breakdown by carrier and stage for 2030 (left) and evolution towards 2050 (right), (IRENA, 2022b)



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3. Hydrogen does not yet pose a security of supply concern.

- The 12mt of hydrogen demand forecasted for 2030 equates to roughly **296TWh of energy, or ~2% of primary energy demand**, roughly half of which is expected to be domestically sourced.
- Considering these figures, **policy makers should not equate hydrogen to natural gas in terms of rationalising security concerns.**
- Europe has the flexibility in infrastructure to move first with a few key pipelines. **Allow remote and island nations to pay for the scaling of shipping**, and then diversify from 2040 when the share of hydrogen in the mix is more meaningful and there is greater clarity on the optimal carrier.
- In the meantime, Europe can **experiment with shipped deliveries of carriers, but using them to directly decarbonise those markets**. Ammonia for ammonia, methanol for methanol, etc.

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The full paper is available on CADMUS.

Many thanks for your attention

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