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The Potential for Green Hydrogen and Related Commodities Trade

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Purpose of the Analysis

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Project: Innovation to Foster Renewable Energy Transition - the project was funded by the European Union and carried out by IRENA in close collaboration with the European Commission.

Funded by the European Union

1. Identify cost-effective global trade patterns

Analyse where green hydrogen, ammonia, e-methanol and DRI could be produced most competitively based on renewable resource availability and costs.

2. Inform national and regional strategies

Provide insights that help countries position themselves as importers, exporters or hubs in emerging green hydrogen markets.

3. Enable just and inclusive participation

Highlight opportunities for developing and emerging economies with abundant renewable resources—while ensuring local priorities like energy access are not compromised.

4. Guide infrastructure and policy needs

Indicate required investments for production, storage, transport and trade, and support policy design across the hydrogen value chain.

5. Support partnership development

Facilitate preliminary identification of potential trade partners and expected commodity flows under different scenarios.

Last Mile of Decarbonization

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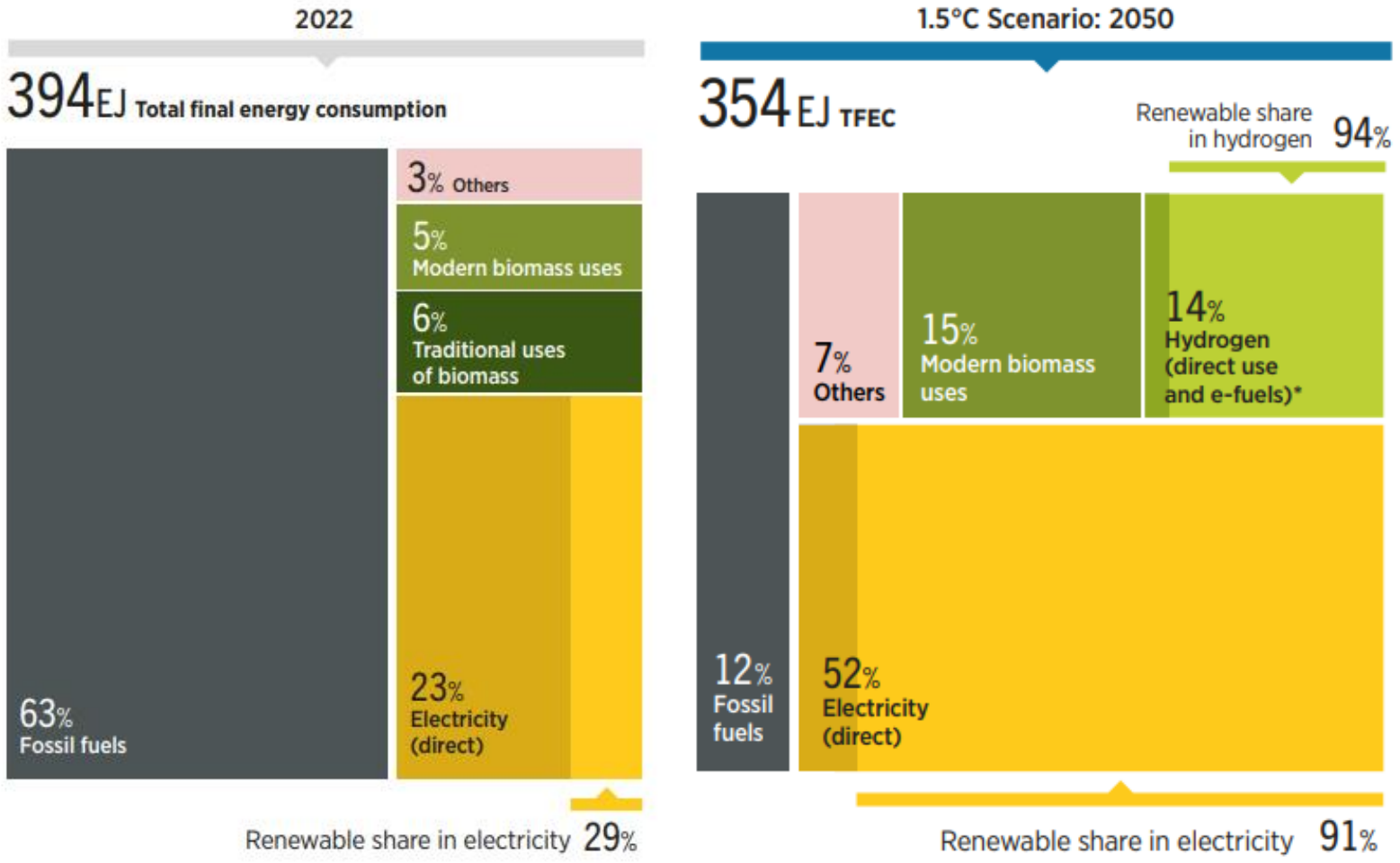
- **Green hydrogen has an important role for achieving the 1.5°C pathway**.
- Enables **deep decarbonisation** of end-use sectors like steel, chemicals, shipping, aviation.
- Hydrogen-based commodities (NH_3, MeOH, DRI) link renewable electricity with end-uses.
- Over **56 national hydrogen strategies** (as per data until 2024) — expected strong global policy momentum.
- Uneven financing conditions strongly affect competitiveness.



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Methodology

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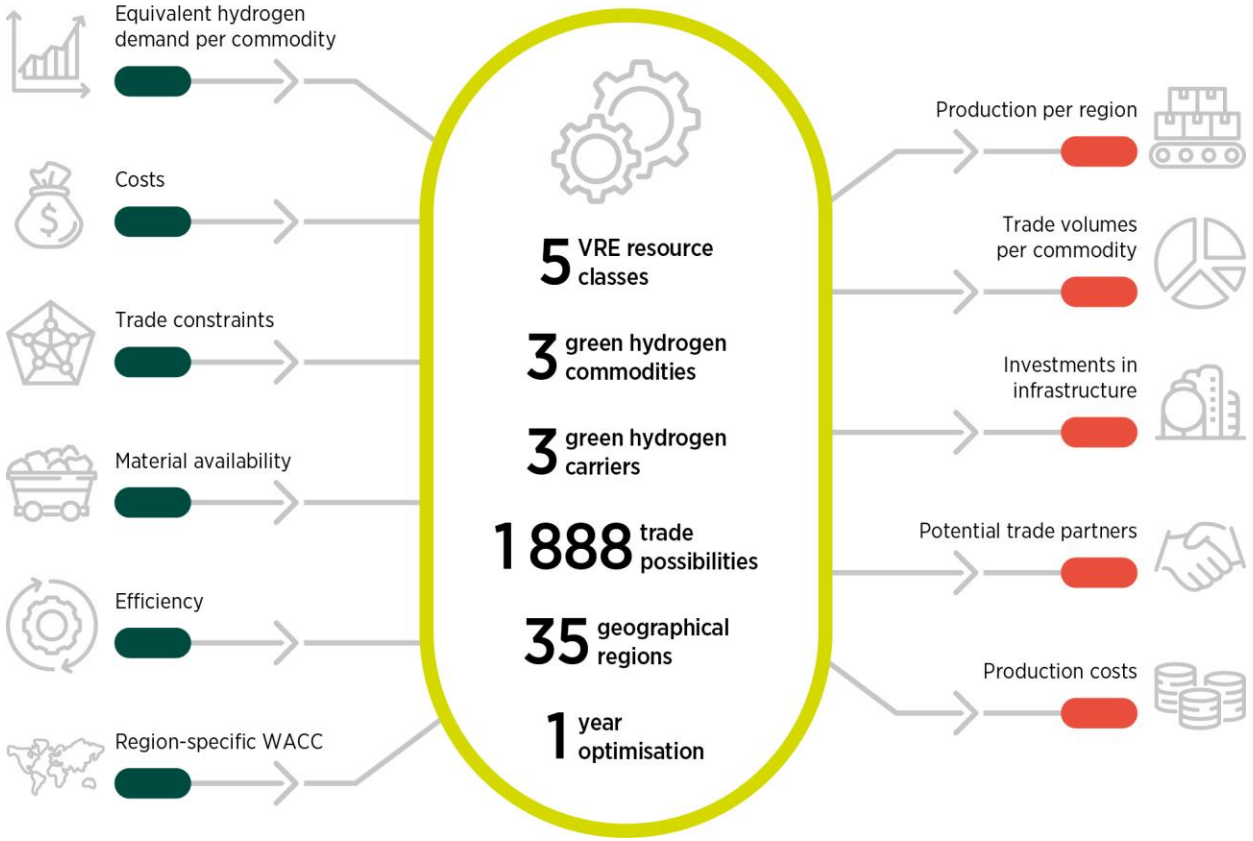
- Cost-optimised global model covering **35 world regions/countries**.
- Includes renewable generation, electrolysers, conversion plants for NH_3, MeOH and DRI.
- Includes hydrogen carriers: NH_3, LH_2, LOHC, pipelines.
- Includes **marine transport and pipeline** networks.
- Purely techno-economic: Excludes **geopolitics and institutional factors**.



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Assumed Hydrogen Demand & Commodities (2050)

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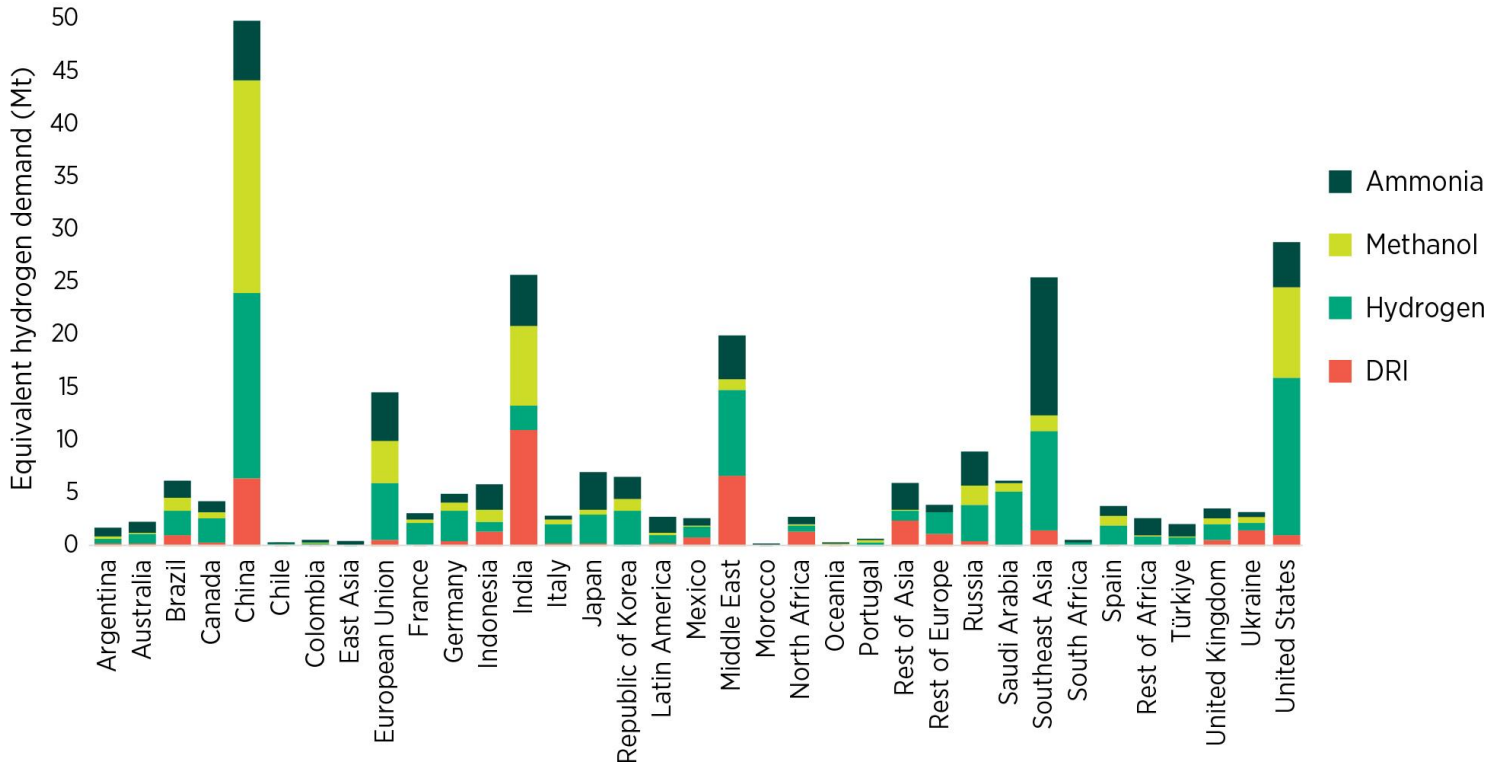
- Global demand assumed at ≈ **260 Mt H_2-equivalent** by 2050.
- Driven by steelmaking (DRI), fertilizers (NH_3), e-fuels and industrial heat.
- Commodities assessed: **ammonia, e-methanol, DRI, gaseous hydrogen**.
- Demand distribution varies substantially **by region.**



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How to Interpret the Results

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- **Techno-economic focus:** Cost-optimised supply based on resources and geography only.
- **Limited scope:** Does not consider energy security, political stability or economic development.
- **Scenario-based inputs:** Uses predefined assumptions for demand and costs (renewables, electrolysers, transport, production plants).
- **Technology restriction:** Covers only renewable-powered electrolysis and derived commodities.
- **Idealised outcomes:** Results indicate potential import/export roles but represent ideal conditions.
- **Need for broader analysis:** Must be complemented with economic, political, social and institutional considerations !

Same WACC Scenario — Trade Volumes

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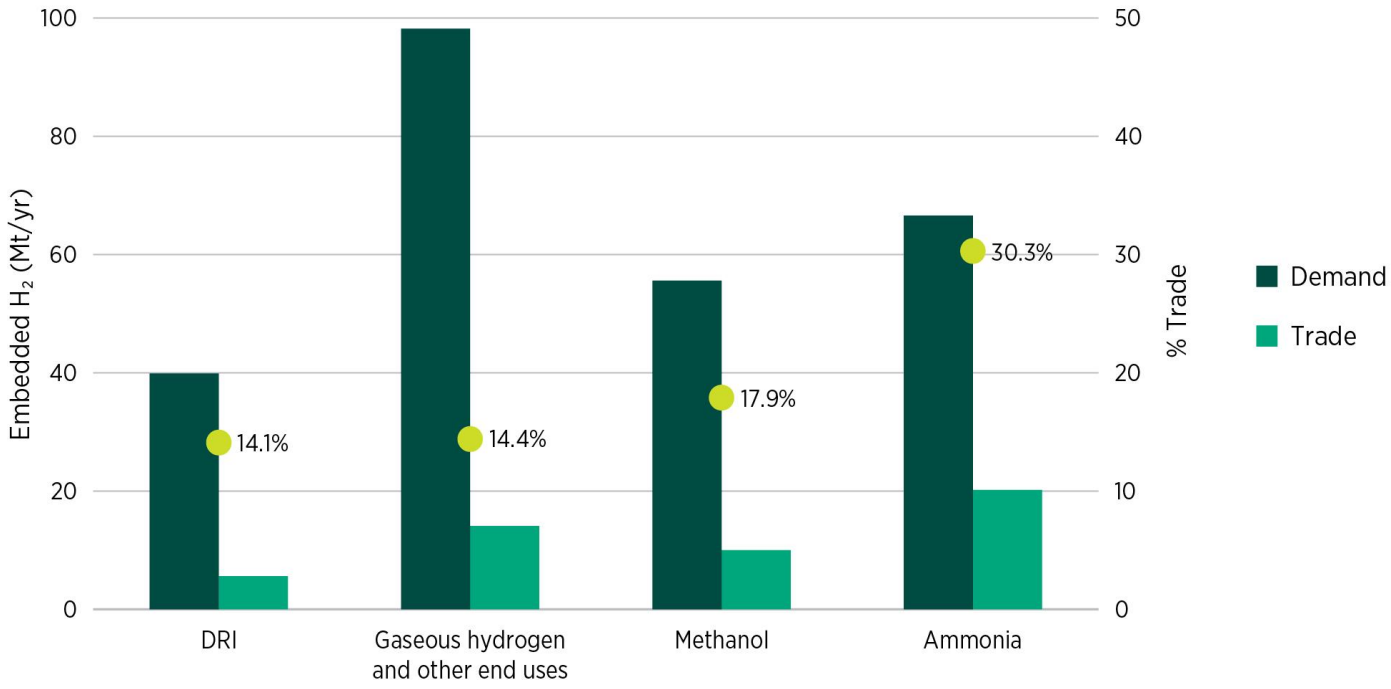
- Approx. **20% of global demand** traded (≈53 Mt H_2-eq).
- Commodity trade dominates: **≈72%** of total hydrogen-equivalent traded.
- Shares traded:
  - 30% ammonia
  - 18% methanol
  - 14% DRI
  - 14.4% gaseous hydrogen



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Same WACC Scenario — Global Trade Patterns

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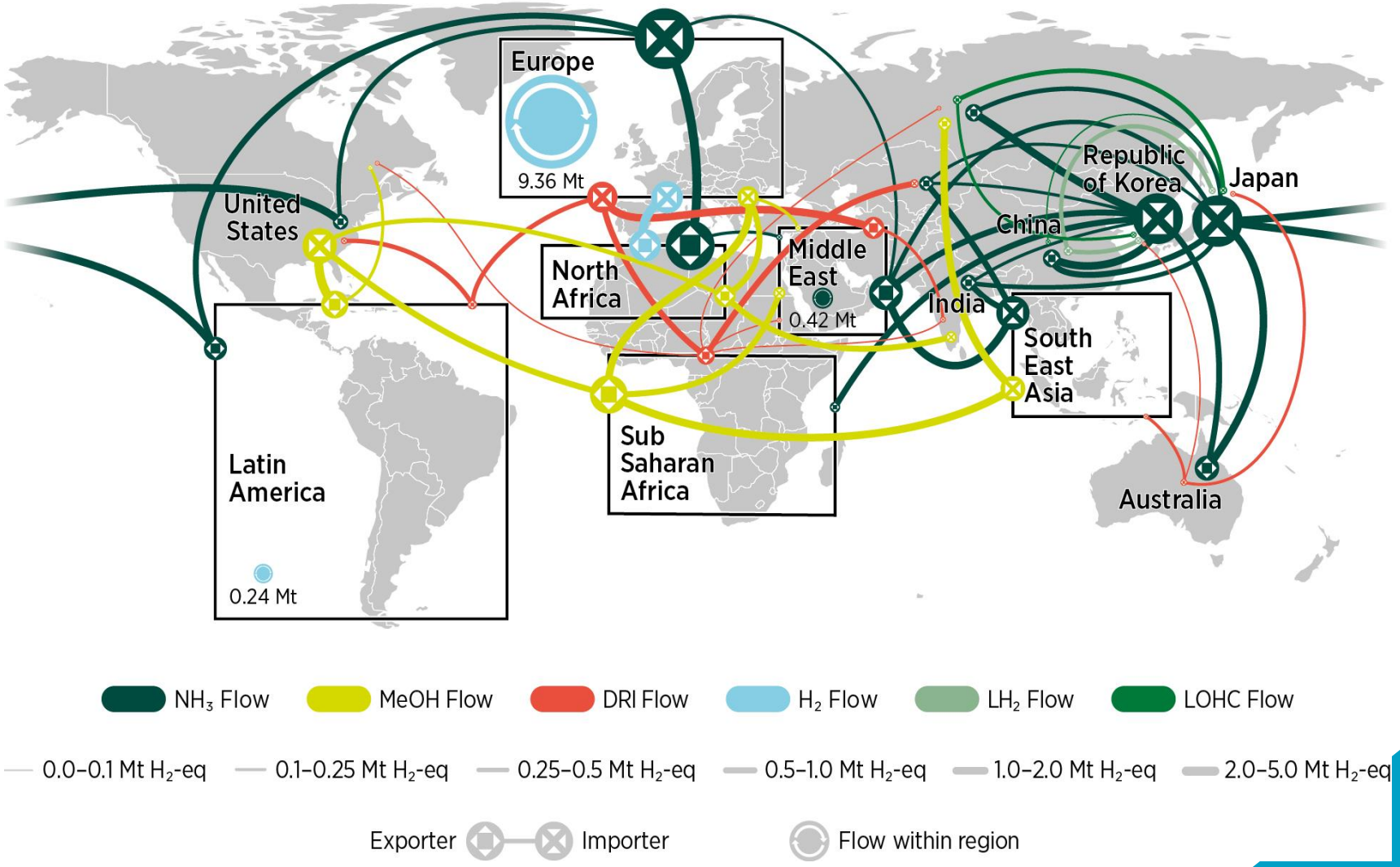
- Gaseous hydrogen trade concentrated in **EU–North Africa** and intra-EU pipelines.
- **Major exporters**: Latin America, Middle East, North Africa, Sub-Saharan Africa.
- **Major importers**: Europe, Japan, Korea, Southeast Asia.
- Methanol trade also driven by **biogenic carbon availability.**
- DRI trade also shaped by **iron ore distribution**.



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Same WACC Scenario — Exporters & Importers

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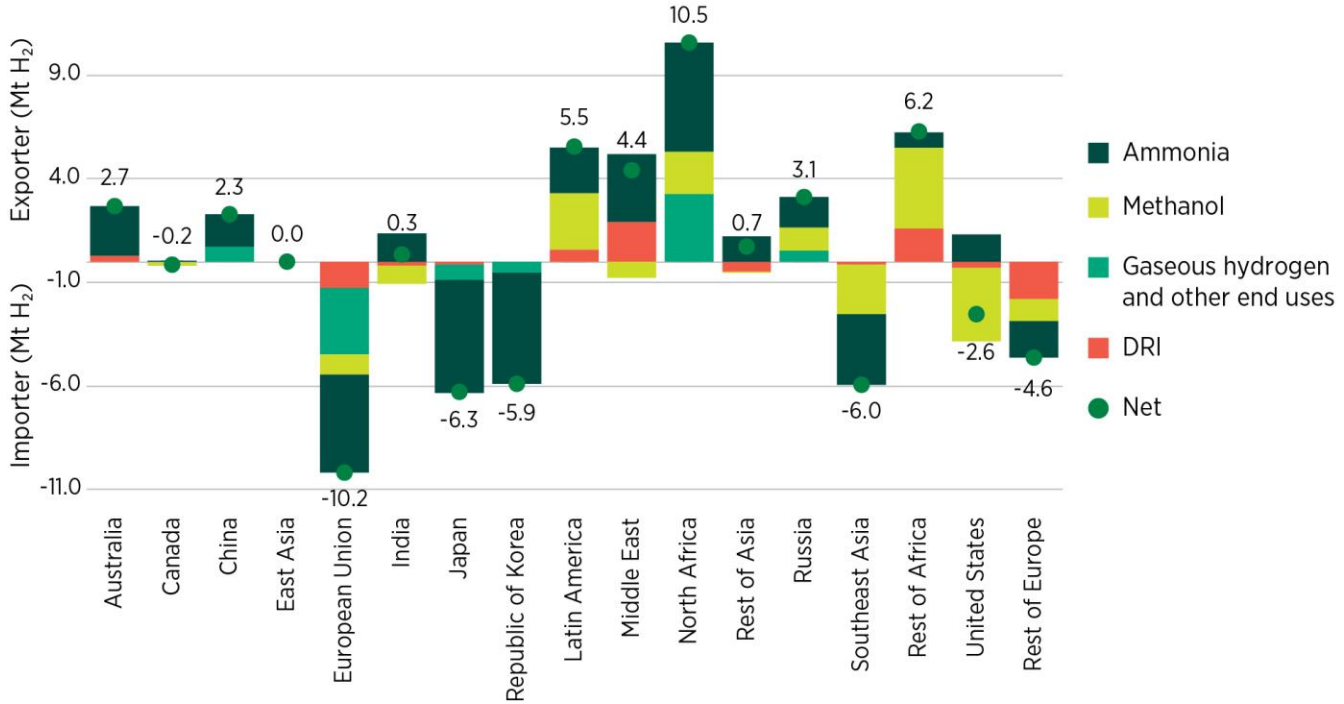
- **Net exporters**: Latin America, Middle East, North Africa, Sub Saharan Africa.
- **Net importers**: EU, Japan, Korea, Southeast Asia.
- Middle East imports MeOH (biogenic carbon constraint) but exports ammonia and DRI.



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Differentiated WACC Scenario — Global Trade Patterns

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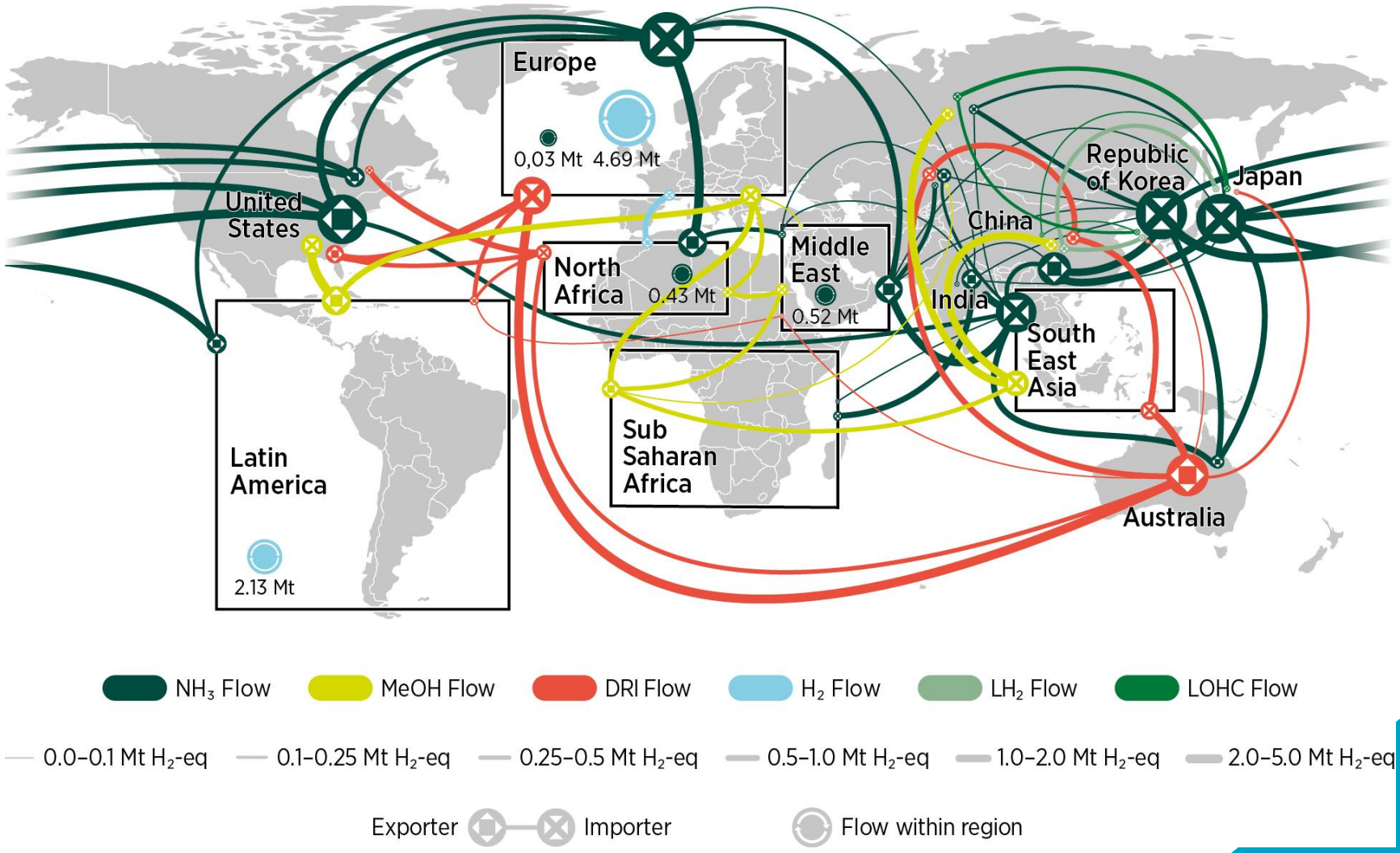
- **Financing** conditions significantly alter **competitiveness.**
- New major exporters emerge: **Australia, China, USA.**
- **Africa and Middle East lose competitiveness** under higher WACC.
- EU import needs **decrease** from 10.2 Mt → 7.1 Mt.
- **Australia dominates DRI exports** under differentiated WACC assumptions.



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Scenario Comparison & Sensitivities

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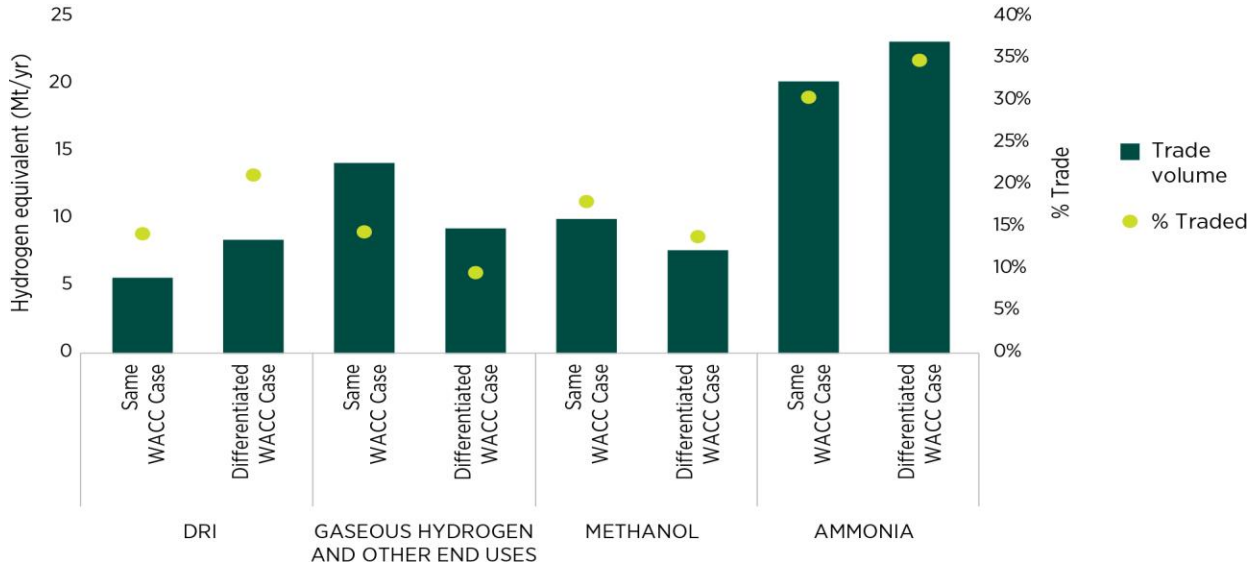
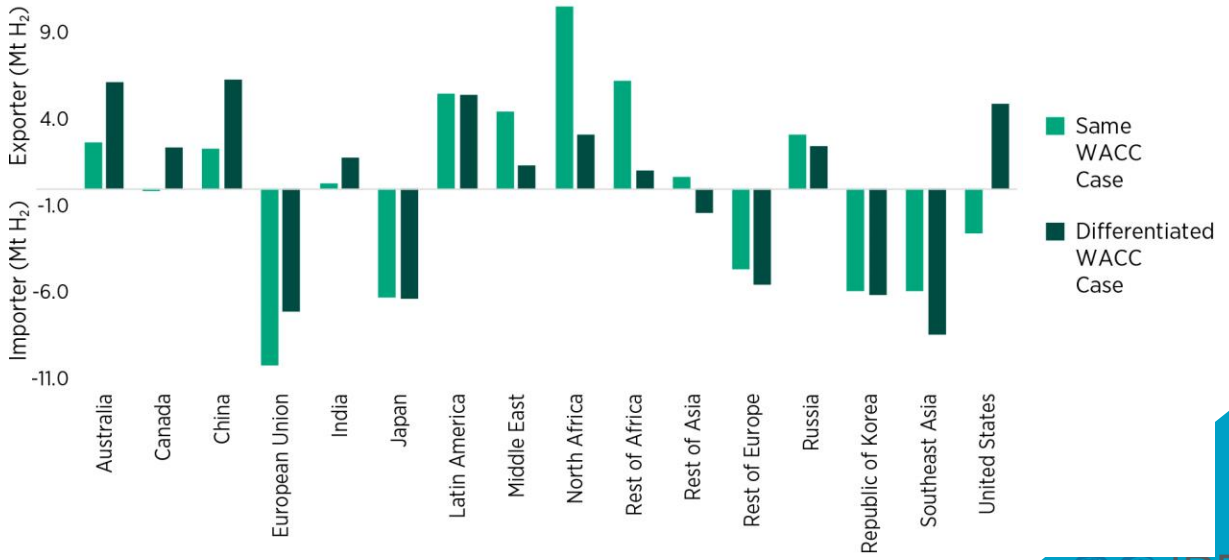
- DRI trade **rises** from 14% → 21% between scenarios.
- Hydrogen gas trade **drops** 14% → 9%.
- Ammonia trade **increases**: 30% → 35%.
- Methanol trade **decreases**: 18% → 14%.
- Sensitivities:
  - Higher VRE costs → **more trade** globally.
  - Higher transport costs → **more local production**.
  - Electrolyser cost uncertainty → relatively less effect.
  - 8% uniform WACC → slightly reduced trade volumes.





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Infrastructure Requirements (2050)

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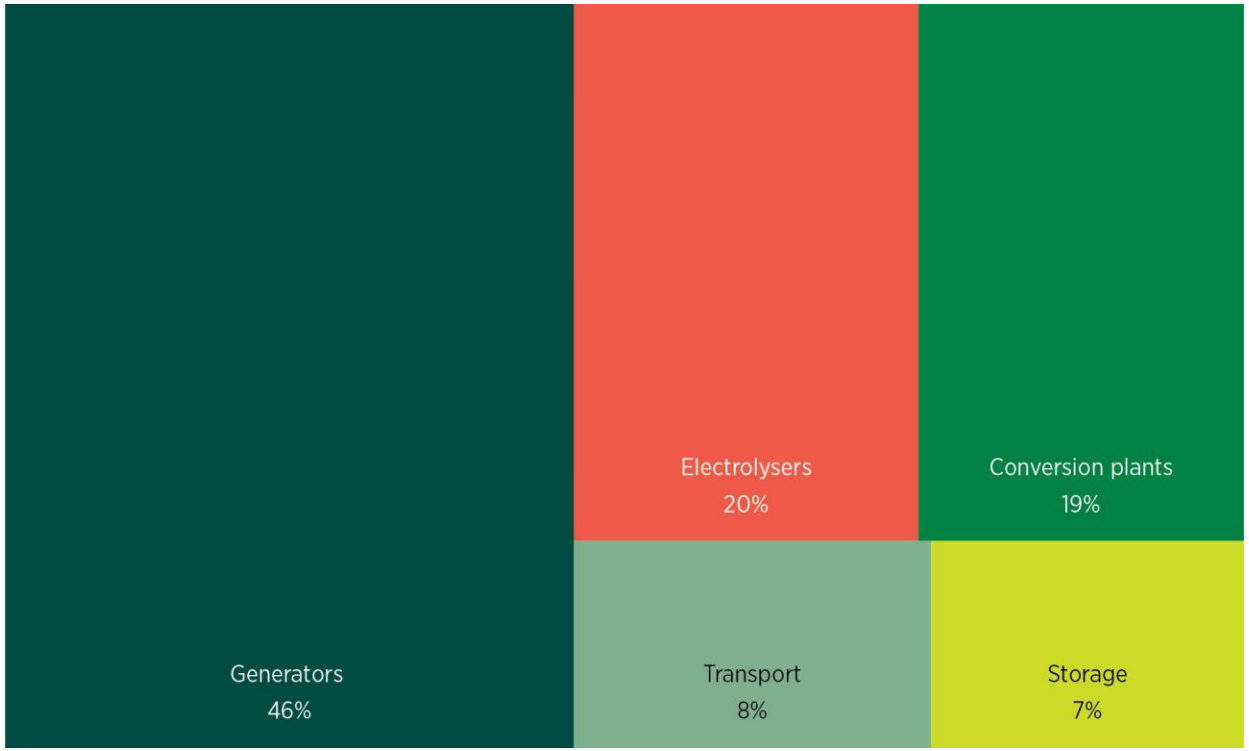
- Includes:
  - 4.7 TW renewable electricity capacity
  - 2.1 TW electrolysers
  - 0.9 TWh storage
  - Shipping, pipelines, storage, conversion plants.
- Infrastructure must scale from **near-zero today**.



Key Insights & Conclusions

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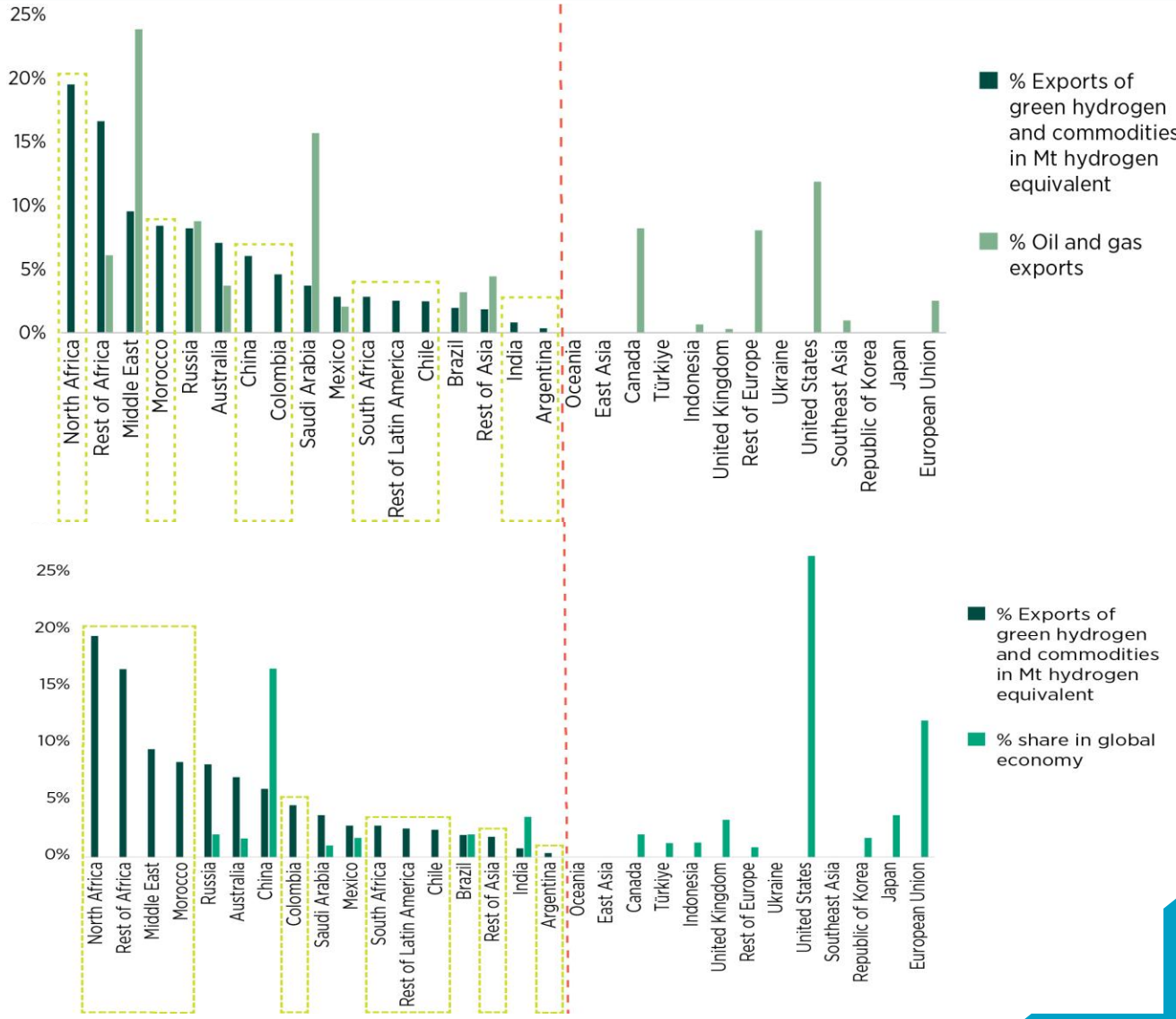
1. Hydrogen-based **commodities** expected to **dominate** international trade (73–80%).
2. Stable **demand creation** is essential
3. **Certification** for hydrogen-based commodities is equally important
4. Significant **investment** is required across the hydrogen value chain
5. **Financing conditions** (WACC) are a critical determinant of competitiveness
6. Green hydrogen and its commodities can enhance **energy security**
7. Trade can support a **just and inclusive** energy transition
8. International **cooperation** is necessary
9. **Customised** policies and **local infrastructure** critical



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Q & A
5 min

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Scope of Hydrogen Trade Model