

SECTION 3

IDENTIFYING ASEAN'S TIPPING POINTS BY SECTOR

This section presents analyses on the six prioritized sectors in ASEAN discussed in Section 2. In each sector analysis, the report seeks to answer the following questions:

Global sector context

- What is the **global context** of how this sector will decarbonize?
- What are the **core low-carbon solutions** that will drive decarbonization?

Geographic sector context

- How is the **sectoral transition progressing** at **ASEAN level**?
- Are there **opportunities or challenges** specific to the region?

Solution status

- What is the **current status** of the core solution being adopted at ASEAN level?
- Is it only **in development**, or being adopted in **niche markets**, or starting to break into **mass market**?

Tipping point status

- How close are we to a **tipping point**, to help the solution break into mass market?
- What are the **key gaps** to be addressed to trigger one?

Tipping point calculation & levers

- What is the **comparison** of the **current** and **potential future costs** of the **low-carbon solution** versus **the incumbent**?

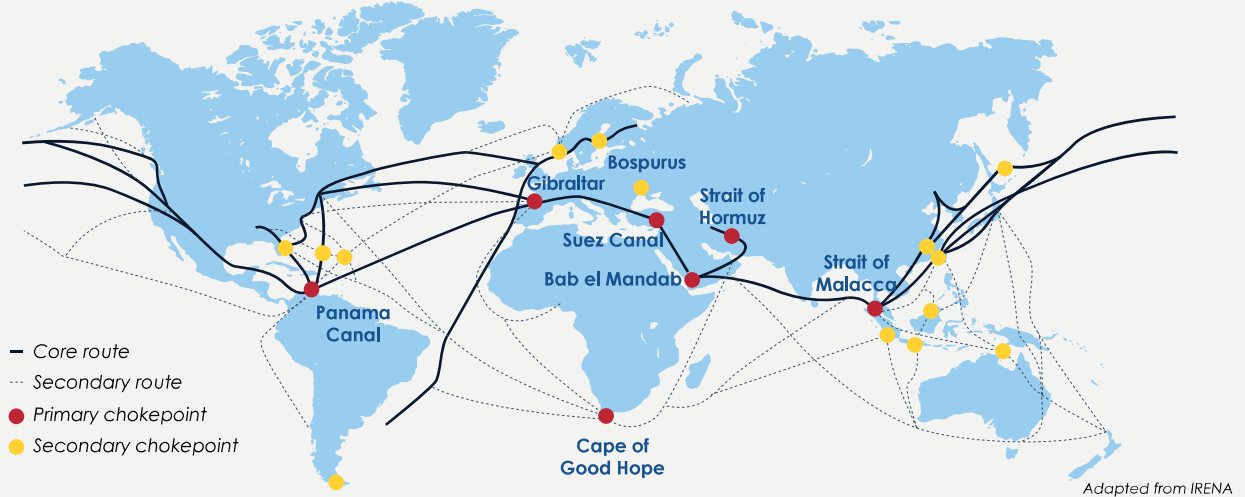
Target conditions progress to trigger tipping point

- What is the **current** and **potential future** status of the **tipping point conditions** (affordability, attractiveness, and accessibility)?

SHIPPING: GREEN AMMONIA FOR SHIPPING FUEL



3% OF TOTAL ASEAN
GHG EMISSIONS 2020

GLOBAL SECTOR CONTEXT



- ~90% of global trade is done through shipping, mostly by long-haul vessels. These vessel types are responsible for ~85% of emissions.^A
- Decarbonizing shipping can be done through alternative energy sources to complement operational and energy efficiency.
- Port location determines importance and influence in shipping industry, including for decarbonization efforts. The top 30 ports global are responsible for 60% of the global container trade.^B
- Leading solutions for clean fuel are green ammonia and methanol, given energy density limits for electric engines or hydrogen fuel, as well as constraints on sustainable biomass availability. Green ammonia is the solution in focus in this analysis, due to challenges expected in sourcing sustainable CO₂ cost effectively for green methanol.

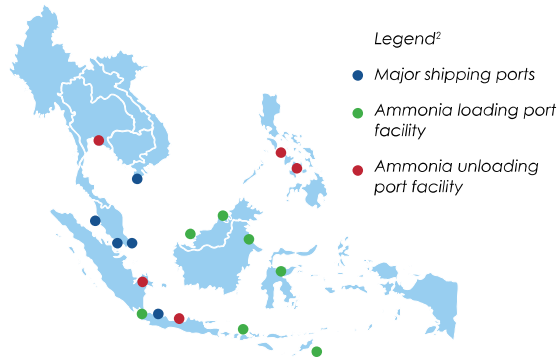
Important long-haul global shipping routes^C

Vessel type	Goods	Route	Volume (m tonnes, 2019)
 Container-ships	Diversified-mainline	Transpacific mainline	202
		Asia-Europe mainline	235
		Transatlantic mainline	58
 Dry bulk	Diversified - non-mainline	Non-mainline East-West	193
		North-South	89
		South-South	144
		Intra-regional	405
	Iron ore	Australia-China	689
		Brazil-China	212
		Australia-Japan	62
		Australia-South Korea	53
		Brazil-Malaysia	29
		South Africa-China	17
		Brazil-Japan	13
		Brazil Netherlands	11
		Soyabeans	Brazil-China
	United States-China	23	
Bauxite	Guinea-China	38	
	Australia-China	31	
Manganese	South Africa-China	11	
Nickel ore	Philippines-China	25	
	Indonesia-China	18	

ASEAN is in the intersection between major large/very-large shipping routes that account for at least 10% of global shipping volume. This means ASEAN is in a strategic position to influence global shipping decarbonization efforts.

Notes: [A] Systemiq (2023), The Breakthrough Effect: How to Trigger a Cascade of Tipping Points to Accelerate the Net Zero Transition; World Shipping Council (n.d.); IRENA (2022), A Pathway to Decarbonize the Shipping Sector by 2050; B) Global Maritime Forum (2023) Fuelling the decarbonisation of iron ore shipping between Western Australia and East Asia with clean ammonia; C) Getting to Zero Coalition (2021), The Next Wave Green Corridors.

GEOGRAPHIC SECTOR CONTEXT



- Southeast Asia has 5 of the top 30 ports in terms of throughput. (Singapore, Klang, Tanjung Pelepas, Tanjung Priok, and Ho Chi Minh has >5 million TEU annual throughput³).
- Singapore has a 20+% share of global bunkering demand⁴, making their bunkering strategy significant for global shipping.
- ASEAN as green corridors beneficiaries⁵. Maritime green corridors are likely to play a role as enablers of the niche markets phase in green ammonia for shipping fuel uptake, and ASEAN sits in the middle of several corridors (e.g., Australia-East Asia, Inter-continental Container corridors).
- ASEAN has existing ammonia infrastructure to build from. There are currently 12 ammonia loading/unloading ports in ASEAN, even though there is still a lot of development to be made to reach bunkering capability, including the vessels procurement.

GLOBAL SOLUTION STATUS

Solution status stages: ● Solution development > ● Niche market > ● Mass market



Green ammonia for shipping fuel solution is still in further development.

- Green ammonia for shipping requires 4 aspects to be fulfilled:
 - 1) **Bunkering infrastructure:** Ammonia handling safety and impact analysis are required. *Still in development*⁶
 - 2) **Green ammonia production:** Green ammonia projects underway but still at pilot scale. *In niche market*⁶
 - 3) **Ship engine development:** No ammonia-engine ships are in deployment right now. *Still in development*⁶
 - 4) **Handling safety:** Required for mass market, leading ports (e.g., Singapore) have done studies. *Still in development*⁶
- **Technology development is progressing quickly.** Up to Q1 2022, 30% of new ship projects and 25% of bunkering & infrastructure projects globally are for ammonia⁷.



Only cheapest green hydrogen/ammonia (+carbon tax or equivalent subsidy) will reach cost parity with HFO, and ASEAN's projected cost of production does not reach this. Add to the fact that 90% of global ships are being built in East Asia⁸, it is expected that ASEAN's contribution to green ammonia for shipping fuel will be bunkering, not production.

TIPPING POINT AND ADOPTION RATE STATUS

Tipping point status

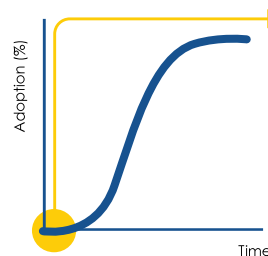
Legend: ✓ Mostly reached ○ Reached in certain cases ✗ Not yet reached

TIPPING POINT 1

Cost of Green Ammonia (\$/ton) vs Heavy Fuel Oil

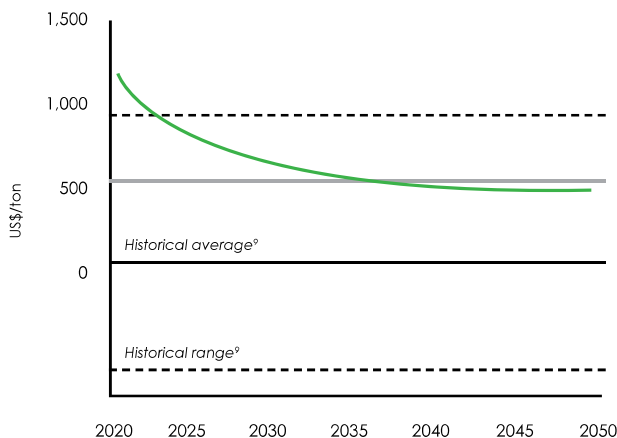
- Tipping point will be focused on the cost of green ammonia vs the incumbent fuel, Heavy Fuel Oil.
- Since solution is in development stage, the tipping point has not been reached.

Current adoption status



Utilization of green ammonia as shipping fuel is still at a nascent stage. Further development and synchronization of each aspect (infrastructure, ship engine, fuel production) is required for accelerated adoption.

TIPPING POINTS FOR GLOBAL SHIPPING



Cost Parity: requires green hydrogen price of \$1.6/kg + \$100/ton carbon price or equivalent subsidy. Government subsidies such as the IRA can further accelerate this tipping point.

HFO + Equivalent Subsidy
Green Ammonia (HFO equivalent)¹⁰
Heavy Fuel Oil (HFO)⁹

Even though fuel cost parity will require time and support from governments, TCO of ammonia ships are competitive for several routes with the help of subsidies (e.g., IRA), as per studies done by Global Maritime Forum.

Notes: [1] IRENA (2022), A Pathway to Decarbonize the shipping sector by 2050. [2] World Shipping Council (n.d.), The Top 50 Container Ports. [3] SeaTrade Maritime, Minerva (n.d.); [4] Global Maritime Forum (2021), The Next Wave: Green Corridors. [5] Systemiq analysis; [6] Getting to Zero Coalition (2022) Mapping of Zero Emission Pilots and Demonstration Projects; [7] United Nations Conference on Trade and Development (UNCTAD) (2022), Ships built by country data; [8] Systemiq (2023), The Breakthrough Effect: How to Trigger a Cascade of Tipping Points to Accelerate the Net Zero Transition; [9] Making Mission Possible (2022), Making 1.5-Aligned Ammonia Possible; [10] INSEE Data (n.d).

AFFORDABILITY

- **Cost parity for green ammonia as shipping fuel vs. HFO**, with the help of subsidies. This cost parity challenge is mostly due to 2 tonnes of NH₃ is equivalent to 1 tonne of HFO in terms of energy volume.
- **Development of major green corridor that goes across the ASEAN region.** (e.g., Asia-Europe Mainline).

- ✗ **Total cost of ownership** of green-ammonia powered vessel expected to be ~70% higher than HFO in 2030¹¹, but several routes can reach cost competitiveness, as outlined by recent GMF studies.
- ✗ **Cost parity is possible by 2035** as green hydrogen cost falls (~\$1.6/kg), but only in favourable locations and coupled with CO₂ price/equivalent subsidy of ~\$100/tCO₂. EU ETS will tax 50% of emissions for ships docking in EU ports.¹²
- ✗ **No indication of ASEAN governments to provide subsidy** on the development of green corridors.

Key actions to accelerate progress:

- **Policy adjustments:** Carbon tax for HFO usage in shipping.
- **Green ammonia development.** Incentive for green corridor development, including ammonia bunkering and other technology investments.

ATTRACTIVENESS

- **Market incentives and market push to provide low-carbon shipping.** As companies using shipping lines aim to reduce Scope 3 emissions, decarbonization of shipping is imminent.
- **Updated international safety & regulation** to address handling and safety concerns around ammonia.
- **Proven positive net impact of ammonia.** Concerns over Ammonia usage to natural nitrogen cycle need to be addressed.
- **Enforcement on low-carbon shipping**, both by ports and regional or country carbon regulations.

- ✓ **IMO is starting to operationalize their decarbonization efforts** through Carbon Intensity Indicator program.¹²
- ✓ **Companies are starting to ask shipping lines to provide ship carbon emission reports** as part of vendor selection.¹²
- ✓ **Several international ports have increased pollution standards** requirement for ships to dock, and EU ETS will tax 50% of emissions for ships that dock in European ports.¹²
- ✓ Several coalitions have been developed e.g., Cargo Owners for Zero Emissions Vessels (COZEV) or Zero-Emissions Maritime Buyers Alliance (ZEMBA)

Key actions to accelerate progress:

- **Policy and regulation adjustments.** Stricter regulation in ports related to pollution and emissions.
- **Market incentive.** Green premium for ships using low-carbon or alternative fuel.
- **Facilitate market coalitions for green shipping.**

ACCESSIBILITY

- **Availability of multiple large ports with bunkering infrastructure**, focused on major and secondary hubs in ASEAN (e.g., Port of Singapore, Vietnam, Indonesia).
- **Shipyards developing capacity to build or retrofit ships** to run safely and efficiently on ammonia.
- **Updated international safety & regulation** to address handling and safety concerns around ammonia.

- ✓ **Plans and studies are in place for import/bunkering terminals** at major ports (Rotterdam, Hamburg, and Singapore).¹²
- ✗ **Pipeline for shipyards** still a major hurdle with overdemand.
- ✓ **First models expected to be available in 2026** (e.g. Eastern Pacific Shipping placed order for ammonia ships).⁷
- ✗ **Safety regulations and re-training the workforce for ammonia handling** has not been issued or commenced.

Key actions to accelerate progress:

- **Improve bunkering capabilities.**
- **Accelerating manufacturing capabilities.**
- **Including ammonia handling/usage in global safety standards and regulations.**

Legend: ✓ Progress is moving well ✓ Progress is mixed ✗ Progress is not happening (or happening far too slowly)

Notes: Tipping point enabling condition's rating guide: Affordability: Green – Parity achieved, Amber: Parity could be achieved with the help of levers before 2030, Red: Parity might only be achieved after 2030. Attractiveness & Accessibility: Green – No barrier to tipping point, Amber – Currently impeding tipping point but strong progress underway, Red – Currently impeding tipping point with limited progress to date.

ASEAN FOCUS FOR GREEN AMMONIA

- **Improving bunkering infrastructure to also provide low-carbon fuels.** Strategic geographic positioning that is well aligned with existing major shipping routes and improved ability to provide bunkering activities in Singapore or Indonesia.
- **Developing ship-building capabilities for low-carbon shipping engines.** Specifically, Vietnam, since there is overdemand in Japanese and Korean shipyards.
- **Forging strategic relationships with countries/private sector that has low green hydrogen/ammonia production.** Strategic off-take agreements with first-mover private sectors that can provide low-cost ammonia producers, such as Australia.

To bring the 3 focus opportunities together, ASEAN countries should look into developing green industrial parks (e.g., for nickel in Philippines and Indonesia) to trigger new large-scale strategic green corridors to China or other battery manufacturing regions, in which these green corridors should also integrate shipping decarbonization in their planning. With the increase in interest for low-carbon battery value chains, this is a strategic approach that should be explored in unison by governments across ASEAN.

[11] Maersk- McKinney Moller Center for Zero Carbon Shipping (October 2021), Industry Transition Strategy; [12] Expert and industry interview; [13] Ammonia Energy Association (August 2022).

