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The Transition to Zero-Emission Shipping

The Spanish Opportunity

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Shipping's transition to zero is moving up the agenda

Ambition:

- Call to Action on full shipping decarbonization by 2050 signed by 240+ industry leaders
- coZEV cargo owners' initiative: full decarbonization by 2040
- Poseidon Principles to align with 1.5 trajectory

Policy:

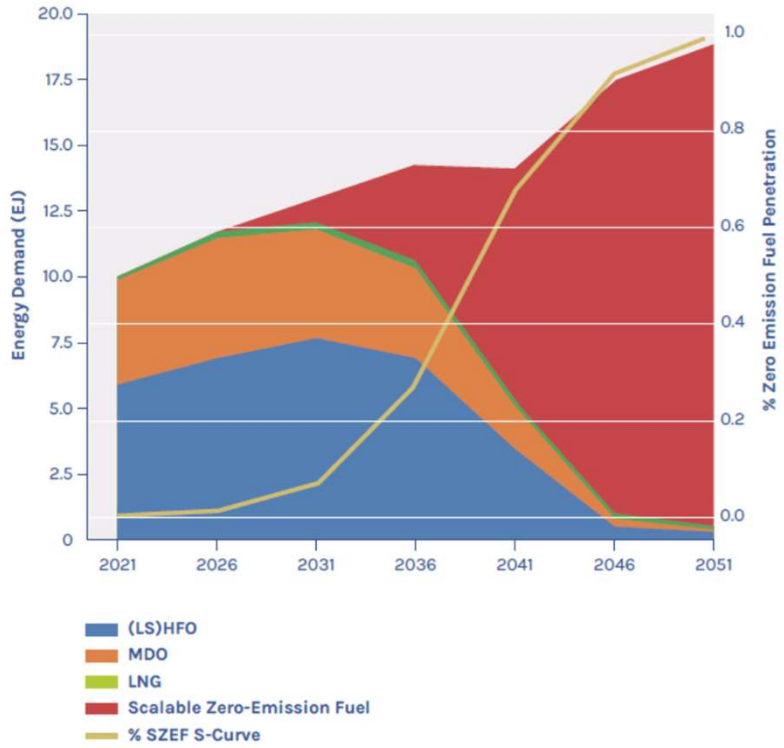
- Clydebank declaration on Green Corridors
- EU Fit for 55 proposal
- Impending revision of IMO GHG Strategy and discussion of MBM

Action:

- 200+ zero-emission pilots & demos
- 20+ Green Corridor initiatives
- First orders for dual-fuel MeOH and NH3 vessels

The Transition will be steep but doable

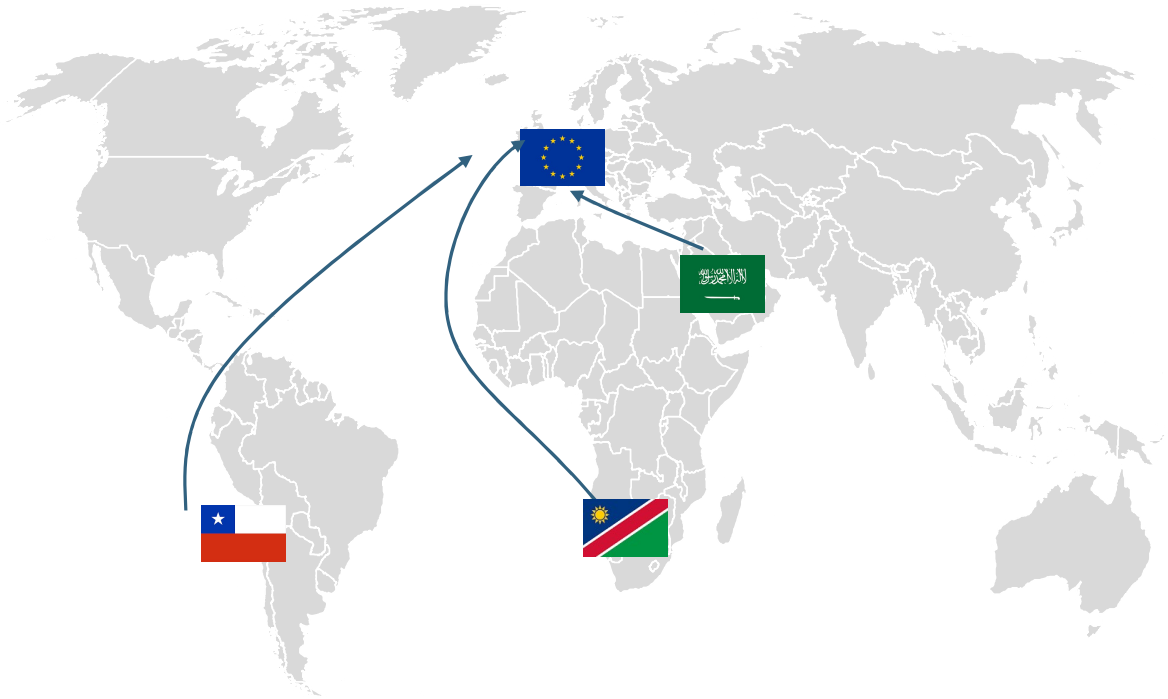
- A successful journey to 2050 will involve a steep rate of change from 2030
- Not every fuel will be able to scale that fast: biofuels are likely only a small contributor
- The emphasis today needs to be on getting Scalable, Zero-Emissions Fuels (SZEFs) and vessel technologies ready for scale-up

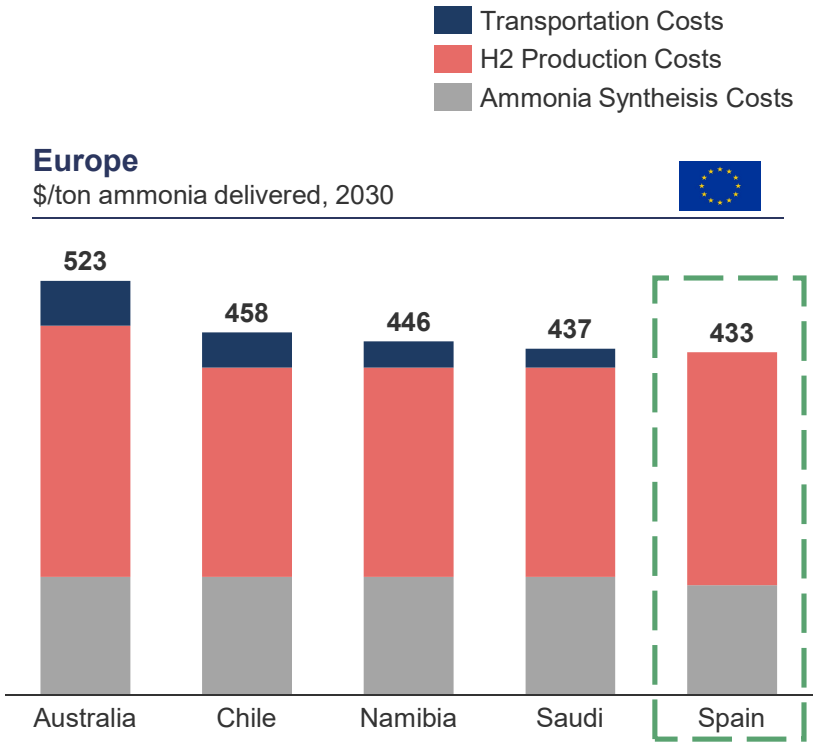


There are a range of potential fuel and/or propulsion pathways, but no single technology pathway is currently agreed upon for deep decarbonisation

	Fuel production	Bunkering	Vessel	Comment
Green Ammonia	+ Strong long-term scalability potential • + Emerging consensus as most viable zero emissions-capable fuel	! High toxicity levels; lack of existing maritime handling regulations ! Existing distribution, but not for fuel purposes	! Dual fuel ICE close to market but not yet commercially available ! Lower volumetric density relative to HFO	• Likely to be the most scalable fuel option in the long-term
Green Methanol	! Carbon feedstock procurement can be difficult ! Carbon capture technology still at nascent stage with uncertain costs	+ Existing maritime handling regulation • + Relatively easy to repurpose existing infrastructure	+ Dual fuel ICE available ! Lower volumetric density relative to HFO	• Proven technology with ease of use throughout value chain • Carbon procurement can be problematic
Biofuels	+ Close to cost Parity with HFO/MGO for select feedstocks ! Long-term scalability concerns due to feedstock and sustainability constraints	+ Limited/no new bunkering infrastructure required	+ Drop-in fuel potential + ICE engines available with mature capex	• Proven technology with ease of use throughout value chain • Doubts about long-term scalability
Green Hydrogen	+ Multi-sector demand to underpin scale and cost reductions	! Minimal transportation by ship at present (1-2 ships) ! High flammability; lack of existing maritime handling regulations	! ICE options not commercially available • ! Cost-intensive storage options	• Lowest technology readiness • Low economic feasibility in short term

Spain has the potential to be among cheapest production locations in the world and hub for European production

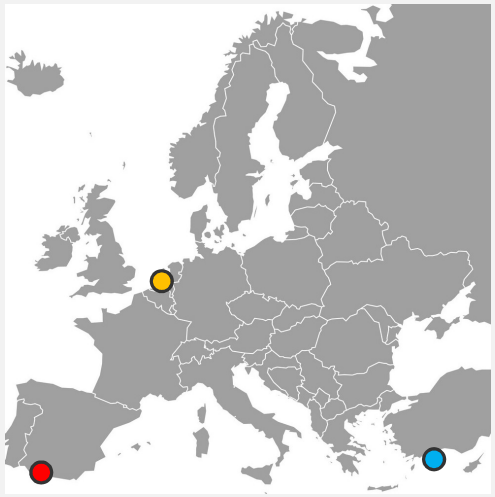




SOURCE: Hydrogen Europe (2021), Clean Hydrogen Monitor 2020, IEA (2021); ETC analysis – assumes $1.5 kg h2 for Spain

First mover advantage could help Spain gain share in future maritime fuel markets

Key figure



Refuelling Hub	Fuel sold FY2020 (million tonnes)	Global Market Share (%)
ARA (Amsterdam-Rotterdam-Antwerp)	14.4	5.8%
Gibraltar strait (Gibraltar-Algeciras-Ceuta)	6.4	2.6%
Turkey	2.5	1%
Total	**23.3**	**9.3%**

Opportunities

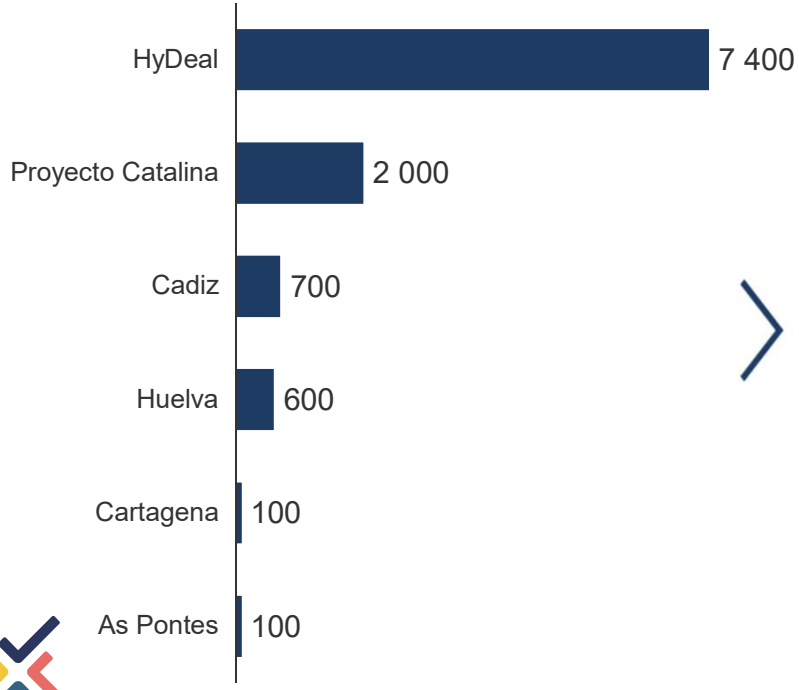
- With shipping entering the EU ETS, **there will be increased pressure to switch to zero-emission fuels**
- Likely that between 2035-2040, **zero-emission fuels will become the dominant marine fuel** sold at ports
- With Spain's cost advantage, it can grab a **significant chunk of Europe's future maritime fuel market**

SOURCE: Ship&Bunker

Spain has a jump start on fuel production with more than 10 GW of green hydrogen production capacity announced in the past 2 years

Announced projects in Spain based on planned capacity,
GW

NON EXHAUSTIVE LIST OF PROJECTS



Location	Technology	Companies involved
Asturias	Green steel and ammonia	ArcelorMittal, Fertiberia, DH2 energy
Aragon	Green hydrogen and ammonia	enagas, Fertiberia, Naturgy
Andalucia	Green steel	ACERINOX, TECNICAS REUNIDAS, edp renewables
Andalucia	Green hydrogen and ammonia	IBERDROLA, Fertiberia
Murica	Green hydrogen for refining	REPSOL
Galicia	Green hydrogen	endesa

SOURCE: El Comercio (2022); Arcelor Mittal (2022)

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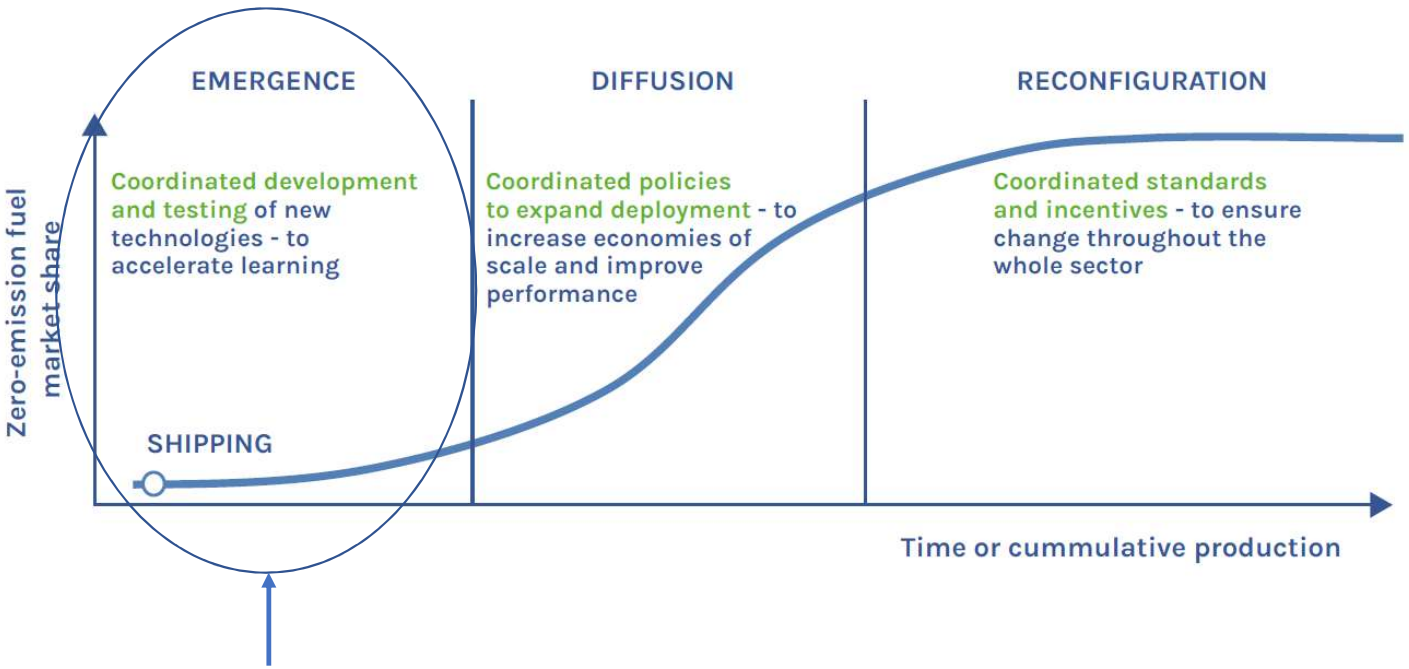
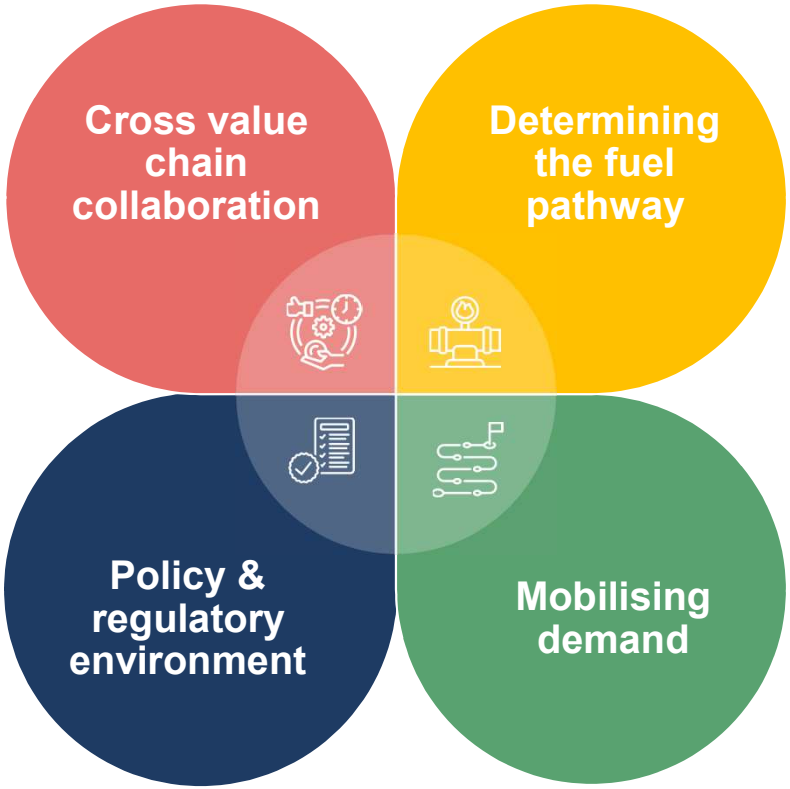
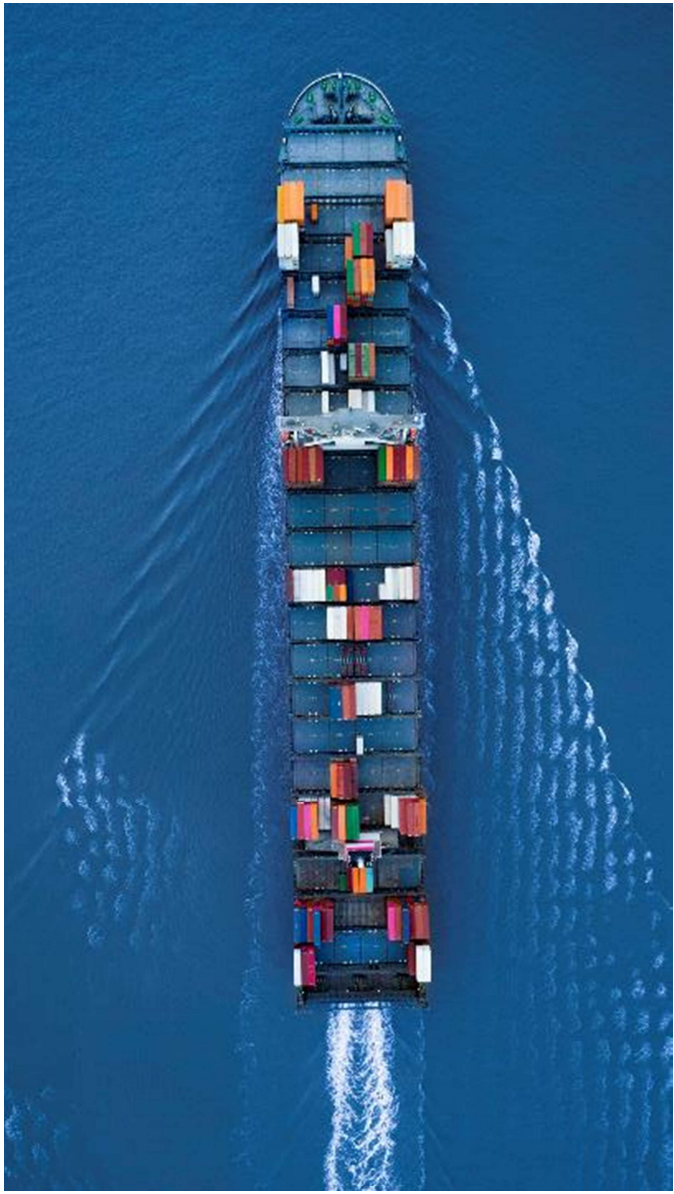
What needs to happen when



Green Corridors

There are promising conditions in Spain across all 4 key building blocks for establishing a zero-carbon green corridor





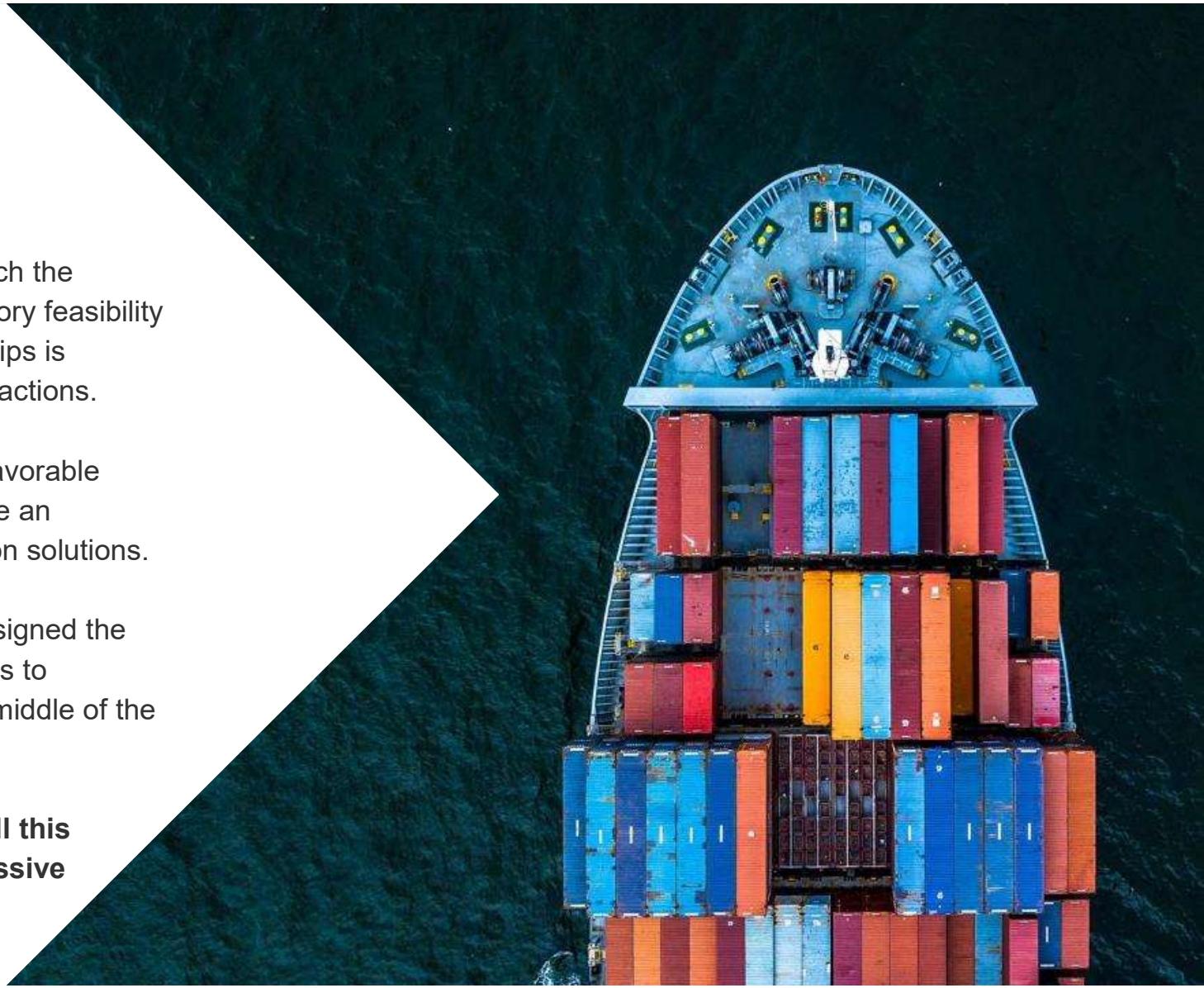
A GREEN CORRIDOR

is defined as a shipping route on which the technological, economic, and regulatory feasibility of the operation of zero emissions ships is catalysed through public and private actions.

Green Corridors take advantage of favorable conditions on specific routes to create an accelerated roadmap to zero-emission solutions.

24 Countries (including Spain) have signed the Clydebank Declaration which commits to establishing Green Corridors by the middle of the decade.

Spain has a unique chance to fulfill this commitment while capturing a massive opportunity



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How might EU policy interact with Spanish initiatives?

- Recycled revenue or sub-mandates for e-fuels could emerge at an EU level – but uptake is not guaranteed
- Green Corridors can help create niche markets where revenue/mandates can take effect
- Spain has an excellent conditions to build these niche markets and create first movers on the demand and supply side who can turn EU policy into action

Source: CLIT International

What next (Time Allowing)

We see four overlapping steps that Spanish stakeholders can take in 2022-2023

Assessment of routes

An evaluation of which routes (cargo, ports, destination) are most promising will be needed to focus resources.

Engagement of stakeholders

A dialogue between industry, ports and key regulatory agencies should be initiated

Feasibility studies

Targeted studies of supply/demand for new fuels, infrastructure and financing needs for prioritised corridors should be undertaken

”Route mapping” and programme development

A joint public-private roadmap for the corridor should be developed and targeted support programmes considered

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Which corridors to green?

High volume routes | Rapid decarbonization routes

		1	2	3	4	5	6	7	8	9	10
		Australia-China iron ore	**Brazil-Asia iron ore**	**Australia-Japan iron ore**	**Trans-Pacific containers**	**Asia-Europe containers**	**Transatlantic containers**	**North South Containers**	**ME-Asia ammonia**	**Korea/Japan-US automotive**	**Saudi-China Methanol**
		Large volumes, fewer policy enablers	*High volume, with higher shipping costs*	*Lower volumes with committed stakeholders*	*Major mainline route*	*Long, high-emission mainline route*	*Small volumes, more policy enablers*	*Low volumes, limited ability to pass on costs*	*Fertiliser input now, likely future marine fuel*	*Low volume, high value, and carbon intensive*	*Potential future fuel, small traded volumes*
	From	Australia	Brazil	Australia	Singapore	Singapore	Rotterdam	West Coast LatAm	Saudi Arabia	Korea (interme-diary stop Japan)	Saudi Arabia
Metric	**To**	China	China	Japan	USA	Rotterdam	USA	Europe	India	USA	China
IMPACT											
A. Trade and logistics											
• Share of global trade volume	BPS	650	195	60	181	210	52	14	2	4	1
• Expected future growth	CAGR until 2025	4%	3%	3%	2%	3%	3%	8%	5%	2%	6%
B. Emissions											
• Carbon intensity on route	KgCO2e/tonne cargo	28	48	29	61	93	56	99	104	197	137
• Current carbon emissions on corridor	Tonne CO2e	20,238,452	10,452,775	1,284,410	12,371,053	36,591,089	3,224,066	1,530,391	268,148	922,619	160,519
FEASIBILITY											
C. Value and cost pass-through											
• Cost structure of traded goods	Relative price increase of end product	11%	28%	11%	3%	2%	2%	12%	4%	1%	4%
• Scope 3 importance for traded good sector	1= low, 5=high	3	3	3	2	2	4	2	1	3	1
D. Zero-emission fuel supply											
• Delivered cost of zero-emission fuel	$/GJ	34.6	37.1	34.6	37.8	29.7	39.7	34.8	29.7	37.8	29.7
E. Stakeholder readiness											
• National policies/regulations (net zero, green H2)	1= low, 5=high	2	2	4	1	3	3	5	1	3	1
• Complexity of stakeholder environment	1= low, 5=high	2	1	2	5	5	5	4	2	1	2

Major Spanish Cargo owners and Global vessel operators will need to be brought together on the effort

Sectors Traded goods	Characteristics	Sector share of trade % volume in tonnage, 2020	Example cargo owners	Vessel port calls % based on # of vessels, 2020	Example vessel operators
Liquid Bulk	Used to transport liquids or gases in bulk	36%	Fertiberia, CEPSA, REPSOL	31%	
Container	Used to transport manufactured goods in intermodal containers	35%	INDITEX, GRIFOLS, CIE Automotive	27%	MAERSK
Dry Bulk	Used to transport unpackaged bulk cargo in cargo hold	19%	ACERINOX, CELSA GROUP, Ebro	27%	StarBulk Carriers Corp.
Automotive (RoRo)	Used to transport automotive and vehicles	6%	Mercedes-Benz, Ford	15%	HÖEGH AUTOLINERS
Other	Other	5%		0%	

SOURCE: Eurostat; various

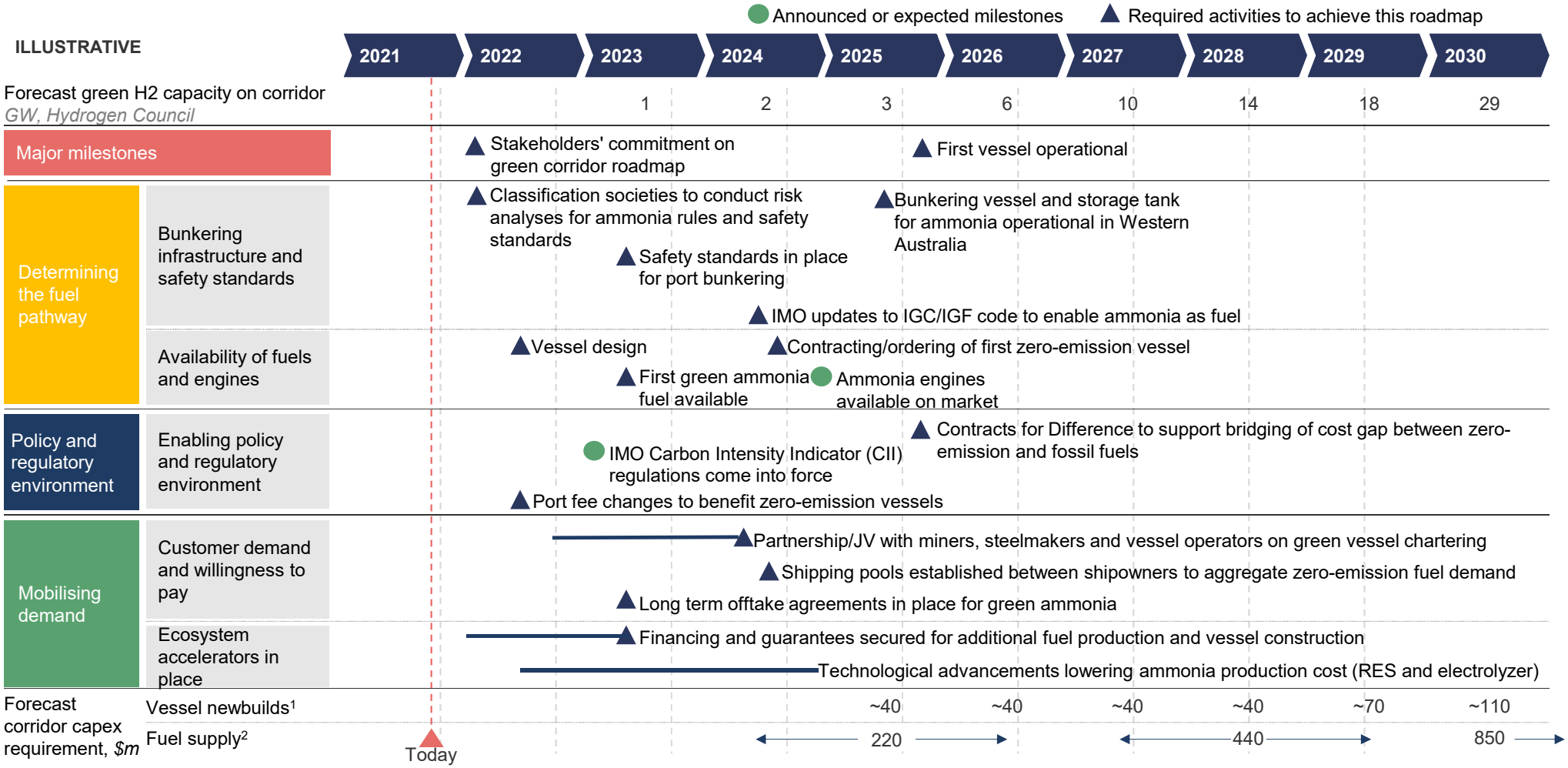
A material amount of trade going through Spanish ports would be suitable as first movers in a green corridor

Top categories of traded good throughput (2020)	Sector share of trade (% volume in tonnage, 2020)	Selected examples of cargo owners
Coke and refined petroleum products	21%	REPSOL
Coal, Petroleum and Natural Gas	14%	CEPSA
Chemicals	12%	Zeltia
Food products and beverages	12%	Ebro, Pascual
Agriculture, Hunting, Fishing Products	9%	
Mineral products (non mining)	8%	HEIDELBERGCEMENT
Metal ores and mining	7%	RioTinto
Fabricated metal products	6%	ACERINOX
Wood and Wood Products	3%	UPM
Secondary Raw materials	2%	RioTinto
Transport equipment	2%	
Machinery and equipment	2%	CATERPILLAR
Textiles and textile products	1%	INDITEX
Furniture, other manufactured goods	1%	IKEA
Total	69% + 30% (Willingness to pay) = 99%	

30% of trade is in categories that are primarily "close to the customer" or are willing to pay for Scope 3 emission reductions

SOURCE: EUROSTAT (2022)

The creation of a potential credible roadmap detailing actions needed for decarbonization is also essential



1. Total capex for ZEV newbuilds slightly more than capex for newbuild HFO vessels
2. Capex required for production of green ammonia required to meet corridor demand, including renewable energy production

Appendix

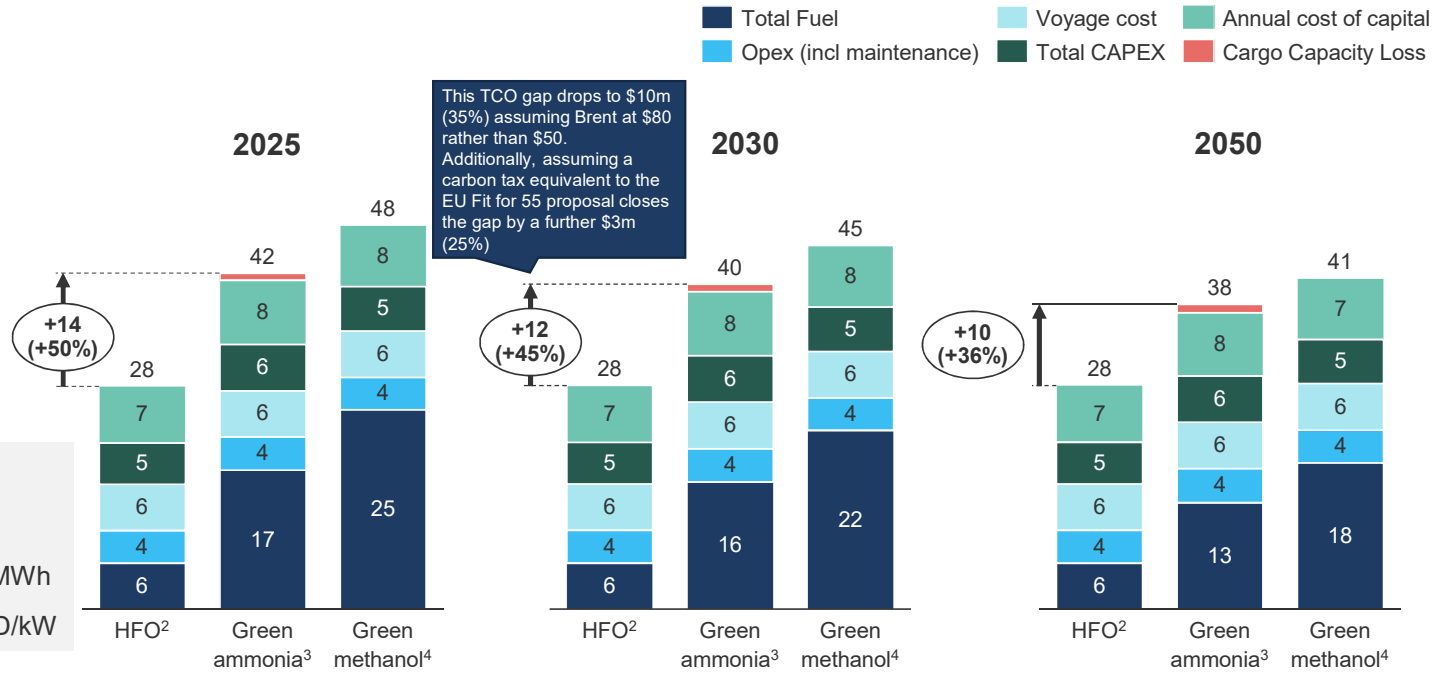
Several policy options can be utilized to facilitate the creation of Green corridors

Text Prioritized measures

MAIN LEVEL OF GOVERNANCE		Example lever	Fuel cost reduction	Enabling ecosystem
Federal governments	1	Provide public investment through credit guarantees, anchored blended finance and grant finance to lower cost of capital	✓	
	2	Mandate zero-emission fuel supply targets for domestic shipping		✓
	3	Provide compensation for use of electrolysers for grid firming services	✓	
	4	Implement (reverse auctioned) CfDs[2] for zero emissions fuels	✓	
	5	Extend fossil fuel subsidies to zero-emission fuels	✓	
State governments	6	Facilitate permitting the use of natural storage for H2 storage	✓	
	7	Best practice guidelines to accelerate fuel production project development		✓
Government research agency	8	Develop ‘Guarantees of Origin’ (GO) schemes for green H2		✓
Classification society	9	Expedited standards on safety requirements (e.g. bunkering at ports)		✓
Port authorities	10	Funding for additional bunkering capacity at ports		✓
	11	Implement crew safety training for handling of zero-emission fuels and workforce retraining	✓	
	12	Reduce port fees for zero-emission vessels		✓

Despite significant reductions in zero-emission fuel costs, a gap of ~25-45% is forecast to remain by 2030

Total cost of ownership pathways for containership, *USDm per vessel/year*[1]



Main assumptions used '25-'30-'50:

Cost of crude: Brent at 50 (flat rate)

Renewable electricity: 25-21-16 USD/MWh

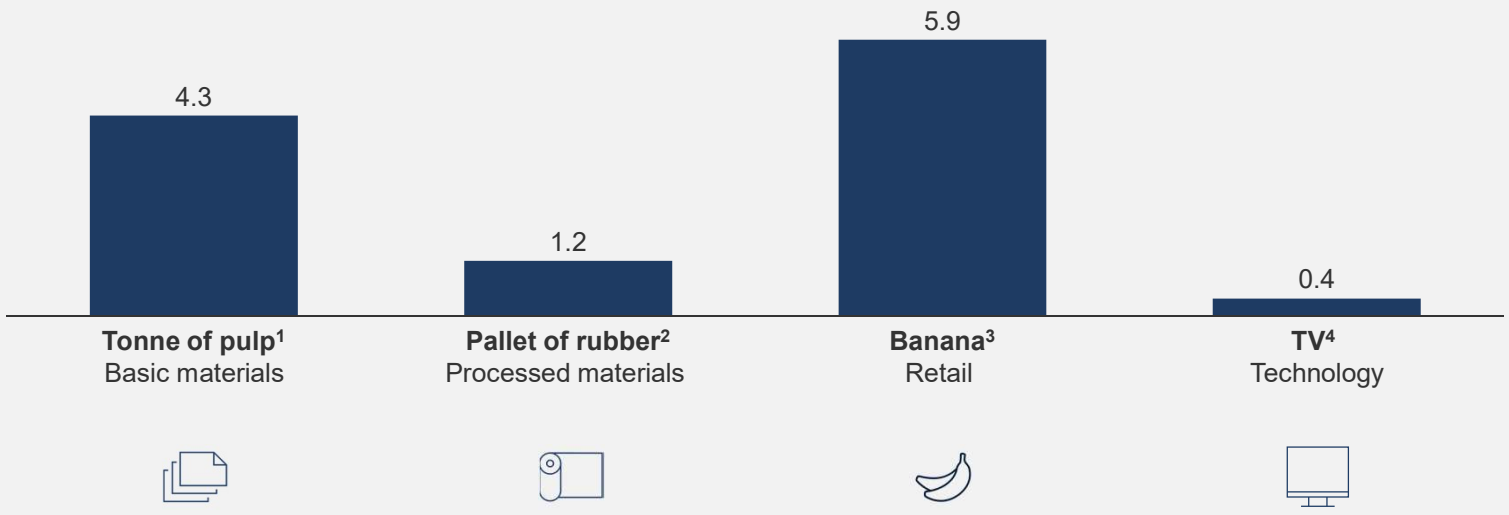
Electrolyser CAPEX: 980-930-630 USD/kW

1. Based on container vessel >15,000 TEU with bunkering in Middle East; Typical speed of 18 knots and 8 annual canal transits (Suez)
2. ICE HFO with LSFO as fuel (100%)
3. ICE Ammonia with 95% Ammonia (Green) and 5% LFSO (dual fuel engine)
4. ICE Methanol with 97% e-Methanol fuel use with Direct Air Capture (DAC) and 3% LFSO (duel fuel engine)

SOURCE: Maersk Mc-Kinney Moller Center for Zero Carbon Shipping NavigaTE model

While a cost gap exists switching to zero-emission fuels would increase the end-user price by less than 10% for most goods

End-user cost increase on goods transported on the Asia-Europe corridor based on TCO cost gap, %



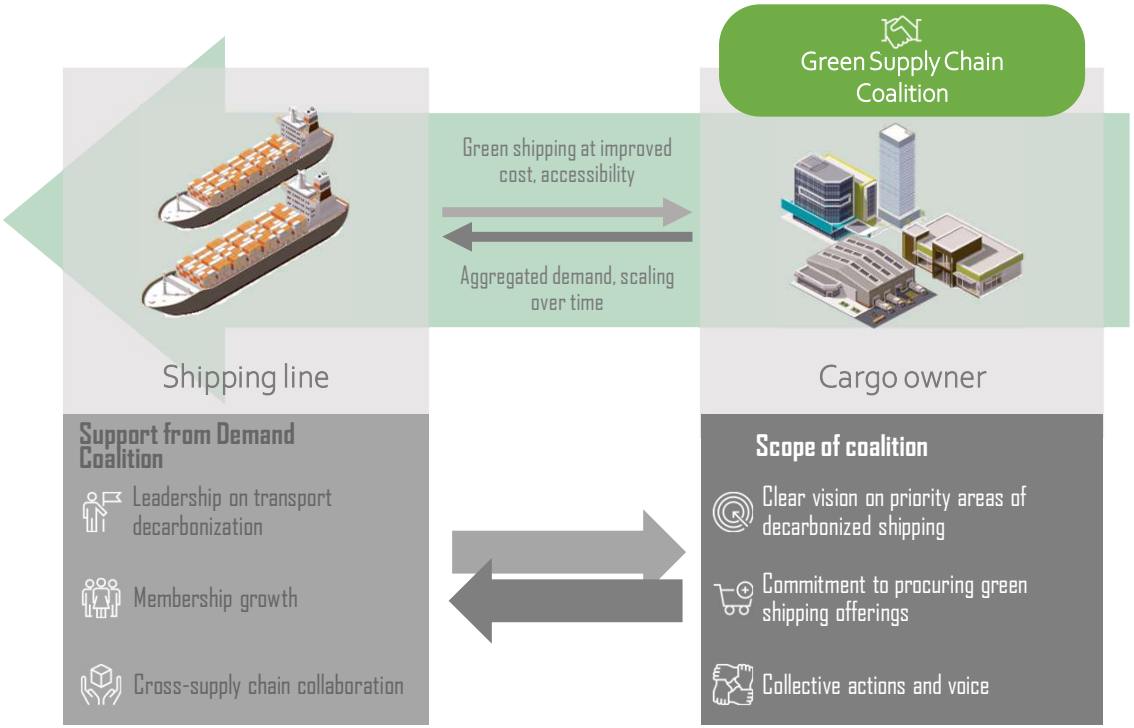
Cost increases from switching to green ammonia fuel are well within the historically high freight rates that we see today

1. Retail price of $968/tonne and 12 tonnes per TEU
2. Retail price of $2110/tonne and 20 tonnes per TEU
3. Retail price of $1.18 per banana and 46 items per TEU
4. Retail price of $336 per TV and 400 items per TEU

SOURCE: Maersk Mc-Kinney Moller Center for Zero Carbon Shipping NavigaTE model

A consolidated demand coalition would send clear demand signals to value chain actors and maintains competition of cargo owners

How does the Green Supply Chain Coalition work?



Existing demand coalitions

- **First Movers Coalition** - Created by US State Department; leverages collective purchasing power of companies globally to send a clear demand signal to scale up critical emerging technologies essential to the net zero transition

- **Cargo Owners for Zero Emission Vessels** - Platform for high ambition cargo owners to collaborate with one another and send collective demand signals for rapid maritime decarbonization

Source: World Economic Forum SAFc (Sustainable Aviation Fuel Certificate) framework