Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

Energiepartnerschaft Viet Nam – Deutschland

Assessment of green hydrogen export potential of Viet Nam.

A study prepared for GIZ Vietnam

Agenda

- Synthesis of the study
- Methodology
- Key findings
- Conclusions
- Recommendations

Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

Synthesis of the study

Synthesis of the Study

The core focus of the study:

To investigate the competitiveness of green hydrogen (GH2) production and exports from Viet Nam to world markets

For exports to:

Synthesis of the Study

The specific objectives of this assignment are

- Estimate GH2 production potential and its levelized cost of production (LCOH)
- Estimate the shipment cost of GH2 and green ammonia (NH3) from Viet Nam to potential importing countries
- Conduct a quantitative and qualitative analysis to identify and evaluate the potential export for GH2 and green NH3 from Viet Nam to potential importing countries.

Synthesis of the Study

GH2 production

Renewables-based electrolysis analysed:

- Dedicated plants
- Single technology (solar, onshore, offshore wind)
- Hybrid configuration (solar + onshore wind)

Transportation

Three **hydrogen carriers** assessed:

- Liquid hydrogen (LH2)
- Ammonia (NH3)
- Liquid organic hydrogen carrier (LOHC)

Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

Methodology

Methodology

Scope of the study

1

Geospatial analysis

2

Estimation of green hydrogen export potential and cost

3

Methodology

Scope of the study

1

- RE technology: dedicated solar PV and onshore wind power plants
- Electrolyser type: PEM (Polymer electrolyte membrane)
- Timeline: 2022 – 2050

Methodology

Geospatial analysis

2

- Modelling of the geographical distribution and area coverage of solar and wind resources
- Data from the Global Solar Atlas of the World Bank Group
- Wind data from the Global Wind Atlas 3.1 (GWA) of the Technical University of Denmark and the World Bank Group

Methodology

Estimation of green hydrogen export potential and cost

3

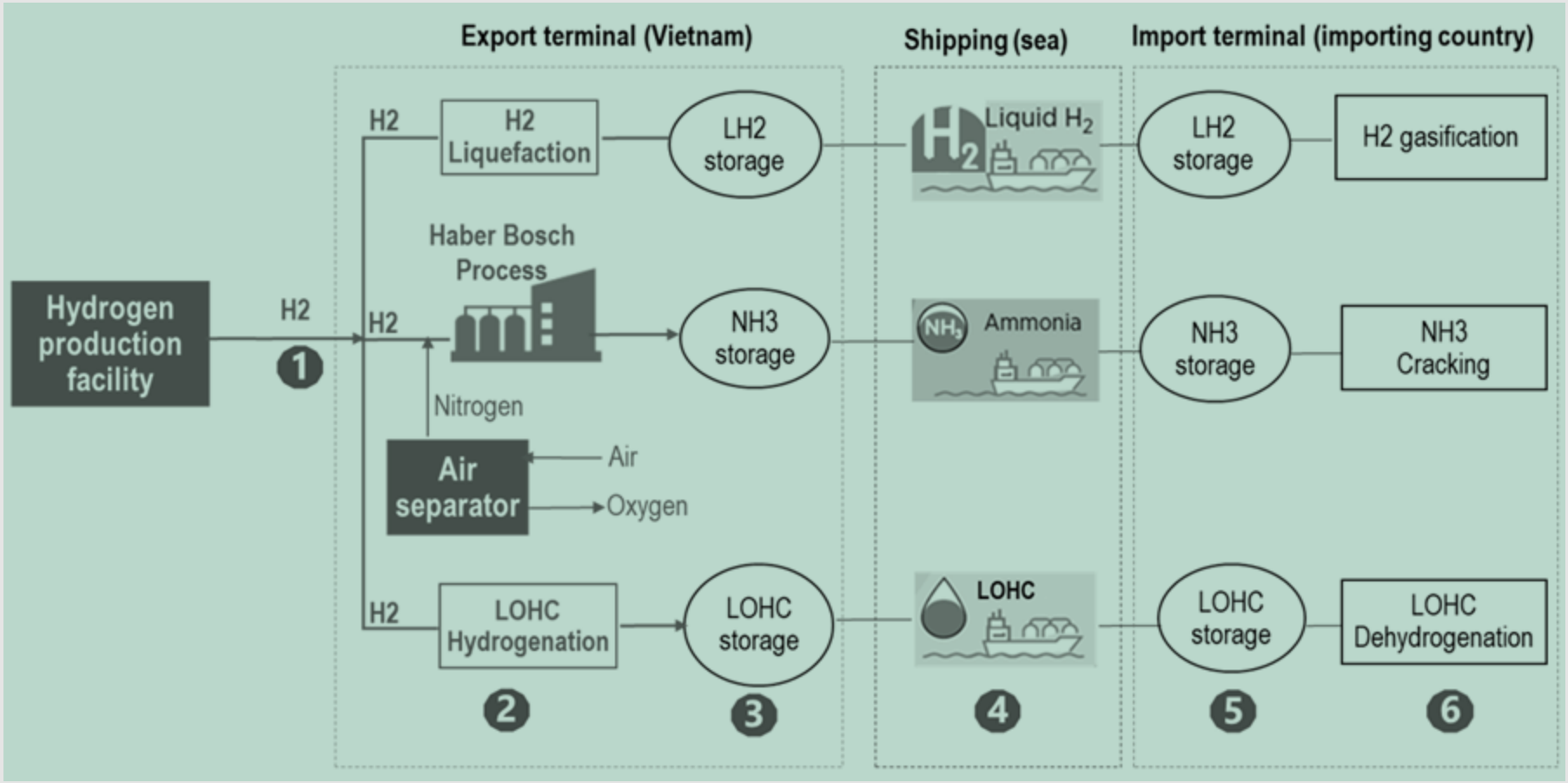
LCOH simulations

Selection of the simulations with low LCOH

GH2 potential estimation

NH3 potential and cost calculation

Methodology



Key findings

Viet Nam has several advantages in terms of GH2 production but also faces a few critical challenges.

Key Findings

Inputs to Calculate Total GH2 Delivery Costs

Key Findings

GH2 Production

Advantages Challenges

GH2 Production

Advantages

I. Stable and forward-looking energy policy framework

II. Large and diverse renewable energy industry

III. Proximity to major importers in the Asia-Pacific region

IV. Strong renewable energy resource potential

V. Low political risk

Key Findings

GH2 Production

Advantages
Challenges

GH2 Production

Challenges

I. Limited land availability when compared to other major potential exporting countries, such as Australia, Chile, and Morocco;

II. Slightly lower resource quality than some of the other potential competitors, in particular solar.

III. Greater geographic distance to the EU (and hence, higher GH2 shipping cost)

IV. Higher cost of capital than many other potential exporting countries such as Australia or Chile.

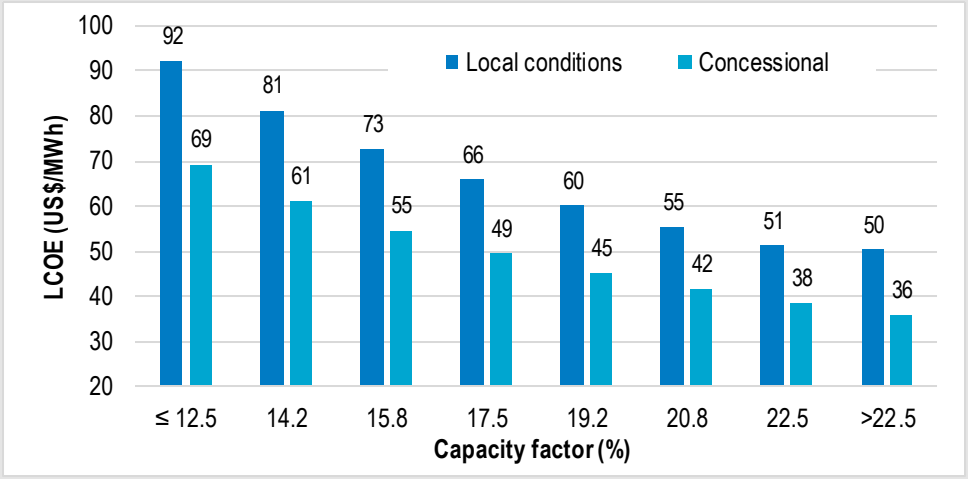
Key Findings

Modelling Electricity prices

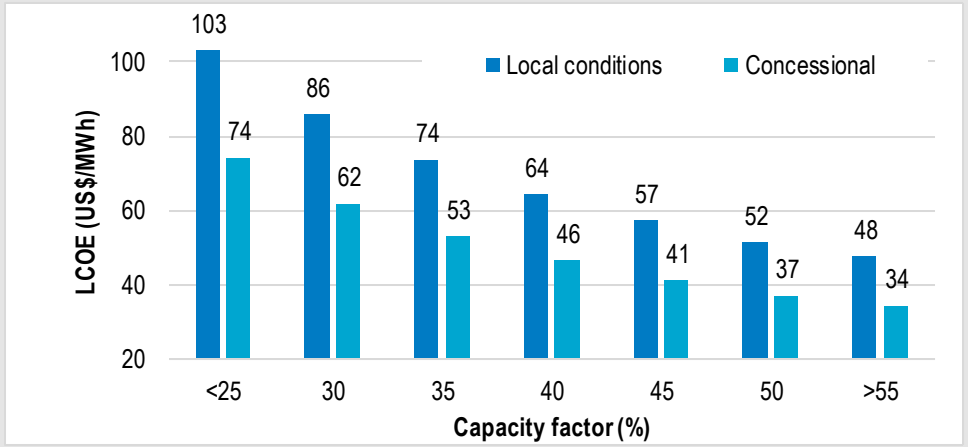
The original “base case” (before high-interest rates)

GH2 Production costs

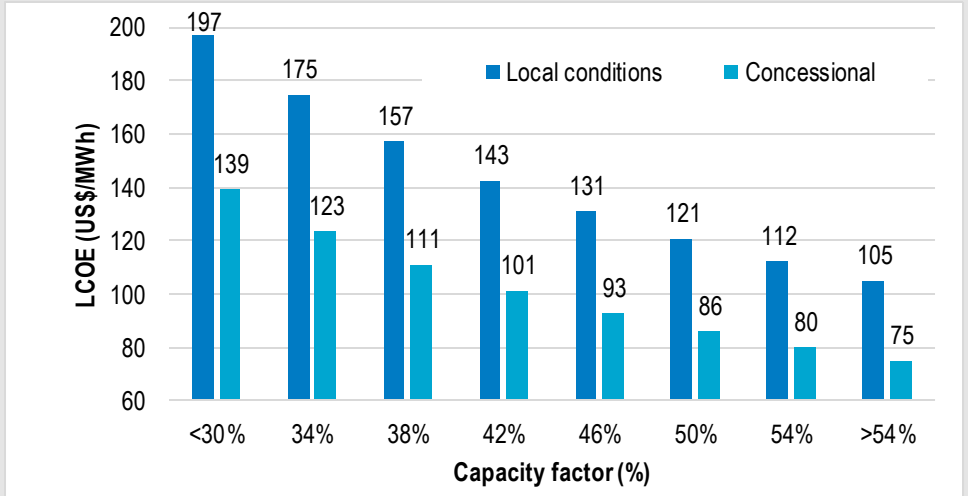
Solar PV



Onshore Wind



Offshore Wind



Key Findings

GH2 Production costs

GH2 Production

The original “base case” (before high-interest rates)

TECHNOLOGY	SCENARIO	MIN	MEDIAN	MAX
Solar PV	Local conditions	3.76	4.86	6.88
	Concessional	2.84	3.63	5.14
Onshore wind	Local conditions	2.79	3.63	5.44
	Concessional	2.09	2.65	3.97
Offshore wind	Local conditions	4.73	6.08	8.43
	Concessional	3.45	4.43	6.02

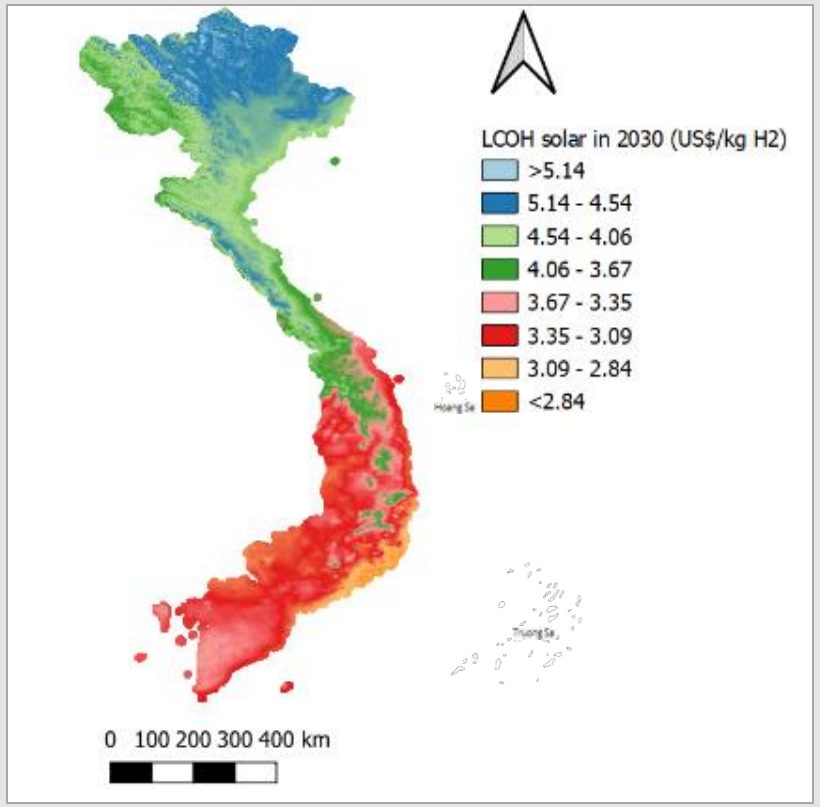
Key Findings

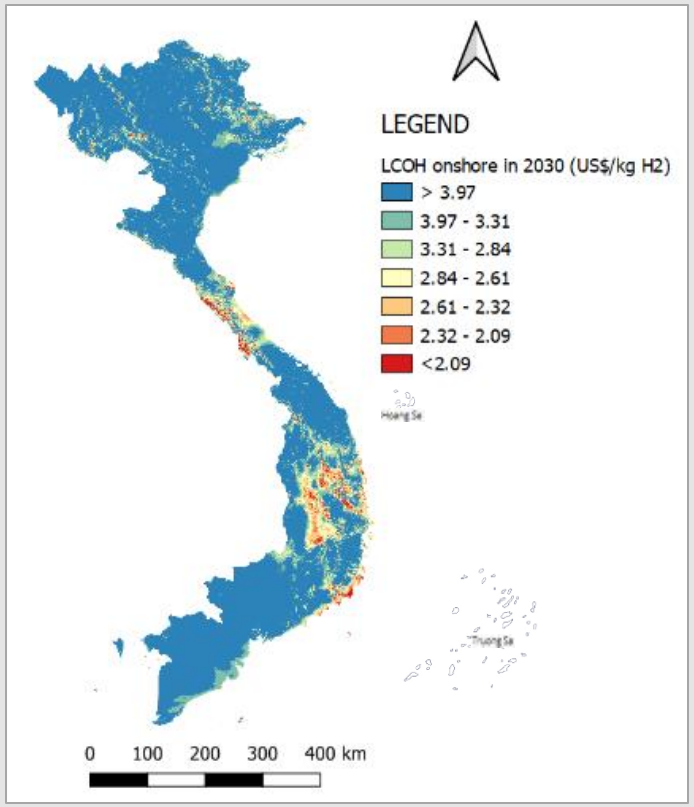
GH2 Production costs

GH2 Production

Costs:

Original ”Base case”

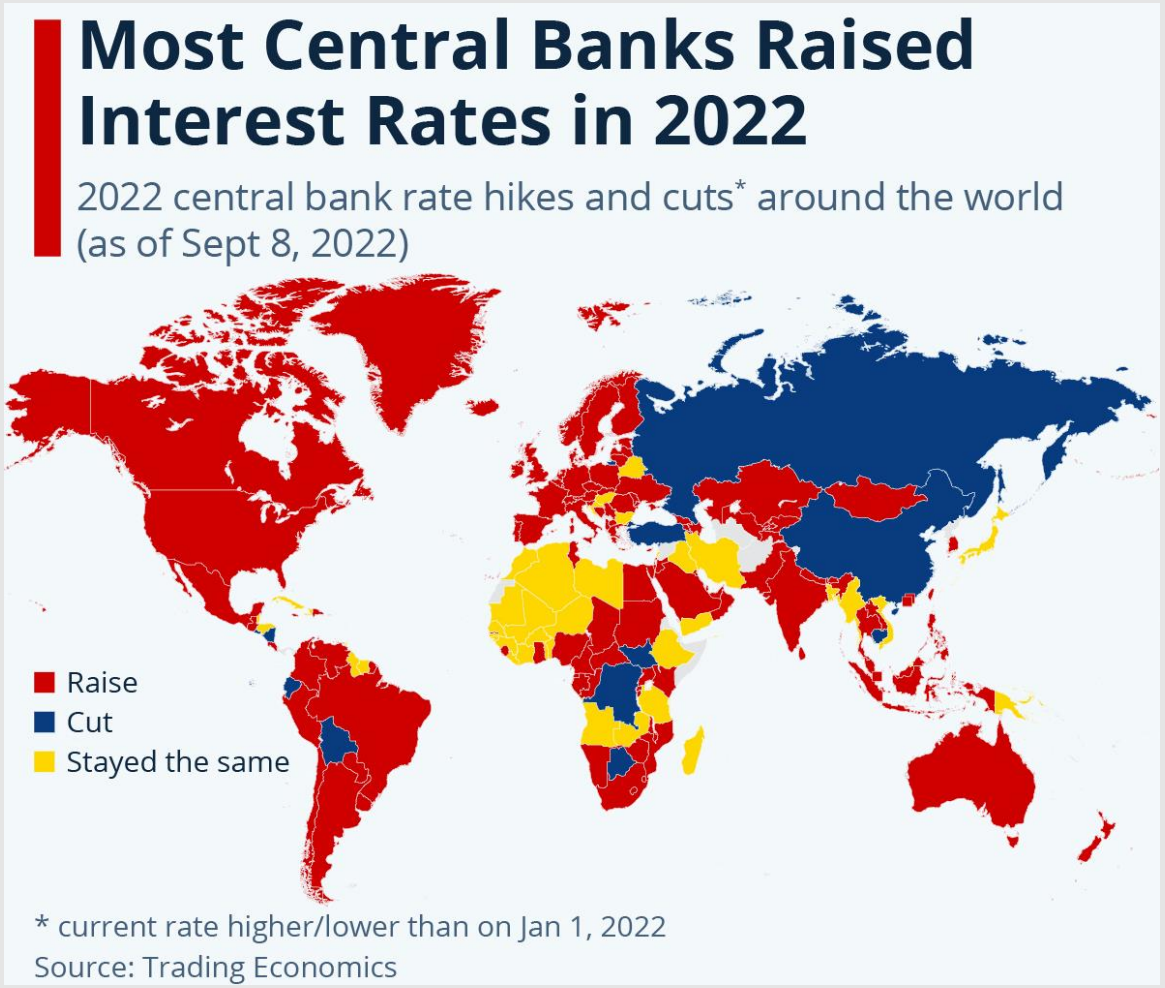




Key Findings

GH2 Production costs

- In line with other major central banks, Viet Nam's State Bank of Vietnam (SBV) introduced **two consecutive interest rates increases** of 100bps, one in September and a second in October 2022.



Key Findings

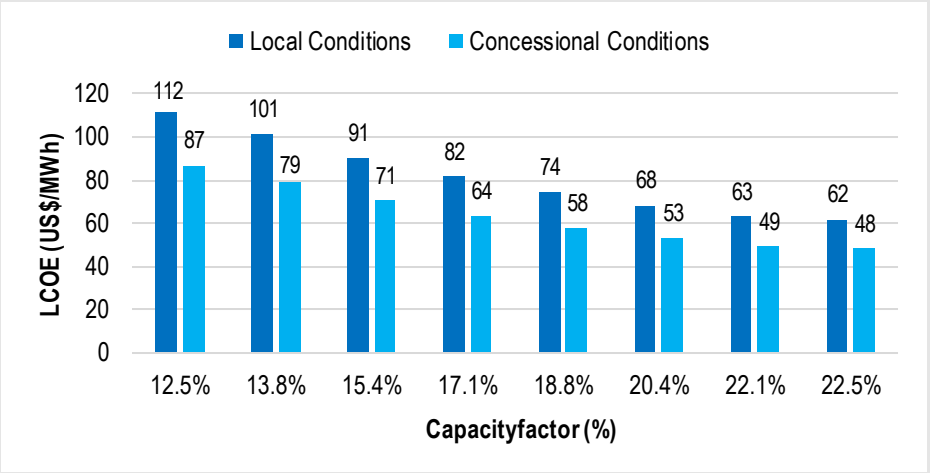
Modelling Electricity prices

The updated case (After high-interest rates)

GH2 Production costs

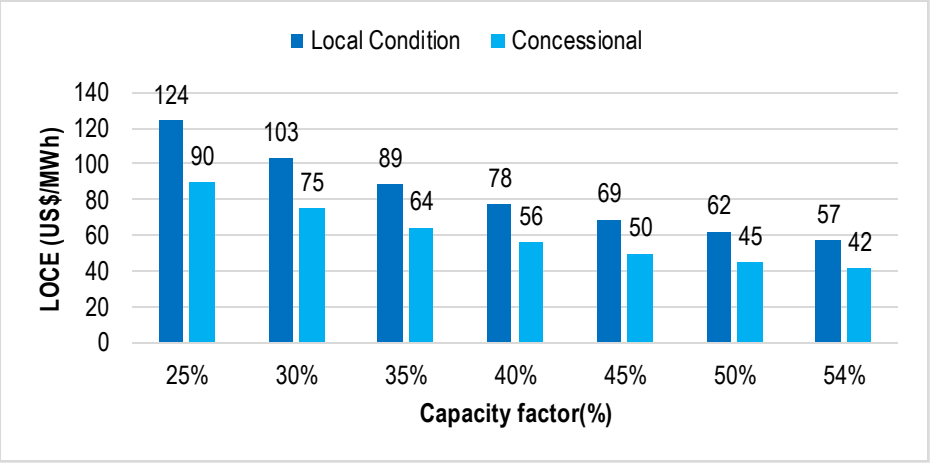
Solar PV

+ 20 - 24%



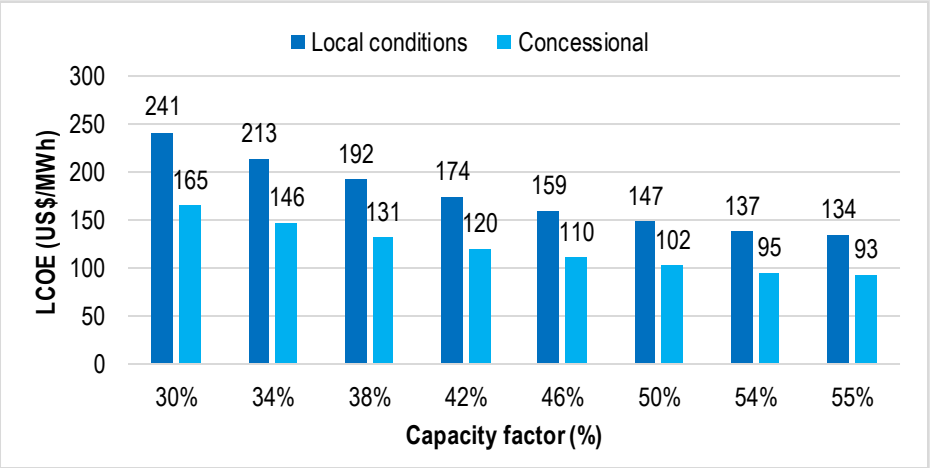
Onshore Wind

+ 18 - 21%



Offshore Wind

+ 19 - 23%



Key Findings

GH2 Production costs

GH2 Production

The updated case (After high-interest rates)

TECHNOLOGY	SCENARIO	MIN	MEDIAN	MAX
Solar PV	Local conditions	4.56	5.9	8.35
	Concessional	3.5	4.53	6.41
Onshore wind	Local conditions	3.4	4.5	6.7
	Concessional	2.5	3.2	4.8
Offshore wind	Local conditions	10.5	7.5	5.8
	Concessional	7.2	5.2	4.1

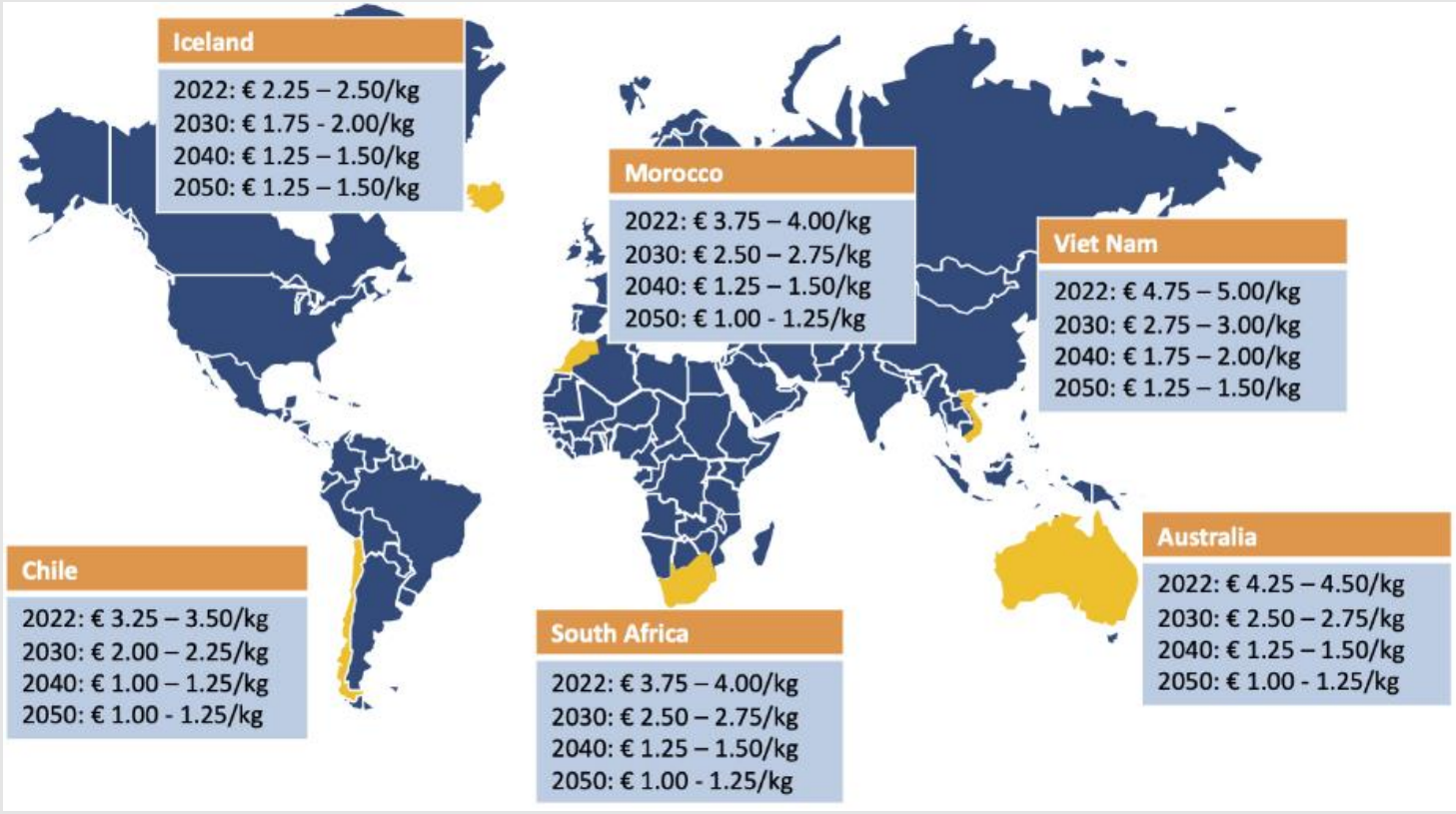
Key Findings

GH2 Production costs

GH2 Production

Costs

- The production cost of GH2 in Viet Nam is currently slightly higher than in other major competing markets like Australia, Chile, and Morocco.
- The cost differential is expected to narrow over time



Source: based on data from PwC (2022). https://www.pwc.com/gx/en/industries/energy-utilities-resources/future-energy/green-hydrogen-cost.html

Key Findings

GH2 Shipping costs

Shipping

Key Parameters

- Energy costs for H2 liquefaction
- Conversion of H2 to NH3 and vise-versa
- LOHC dehydrogenation

Key Findings

GH2 Shipping costs

Shipping

Key Parameters

01 Cost for converting pure hydrogen into LH2, NH3 and LOHCs

02 Cost of storing LH2, NH3 or LOHCs in ports before their shipment

03 Transportation cost from export terminal to the terminals in importing countries

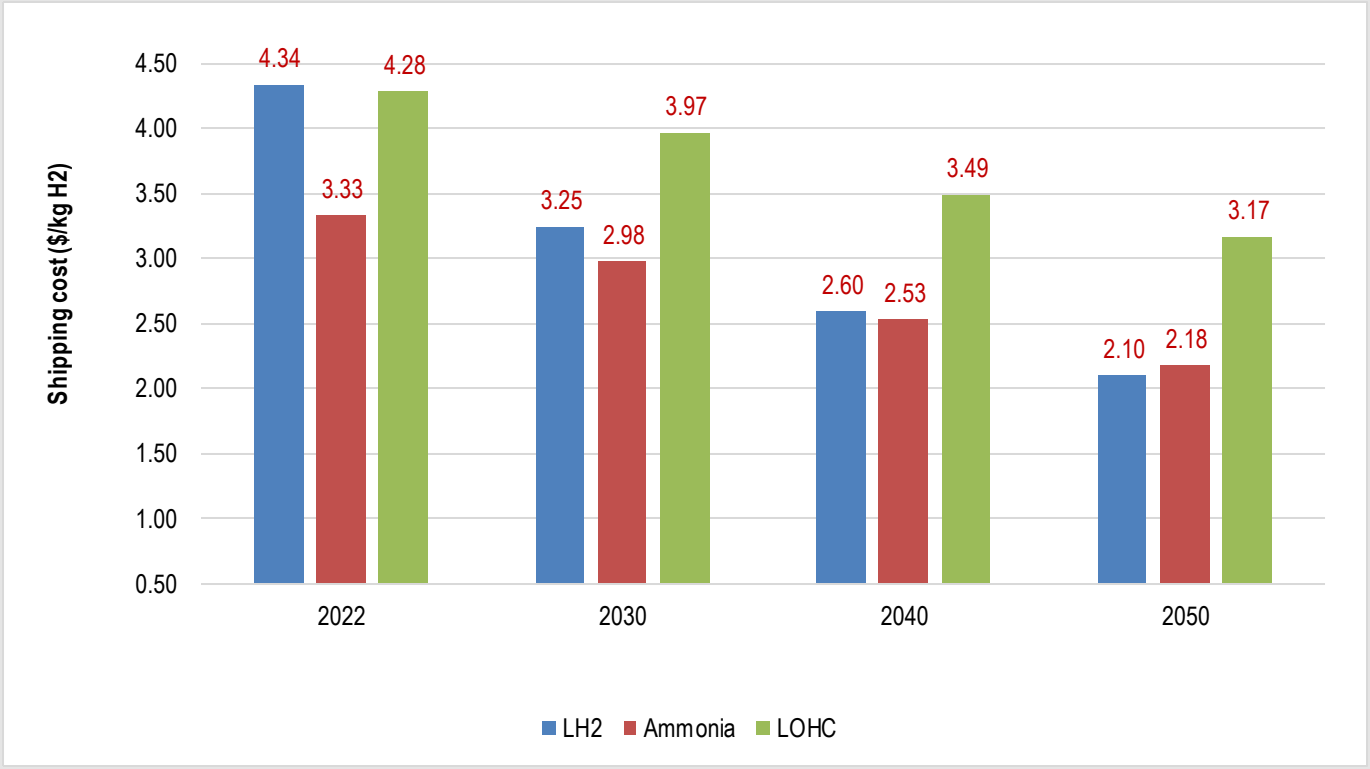
04 Boil-off gas (BOG) cost for LH2 and NH3

05 Cost of re-converting NH3 and LOHCs to pure hydrogen

Key Findings

GH2 Shipping costs

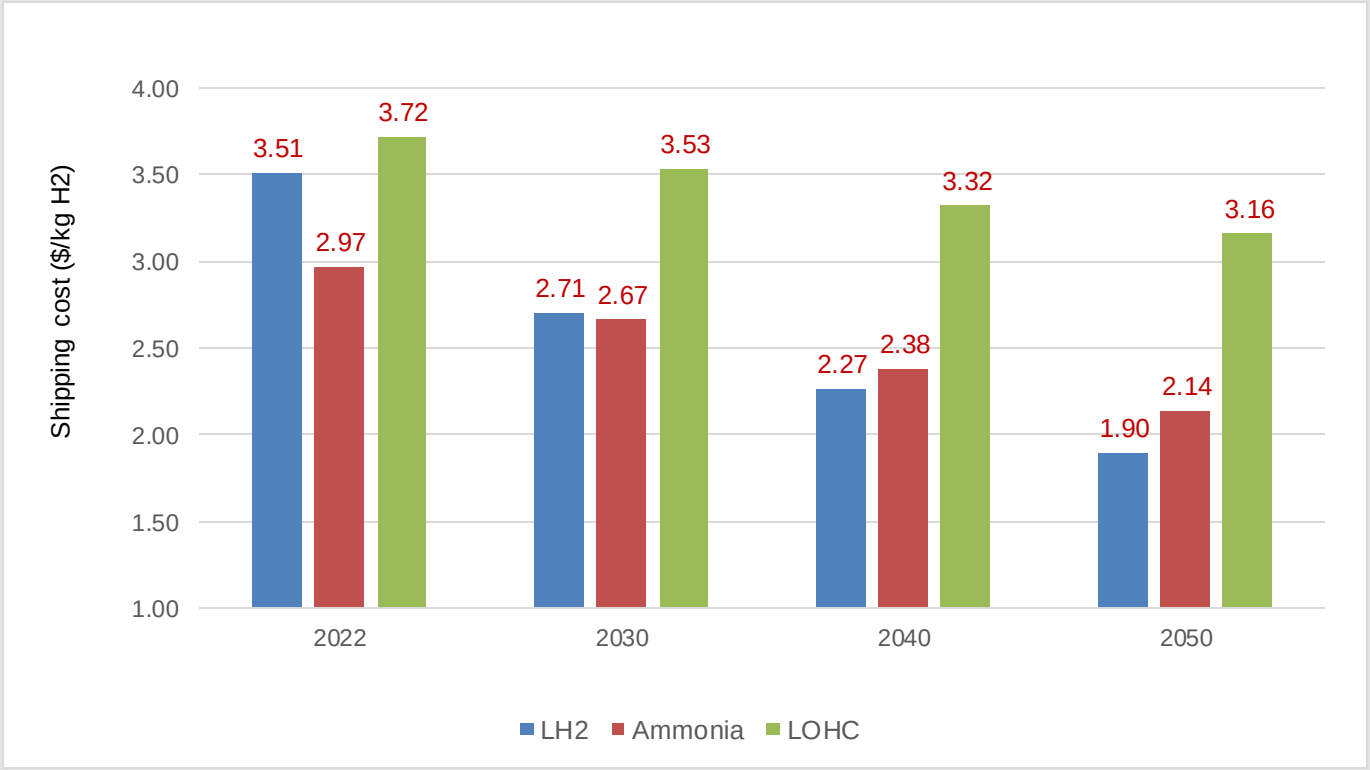
Shipping Costs (Europe)



Key Findings

GH2 Shipping costs

Shipping Costs (Japan)

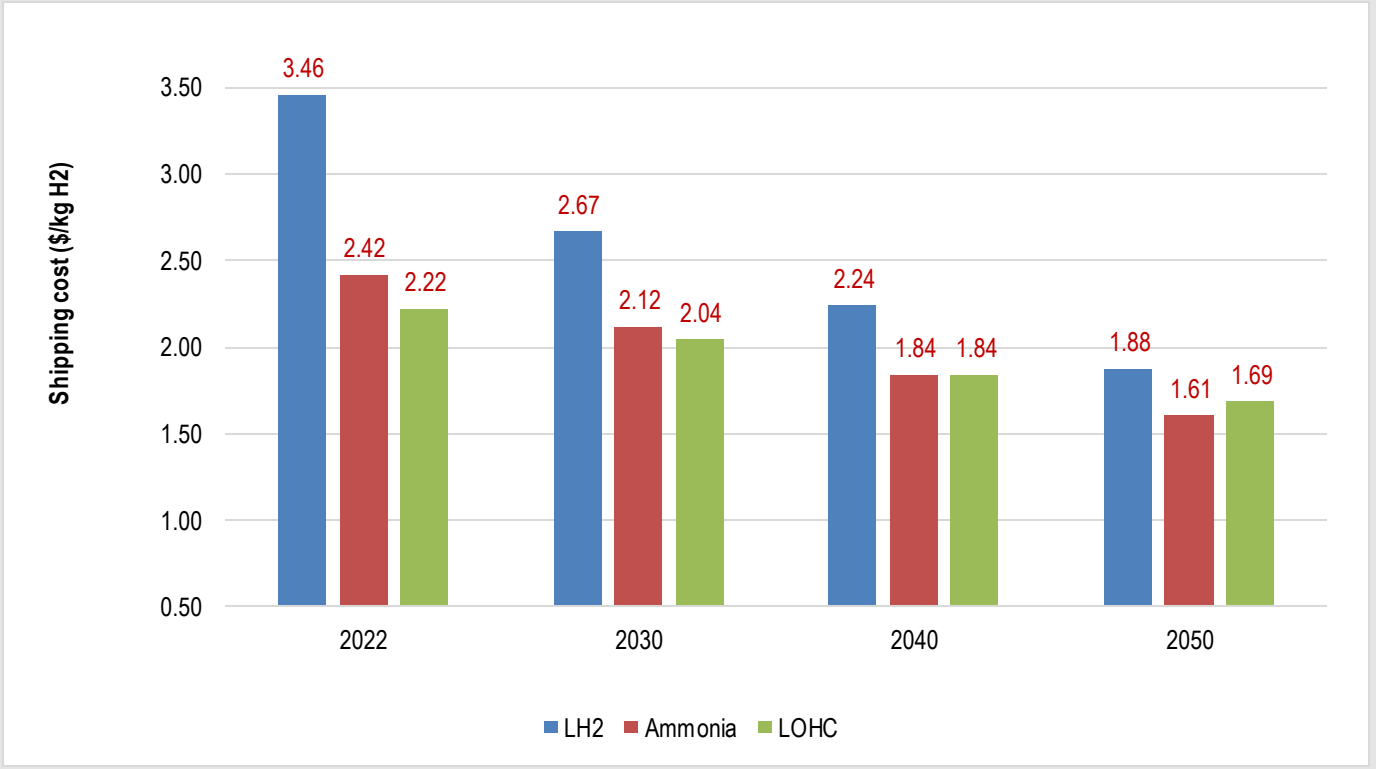


Key Findings

GH2 Shipping costs

Shipping Costs (South Korea)

The lower cost of shipping hydrogen using ammonia and LOHC is explained by the comparatively lower electricity price in South Korea of 0.075 US$/kWh for businesses.



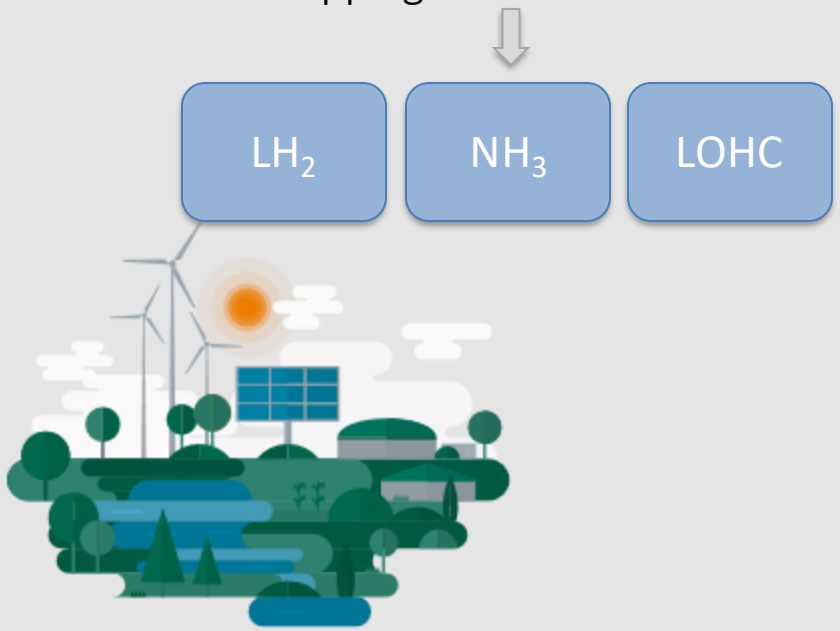
Key Findings

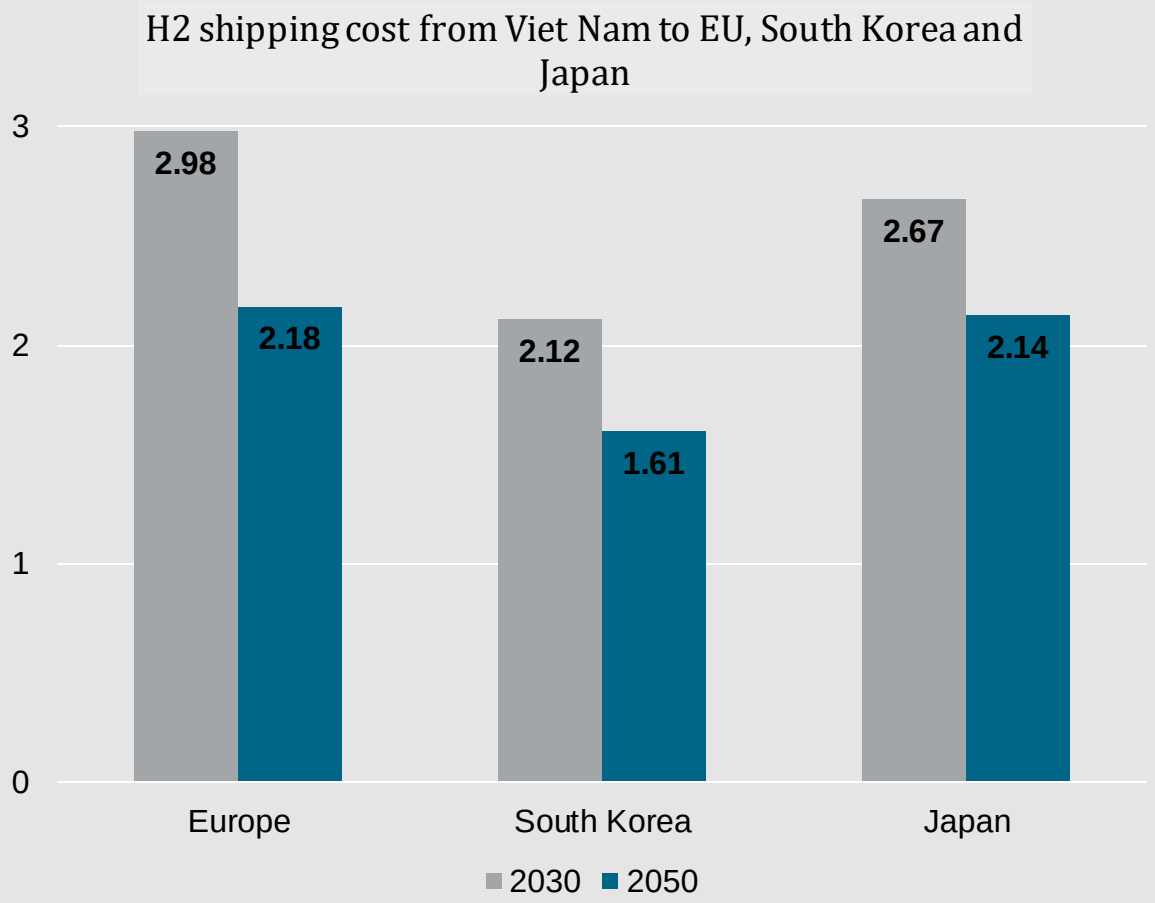
GH2 Shipping costs

Shipping

Costs

The cost of shipping varies with the carrier used.





Key Findings

GH2 Shipping costs

Shipping

Costs

NH_3 (Ammonia) is emerging as the most feasible option

Shipping cost is relatively lower compared to LH2 and LOHC

Shipping costs can drop further if part of the delivered NH_3 is used directly (e.g., in fertilizer production)

Key Findings

GH2 Shipping costs

Shipping

Costs

- Viet Nam is approximately 5-7 times farther from key EU ports than other major potential competitors such as Morocco.
- Shipping adds significant additional costs and losses

Shipping costs are therefore expected to represent roughly 50% of total LCOH delivery costs (i.e., production + transport) by 2030

Transportation

The estimated cost of shipping to Japan and South Korea ranges from USD 2 – 3/kg of GH_2, depending on the carrier used :

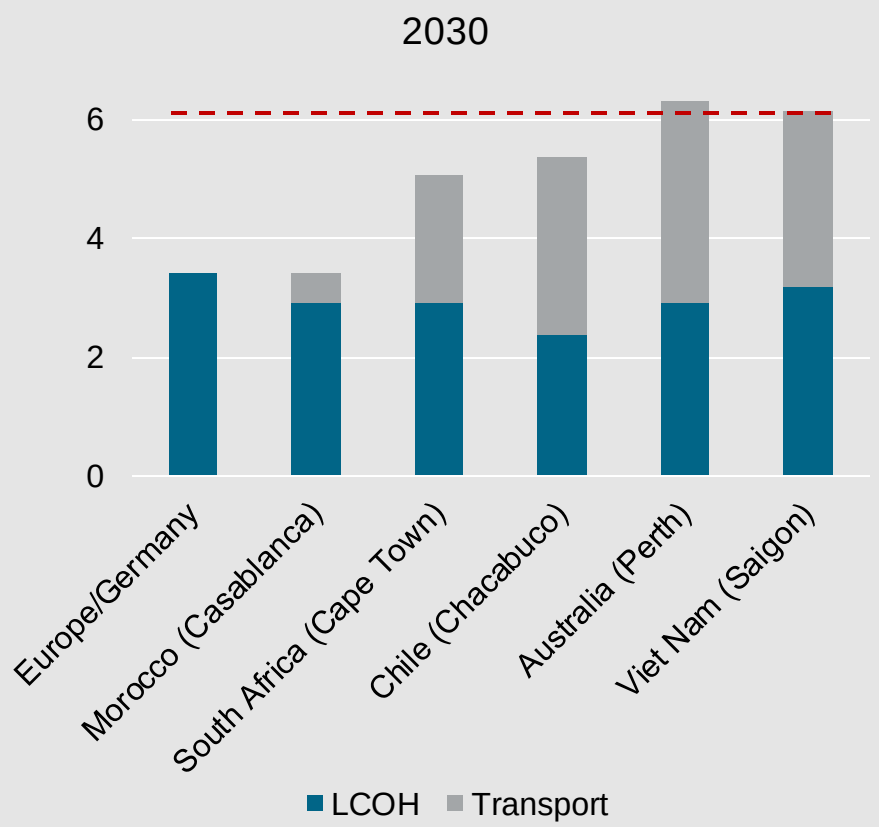
- Liquid hydrogen (LH_2)
- Ammonia (NH_3)
- Liquid organic hydrogen carrier (LOHC)

Key Findings

Total GH2 Delivery costs

Shipping

Costs (Europe)

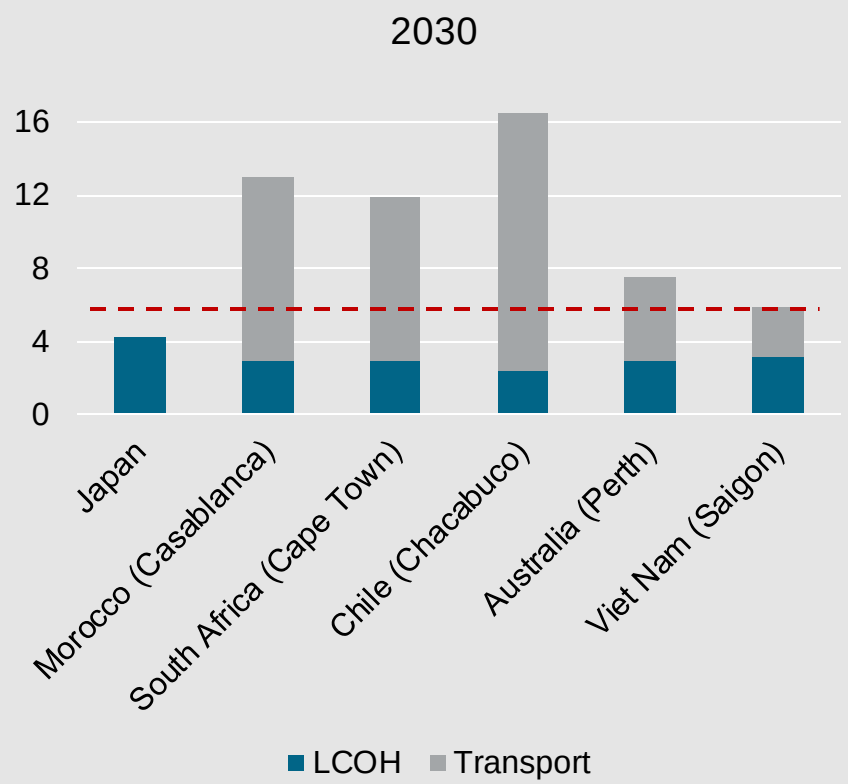


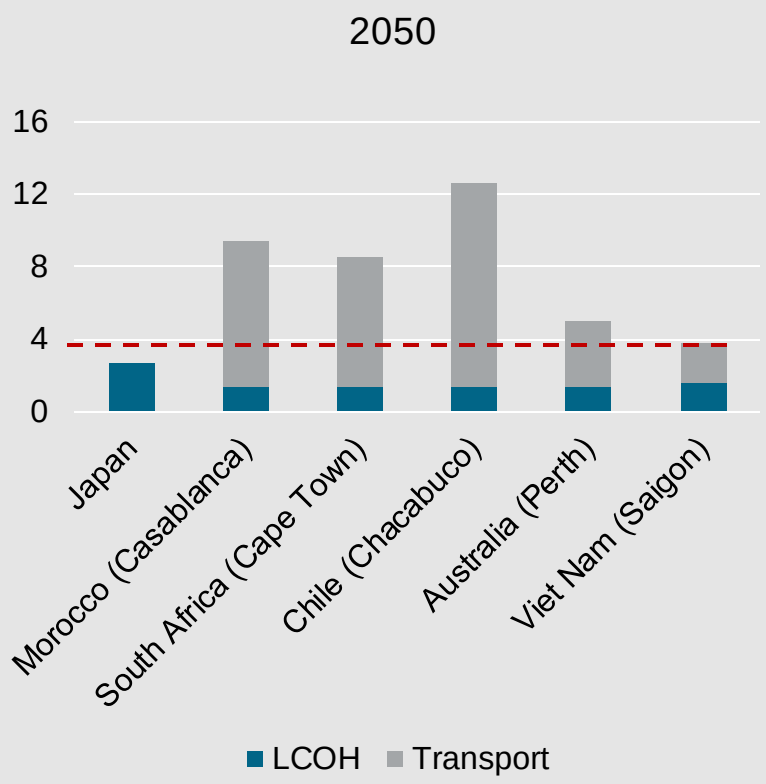
Key Findings

Total GH2 Delivery costs

Shipping

Costs (Japan)



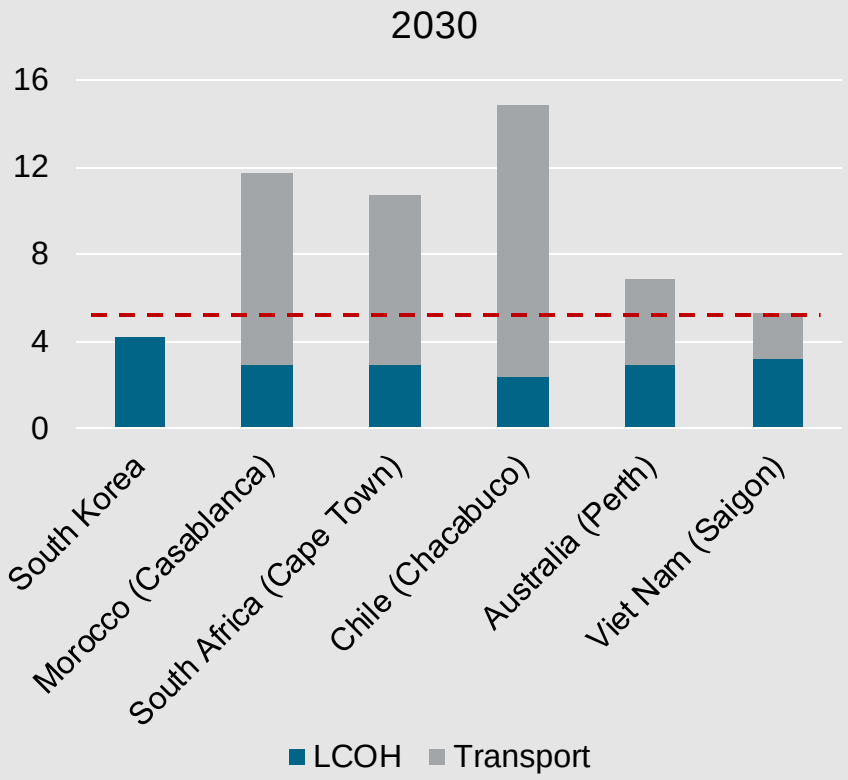


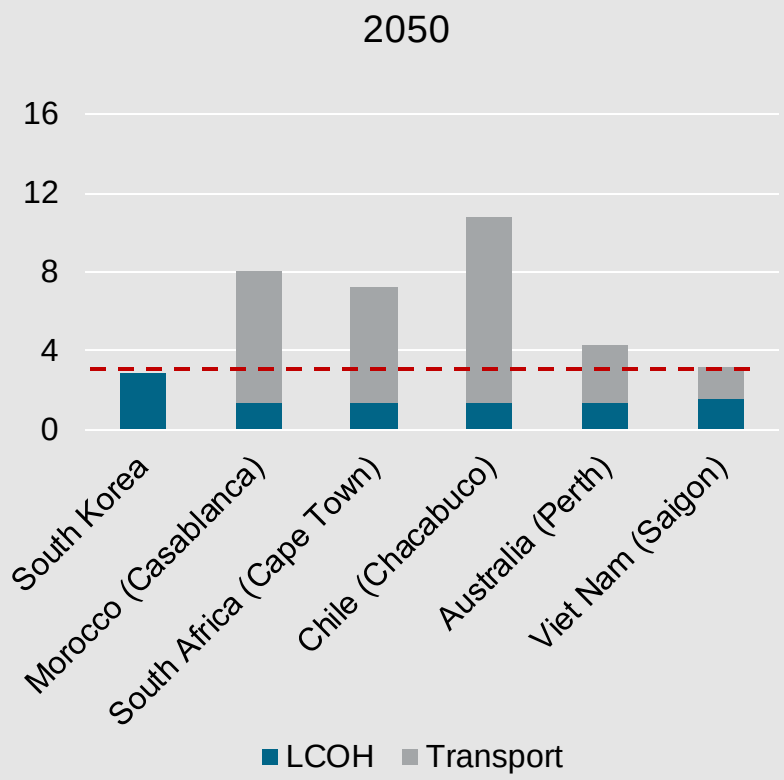
Key Findings

Total GH2 Delivery costs

Shipping

Costs (South Korea)





Options to Increase Domestic Demand of GH2

Encouraging Domestic Demand

Refineries

A major amount of hydrogen is produced and consumed on-site in refineries. Viet Nam currently has **two refineries** (Dung Quat Refinery Plant and Nghi Son Refinery Plant). (Grey) hydrogen demand at these refineries stands at 177 thousand tons per year.

Viet Nam is planning to expand Dung Quat (Decision 1623/QD-TTg dated 25/11/2017) and to add new refineries in the coming years (Van Phong Refinery Complex and Long Son Oil Refinery Plant by the early 2030s)

This points to significant opportunities to increase demand for green hydrogen.

Encouraging Domestic Demand

Power sector

NH3 is used to remove NOx in coal-fired power plants. Viet Nam's coal–fired power plants are estimated to consume about 2.0 - 2.5 million tons of NH3 per year (equivalent to 0.36 – 0.45 million tons of H2 per year) to remove NOx to meet environmental standards QCVN 22:2009/BTNMT.

Also, hydrogen can be converted to ammonia and used in coal-fired power plants. Currently, some countries have been testing co-firing ammonia in existing coal plants, including Japan, Chile, and the U.S.

Japan's demonstration project runs for about four years through March 2025 with a target of achieving a co-firing rate of 20% at a 1 GW coal power plant at Hekinan.

Source: https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/053122-japans-jera-to-advance-20-ammonia-co-firing-at-hekinan-by-a-year-to-fy-2023-24

Encouraging Domestic Demand

Chemical industry

There is also potential for the greater use of GH2 and Green Ammonia in the chemical sector.

For fertilizer plants, hydrogen is used to synthesize ammonia for urea production. Viet Nam has several fertilizer plants (Phu My, Ca Mau, Ninh Binh, Ha Bac). Like Viet Nam's refineries, these plants rely mainly on **grey hydrogen**.

Table 30 Summary the amount of hydrogen produced and consumed in fertilizer plants

Fertilizer plants	Hydrogen production and consumption. 1.000 tons/year
Phu My	97.5
Ca Mau	89.7
Ninh Binh	68.3
Ha Bac	60.9

Source: Vietnam Petroleum Institute (VPI)

Encouraging Domestic Demand

Other industries

The potential future demand for H2 gas in other specific industries in Viet Nam in the period of 2020-2035 is shown in the following table:

Field of use	2020	2025	2035
Construction mechanical	11,000	15,567	40,380
Shipbuilding industry	16,500	20,756	49,802
Pharmaceutical and other	9,100	15,567	44,418
Total	36,600	51,890	134,600

Source: Vietnam Chemical Industry Development Strategy Report to 2030, Vision to 2040

Encouraging Domestic Demand

Summary

Currently in Viet Nam, the refining, petrochemical and fertilizer sectors are still the main hydrogen consuming industries with a total demand of 439,000 tons/year; the demand of the steel and other industries is significantly smaller, estimated at approximately 2,270 tons/year.

The hydrogen currently being used is predominantly grey hydrogen, i.e. produced with the use of fossil fuels.

This points to significant opportunities to transition to green hydrogen and green ammonia in the years ahead.

This could support the achievement of Viet Nam's decarbonization objectives and create new industrial activity and investment.

Conclusions

Conclusion

- Viet Nam well-positioned, but policy and partnerships will be essential to ensure success
- Much of the hydrogen production capacity being built for export is likely to be developed in the context of **bilateral partnerships**, with preferential financing conditions and long-term supply contracts.
- Under such an approach, Viet Nam's production costs are likely to be sufficiently competitive to be able to compete on the global market.

Policy and partnerships are essential for success

Conclusion

Policy and partnerships are essential for success

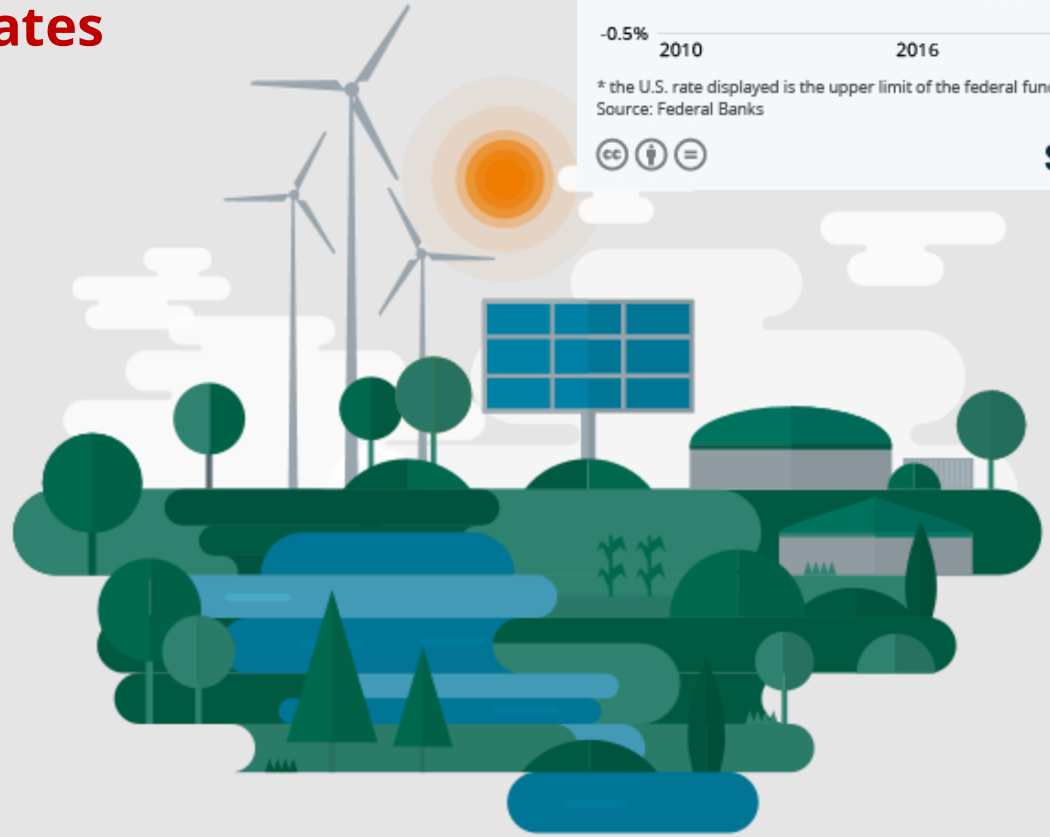
- In the absence of such bilateral partnerships, the path to competitiveness is much more challenging.

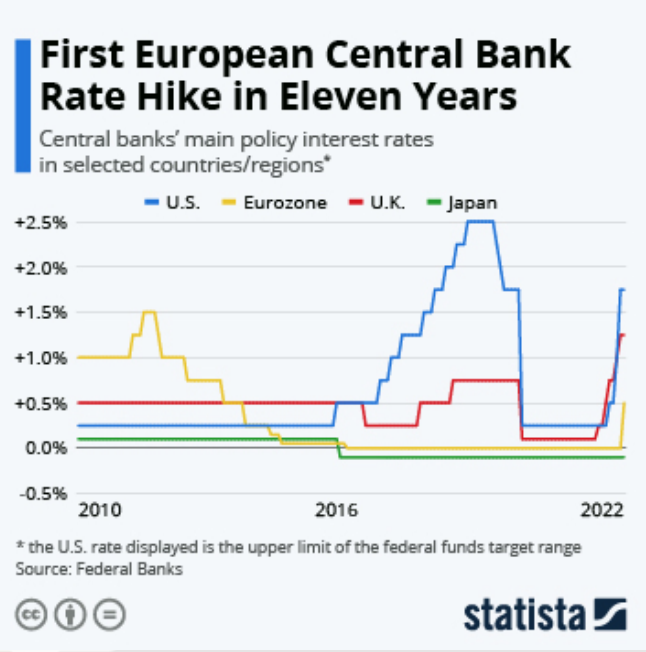
Conclusion

- Rising global interest rates could negatively impact the economic competitiveness of GH2 exports from developing markets.

- In line with other major central banks, Viet Nam's State Bank of Vietnam (SBV) increased interest rates by 100bps in September 2022, and a further 100bps in October 2022

The negative impact of rising interest rates



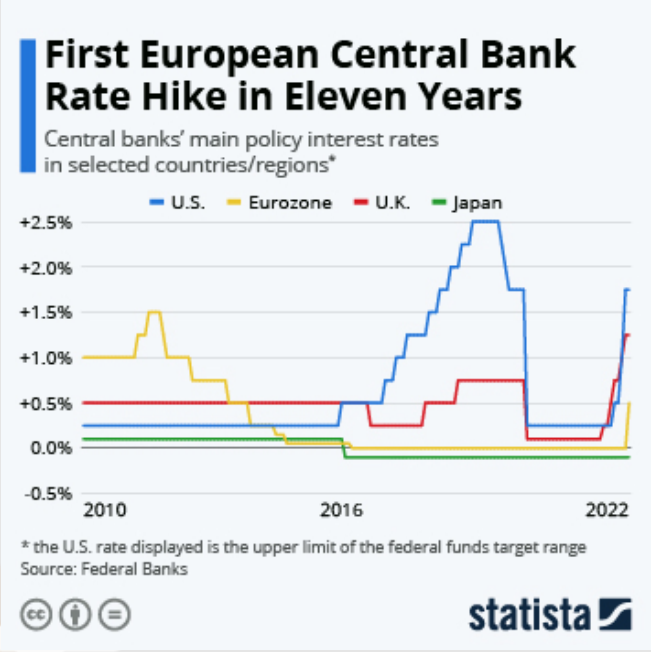


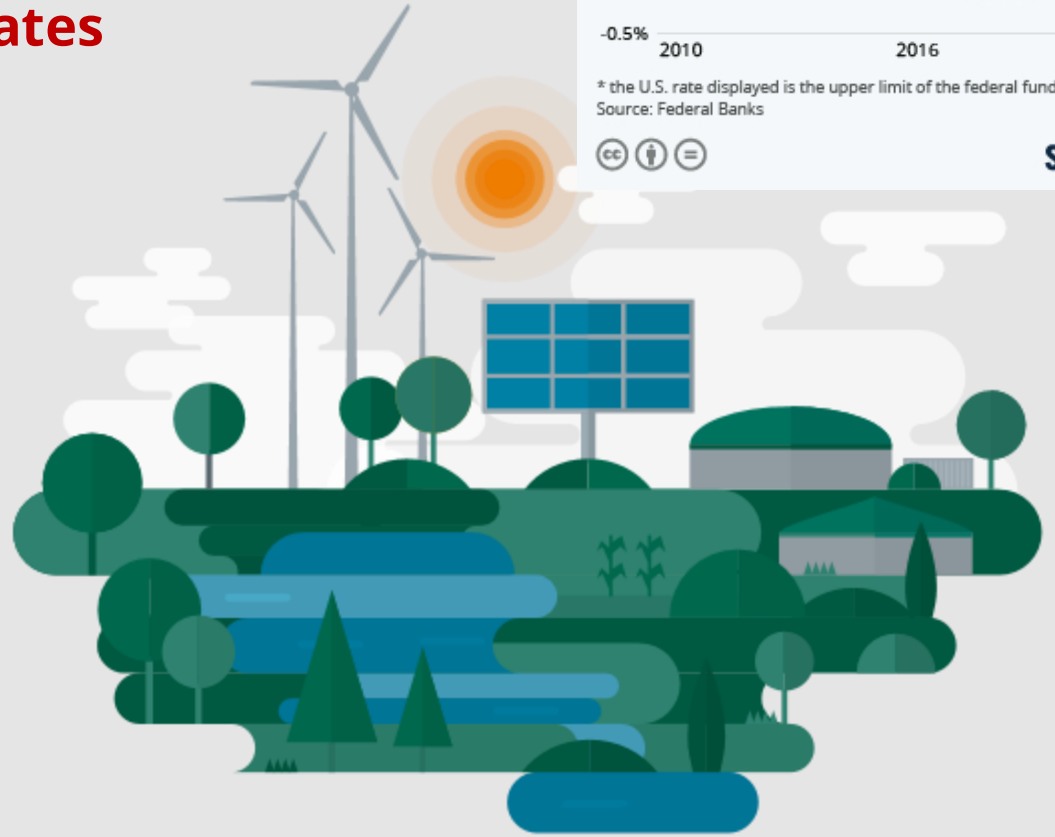
Conclusion

- Rising global interest rates are likely to make it challenging to secure the attractive financing conditions present during the low-interest rates period from 2015-2021.

- Rising interest rates will have knock-on effects on all major infrastructure projects, including GH2 production: one result is that GH2 exports to Europe likely to be more challenging

The negative impact of rising interest rates





Conclusion

Regional markets are more likely to be cost-competitive in the near term.

- Given the substantial impact of shipping costs, it is likely in the next decade that the international trade in green hydrogen will occur primarily on a regional basis: South Korea, Japan, etc.

- Regional trading hubs based on bilateral contracts are already starting to emerge in the Asia Pacific region as well as in Europe and North Africa.

Conclusion

- In order to increase the chances of success with Vietnam decarbonization agenda, efforts should be focused not only on ***exports***, but also on the production of GH2 to meet the ***domestic needs*** for hydrogen and ammonia, such as in the industrial sector (e.g. in the oil, gas, and chemical sectors)

Exploring the domestic use of GH2 and green NH3 could help de-risk investments in production

Recommendations

Recommendations

- Establish clear long-term targets for the production of green hydrogen in Vietnam
- Seek out strategic partnerships with major importing countries like Japan and Germany for the production of green hydrogen
- Introduce favourable tax and fiscal rules for green hydrogen production
- Explore the introduction of feed-in tariffs for green hydrogen production fed into the natural gas network
- Develop monitoring and certification protocols to ensure compliance with international standards.
- Establish a designated industrial cluster for hydrogen production and research.

Recommendations for encouraging GH2 supply

New IRENA report on GH2 Certification and Standards (2023)
https://www.irena.org/Publications/2023/Jan/Creating-a-global-hydrogen-market-Certification-to-enable-trade

Recommendations

Recommendations for encouraging GH2 demand

- Introduce standards for the injection of green hydrogen into natural gas infrastructure.
- Provide fiscal incentives for industries to shift their hydrogen or ammonia consumption to green hydrogen.
- Introduce policies to encourage green hydrogen use in key sectors such as oil, gas, chemicals, and shipping.
- Adopt carbon pricing: carbon pricing helps make green hydrogen more cost-competitive against grey hydrogen
- Commission a more detailed study to examine the practical implementation of GH2 production in Viet Nam