A Sea Change

Which shipping companies are ready for the low-carbon transition?

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Linking climate metrics to earnings for Shipping companies

This is CDP's first research report for investors on the Shipping Sector. It ranks 18 of the largest publicly listed Shipping companies on business readiness for a low-carbon economy transition. The universe covers a diverse range of companies but focuses on the Bulk, Container and Tanker business segments of companies' operations.

The Shipping Sector accounts for between 2 - 3% of global emissions and around 10% of global transport emissions. Based on current technology it is one of the least emissions intensive modes of freight transport. However, with demand for freight services expected to increase 3 – 4% annually it is imperative that the sector is able to decouple emissions from future increases in demand for freight transport[1].

The recent introduction of the International Martitime Organization's (IMO) Greenhouse Gas Strategy which targets a minimum absolute emissions reduction of 50% by 2050 has created greater impetus for companies to take a more structured approach to long-term decarbonisation efforts.

We cover approximately 47% of the container transport market, 17% for bulk and 13% of the oil tanker market when assessed on a DWT capacity basis. Around 42% of seaborne trade starts its journey in Asia and this is reflected in the universe of companies included in this report.

More than 70% are listed in Asia, most notably Japan, China and Taiwan. There is also representation from companies listed in both the US and Europe.

There are three key areas assessed in the League Table, which are aligned with recommendations for company reporting from the G20 Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD):

Transition risks: We assess the operational and technical efficiency of companies' fleets and how their vessel purchasing decisions affect this. We assess the capital flexibility of companies and conduct an assessment of companies' exposure to longer-term market risks for transported commodities.

Transition opportunities: We look at innovation activities to develop lower carbon fuels, technologies and practices. We conduct our analysis using a scorecard approach to differentiate between the materiality of the technical and operational measures being taken.

Climate governance and strategy: We analyse companies' governance frameworks by looking at their climate management structures, board level climate expertise and ship recycling governance. We also assess companies' emission reduction targets as well as the quality of their disclosure.

Key findings

- **Container transport is the most emissions intensive shipping subsector** but has achieved the highest emission reductions across the sub-sectors, on average reducing by 5.3% p.a. between 2012-17[2].
- **Emissions from the Bulk and Tanker divisions have stagnated** with emission intensities from both sectors increasing 1% and 0.5% p.a. on average over the same period.
- **Achieving long-term emission reductions will be challenging for the sector** with a clear gap between company ambition and the technologies and fuels required to deliver the IMO's long term emission reductions.
- **Biofuels, Hydrogen and Ammonia based fuels which can deliver significant emission reductions are under developed** with only a few companies showing evidence of collaborating to facilitate their development.
- **10 companies are actively facilitating the development of LNG marine fuel** through collaborations or integration of LNG-ready vessels into their fleet.
- **Retrofitting existing fleets could be a capital efficient strategy over the short term before more transformative technologies become viable** – 14 companies show evidence of retrofitting activity.
- **The average fleet age of the universe was found to be below the global average for vessels** across the three sub-sectors, but this does not necessarily position the universe for longer term emission reductions.
- **Technology adoption is challenged by low EBIT Margins and high indebtedness –** Margins averaged 2.5% and the average debt-to-equity ratio was 110%.
- **Slow steaming is an important short-term lever capable of delivering emission reductions of around 30%** - 13 companies were found to have a slow steaming strategy.
- **LNG with a significant role as a transition fuel in the IEA's Sustainable Development Scenario (SDS) for below 2°C** presents a growth opportunity for LNG carriers out to 2040. Bulk and tanker companies exposed to thermal coal and oil product transport are more at risk from decarbonisation trends.
- **Container Transport is more resilient to long- term decarbonisation trends** due to diversity in the products transported.
- **12 of the 18 companies have disclosed emission reduction targets.** 50% of these are long term Scope 1 targets out to 2050; however, these need ongoing scrutiny given the low reported board level oversight and lack of immediate technology options to decarbonise.
- **Two companies are targeting net zero emissions by 2050.** Another 2 have set Science-based targets and 2 others have aligned their targets with the 2018 IMO GHG strategy.
- **Board level oversight of climate issues is very low compared to other sectors.** Only three companies have a formal climate / environmental committee at the board level.
- **Disclosure is poor for the sector.** Only 4 companies are official supporters of the TCFD and only 5 companies in the universe completed CDP's 2018 Climate Change questionnaire.
- **There is a lack of uniformity in emissions intensity reporting** with companies using different methodologies. 12 companies report using the IMO Energy Efficiency Operational Index (EEOI) which is the most accurate measure of transport work. Other companies report on a nominal capacity basis which assumes vessels are always fully loaded.
- **NYK** is ranked in first position overall with **Maersk** and **MOL** in second and third position. Lowest ranked companies are **COSCO S.ET** and **NS United.**

1. Lloyd's Intelligence, 2017
2. This is based on an emissions intensity methodology consistent with the IMO's Energy Efficiency Operational Index (EEOI) which measures emission intensities based on the volume of cargo transported over a given distance (e.g. gCO2/t.km)

The summary League Table below presents headline company performance and ranking. It is based on detailed analysis across a range of climate related indicators which could have a material impact on company performance. The League Table is designed to serve as a proxy for business readiness in an industry which will have significant opportunities as governments increase efforts to implement the Paris Agreement. Companies placed towards the bottom are deemed less prepared for a low-carbon transition.

Figure 1: League Table summary [i]

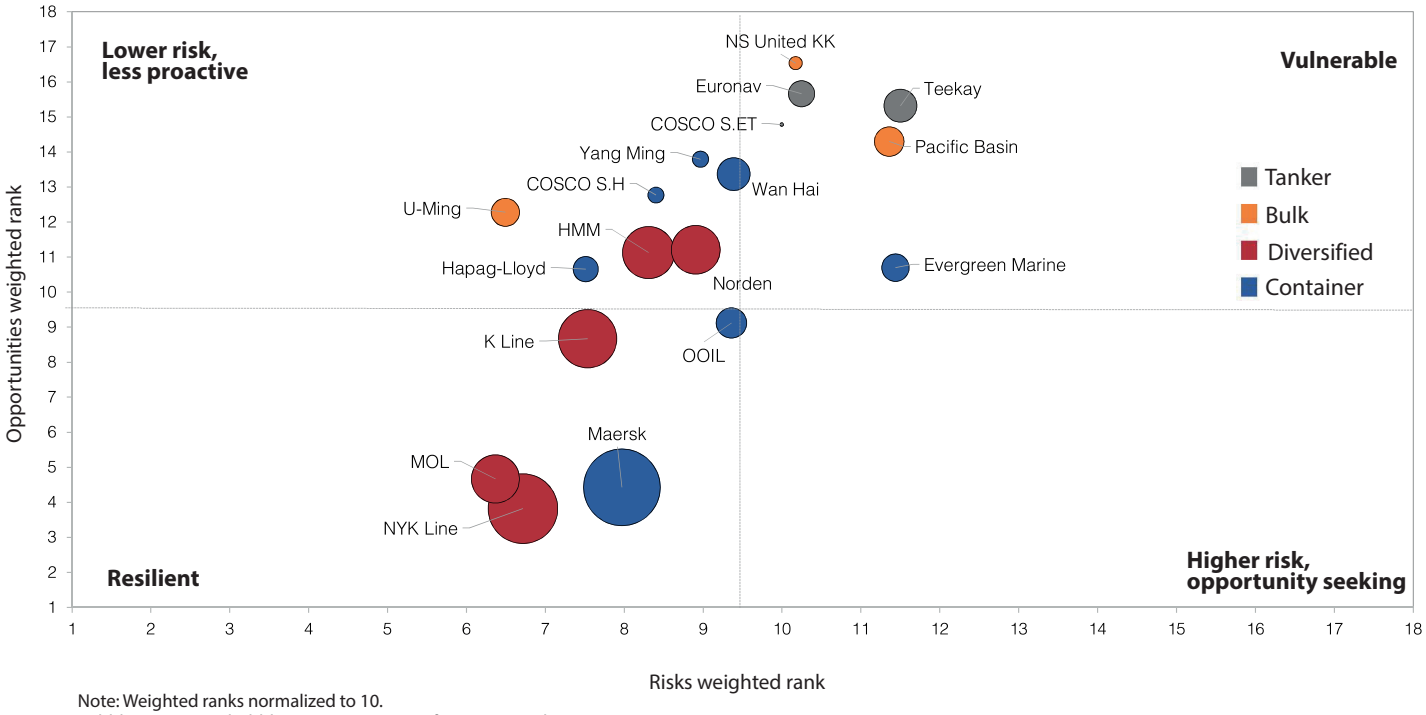
League Table rank	Company (ii)	Ticker	Stock exchange	Market Cap Average FY 2018 Q4 (US$bn)	Weighted rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank	Fleet breakdown (%)
1	NYK Line [iii]	9101 JP	TSE	3.4	4.89	3	1	2	
2	A.P. Moller-Maersk	MAERSKA DC/ MAERSKB DC	CSE	25.3	5.03	6	2	1	
3	Mitsui O.S.K[iii]	9104 JP	TSE	3.5	6.53	1	3	6	
4	K Line [iii]	9107 JP	TSE	2.2	7.43	5	4	3	
5	HMM	011200 KS	KRX	1.0	8.87	7	8	4	
6	Norden	DNORD DC	CSE	0.6	9.34	9	9	5	
7	OOIL[iv]	316 HK	HKEX	6.0	10.15	11	5	9	
8	U-Ming	2606 TT	TWSE	0.9	10.24	2	10	11	
9	Hapag-Lloyd	HLAG GR	FWB	4.5	10.32	4	6	14	
10	Wan Hai	2615 TT	TWSE	1.2	11.26	12	12	8	
11	Evergreen Marine	2603 TT	TWSE	1.8	11.55	17	7	12	
12	COSCO S.H [iv]	601919 CH/1919 HK	SSE/HKEX	5.4	11.91	8	11	16	
13	Yang Ming	2609 TT	TWSE	0.7	12.40	10	13	15	
14	Pacific Basin	2343 HK	HKEX	0.9	12.46	16	14	10	
15	Teekay	TK US	NYSE	0.3	12.58	18	16	7	
16	Euronav	EURN BB	BXS	1.6	12.72	15	17	13	
17	NS United KK	9110 JP	TSE	0.5	13.86	14	18	17	
18	COSCO S.ET	600026 CH/1138 HK	SSE/HKEX	2.4	13.94	13	15	18	
Weighting						**35%**	**30%**	**35%**	

Fleet breakdown (%): Offshore, Other, LNG, Car Carriers, Tankers, Bulk, Container

(i) Weighted ranks are calculated for each area. We display non-weighted ranks in this summary for simplicity only.
(ii) Only K Line, Maersk, MOL, Norden and NYK Line responded to CDP's 2018 Climate Change questionnaire. We encourage investors to raise the lack of transparency by other companies in discussions with company management.
(iii) K Line, NYK Line and Mitsui O.S.K formed a joint venture to form the Ocean Network Express (ONE) in April 2018.
(iv) COSCO S.H acquired a majoriy equity stake in OOIL in July 2018.

Source: CDP

Figure 2: Opportunity vs. risk for low-carbon transition

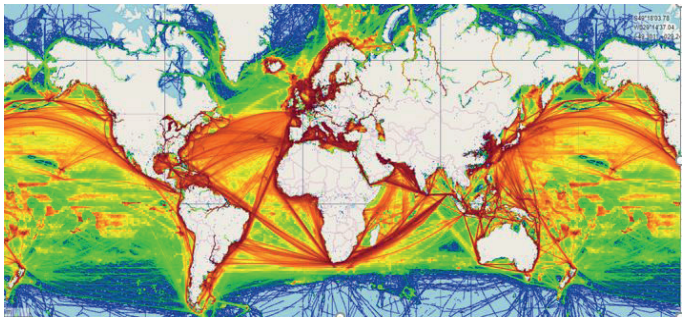


Note: Weighted ranks normalized to 10.
Bubble size: Larger bubble size = stronger performance on climate governance & strategy.
Source: CDP

Overview

Marine freight transportation is an integral part of the global economy, transporting around 80% of the world's trade in physical goods. Since the turn of the century the volume of cargo transported has increased by more than 78%; driven mostly by growing demand from countries in Asia. Trade flows to the region have increased significantly and in 2017 was the destination for more than 60% of all tonnage traded[3].

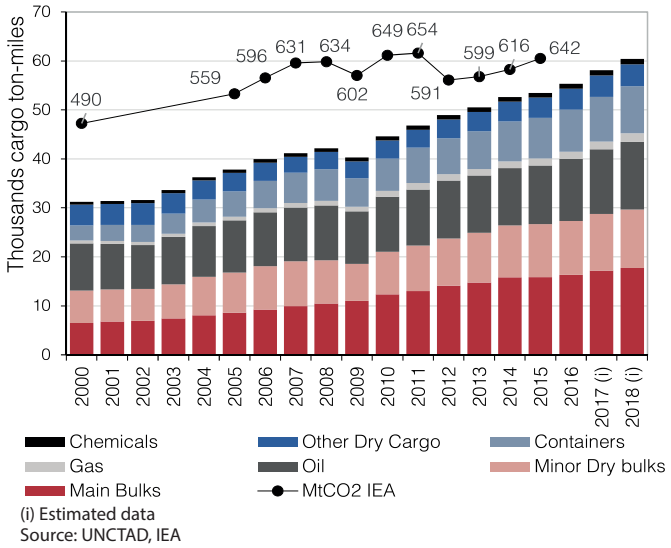
Figure 3: Shipping density map



Source: Marine Traffic

As an integrated part of the global supply chain, growth in marine transport is contingent upon continued growth in the global economy. Based on current projections of GDP, growth in seaborne trade is expected to increase between 3 – 4% per year in the near term; with growth in Container, Bulk and Tanker products accounting for much of this growth. The transport of these products forms the majority of shipping sector activity and accounted for around 85% of global shipping capacity in 2018.

Figure 4: World seaborne trade 2000 - 2018



(i) Estimated data

Source: UNCTAD, IEA

Figure 5: Shipping divisions and share of global activity

Segment	Commodities Traded	tonne-miles
Bulk	Iron ore, coal, grain, bauxite, nickel ore, steel	49%
Tanker	Crude oil, refined oil products, gas, chemicals	27%
Container	Containers	16%
General cargo	General cargo	8%

Source: UNCTAD

Shipping accounts for 2 - 3% of global emissions and roughly 10% of transport emissions; the majority of this consisting of Scope 1 emissions generated from fuel combustion during vessel operation. Based on current technologies, marine freight is one of the least emissions intensive modes of transportation when measured on a transport work basis (e.g. gCO_2 / t.km). This is due in part to the difference in capacity to other modes of transport which allow for more cargo to be transported per unit of fuel combusted.

Reporting emissions intensity on a capacity utilisation basis rather than a nominal capacity basis is key to understanding performance and benchmarking emission intensities.

There is evidence that the sector has begun to decouple its GHG emissions from increases in freight demand, with emissions increasing at half the rate of cargo transported between 2000 – 2015. However, the IMOs 2014 GHG Study estimated that the sector's absolute emissions could increase between 50 - 250% by 2050 (2012 base year) under the IMO's BAU scenarios depending on future growth in the global economy, the penetration rate of alternative fuels and progress made in improving overall fleet efficiency[4].

To avoid these future scenarios, it is necessary for the sector to adopt a combination of technical and operational measures to decouple GHG emissions from future increases in demand. In the past the impetus for pursuing such measures was an indirect consequence of companies seeking better fuel economy in response to high oil prices; however, in recent years there has been growing pressure from the IMO and other stakeholders for companies to take more action, putting decarbonization efforts high on the list of strategic considerations for companies.

This is perhaps best reflected in the IMO's GHG Strategy introduced by the MEPC in April 2018 which targets a 50% minimum reduction in absolute emissions from 2008 by 2050. There is also a clear committment from the IMO to align this strategy with the ambitions of the Paris Agreement upon its revision in 2023.

The Perfect Regulatory Storm

These considerations are taking place against a backdrop of wider regulatory changes that have significant implications for companies' CAPEX and OPEX decisions in the short-term.

IMO 2020 Sulphur Cap designed to limit the maximum sulphur content of Heavy Fuel Oil (HFO) from 3.5% m/m to 0.5% m/m (mass by mass) comes into force on 1 January 2020. HFO currently accounts for 75% of all fuels consumed within the sector. Unless vessels are equipped with scrubbers, companies will be forced to shift to compliant fuels such as Marine Gas Oil (MGO) – 0.1%m/m or Very Low Sulphur Fuel Oil (VLSFO) – 0.5% m/m which are expected to trade at a significant premium to HFO. Fuel accounts for 50 - 60% of a vessels' total operating costs. The increase in fuel costs would impact cashflows and test the resilience of companies' balance sheets. This could potentially compromise their ability to finance low-carbon technical measures in the short-term.

Water Ballast Management Convention, designed to stop the spread of invasive marine species in the ballast water of vessels, presents similar challenges. Companies must weigh up the costs of retrofitting non-compliant vessels in their fleet vs selling / scrapping them. Vessels that are young but non-compliant will need to be retrofitted to continue in operation Post-2024. Older non-compliant vessels can follow the normal asset cycle or be retired early if retrofitting is uneconomic. The level of disruption caused will be dependent on the age profile of companies' fleets and the share of non-compliant vessels. Companies that are diversified, have a high degree of fleet flexibility (both in terms of the products they transport as well as the share of vessels on short-term leases) are arguably better placed to adapt in the event of an acceleration towards a low-carbon economy.

From as early as 2006 The Marine Environmental Protection Committee (MEPC) recognised that operational and technical measures may not be enough to reduce GHG emissions and explored the introduction of **Market Based Measures (MBMs)** as a way of creating the right economic incentives for companies to adopt lower carbon technologies.

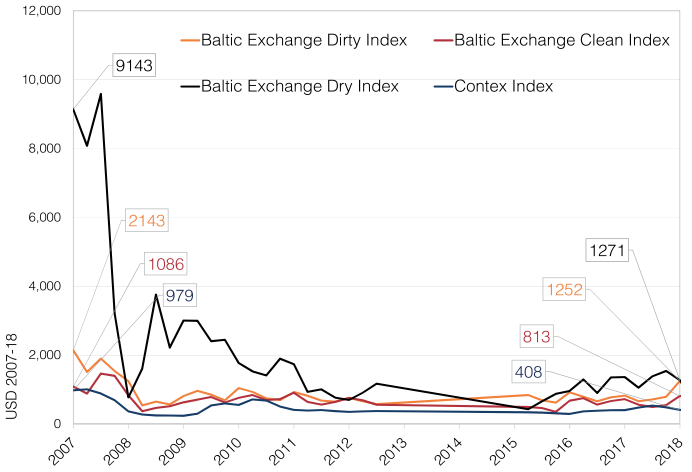
3. UNCTAD, 2018
4. IMO, 2015

Though discussions within the IMO have stagnated in recent years MBMs remain an ever-increasing possibility in the short-medium term, especially in-light of the IMO's 2018 GHG strategy and the price differences between fuel oil and lower carbon alternatives that are expected to persist in the short-medium term.

A Fragile Market

The shipping sector is only beginning to recover from historic lows in freight rates caused by an oversupply of capacity in the market in the wake of the financial crisis. Tight market conditions combined with growing geopolitical uncertainty make these strategic considerations all the more critical. Companies that are able to weather these changes whilst also positioning themselves for a 2°C trajectory will be better placed to provide a more competitive offering to their customers.

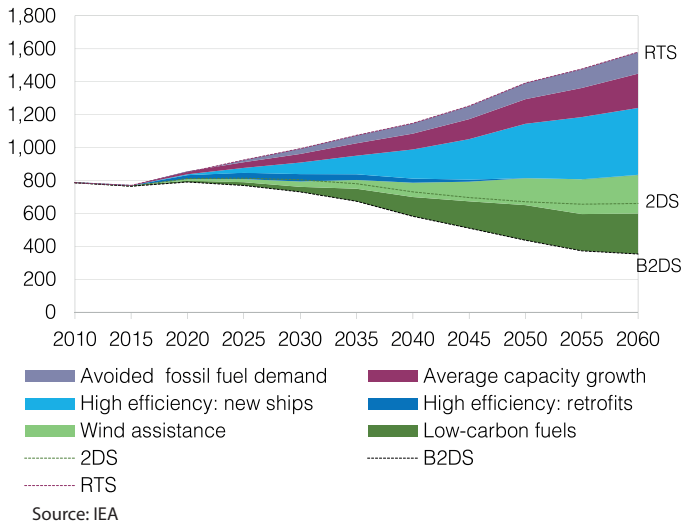
Figure 6: Freight rates 2007-18



Source: Bloomberg

Longer term there are potential risks from changes in the demand for some of the key commodities transported by companies under low-carbon scenarios. Under the IEA's Sustainable Development Scenario (SDS) which targets a 1.75°C decarbonisation pathway, demand for coal and crude oil are expected to fall by 42% and 40% by 2040 respectively. In 2017 coal accounted for 38% of all major bulk products transported whilst crude oil accounted for 60% of the oil & gas tanker trade[3]. Following a decarbonisation pathway consistent with the commitments set out in the Paris Agreement could have severe implications for companies who derive a large share of their revenue from transporting these products.

Figure 7: Well to wake GHG emissions in international shipping



Source: IEA

Companies that are diversified, have a high degree of fleet flexibility (both in terms of products that can be transported as well as the share of vessels on short-term leases) are arguably better placed to hedge against an acceleration towards a 2-degree world.

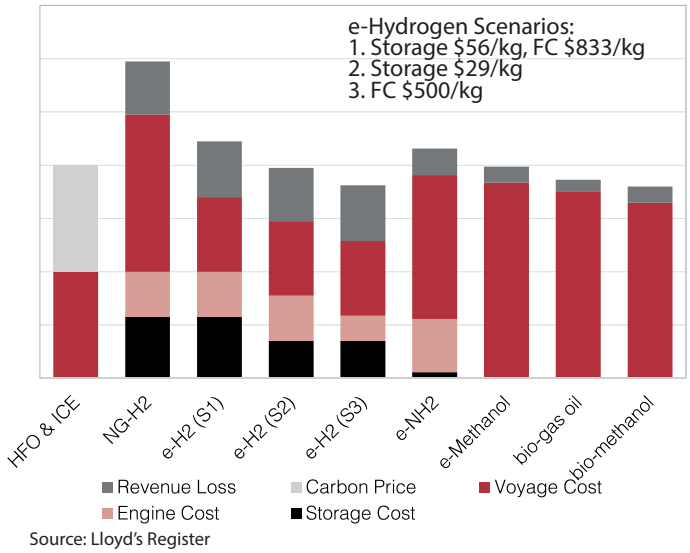
Emission Reduction Options

Achieving the ambitions set in the IMO's GHG Strategy will require companies to improve the operational efficiency of their operations. This will involve better voyage planning, weather routing and vessel utilisation; for which there are already strong economic incentives. Slow-steaming is also a measure that can deliver fuel savings in the region of 10-50%. However, it requires that vessels are optimised for operating at low speeds whilst also having the potential to distort the market by driving up freight rates if companies choose not to increase fleet capacity to compensate for lower lifting volumes.

With respect to the technical measures available to companies, retrofitting vessels with fuel efficient modifications and replacing older vessels with younger more fuel-efficient alternatives represent the low hanging fruit for the sector. The IEA estimate that these measures could account for 37% of emission reductions by 2050. In the short-medium term the use of lower carbon fuels like LNG present a lower carbon alternative to the current use of Heavy Fuel Oil (HFO) but studies show that the emissions savings on a life cycle basis are only around 10% compared to the HFO used today.

Longer-term, Biofuels, Hydrogen or Ammonia based fuels produced using renewable energy ("electro-fuels") and/or CCS present a potential carbon neutral energy source for the sector. However, significant questions remain about the economic and technical feasibility of these options. A study conducted by UMAS showed how even in a scenario where renewable energy capacity expanded significantly allowing for the energy intensive process of producing electro-fuels, Fuel Oil vessels would still remain competitive compared to the alternatives, even in the presence of a $80/tonne carbon price.

Figure 8: Projected annual costs of fuel options 2030



Source: Lloyd's Register

The operating life of most vessels is around 20-30 years. Given the time horizons over which transformative technologies for the sector can be expected to materialise, companies need to think carefully about their purchasing decisions in the short-term. Introducing vessels into the fleet that only marginally improve on the emissions performance of existing vessels may compromise their ability to meet longer term emission reduction targets by locking in emissions that could be more effectively abated by waiting for more transformative technologies to become viable.

Key report findings[5]

Transition risks

- **Container transport is the most emissions intensive subsector** but has achieved the highest emission reductions across the sub-sectors. Wan Hai have made the most progress, reducing their emissions by a CAGR of -9.0% between 2012-17. MOL come first overall.
- **There is a lack of uniformity in emissions intensity reporting.** Most companies are disclosing a measure consistent with the IMO's EEOI. However, just under half the container liners report using a nominal capacity-based measure (assumes vessels are always fully loaded) or lack clarity on the methodology used.
- **Roundtrip Utilisation data is not well reported.** Given the preference for many container liners to disclose emission intensities on a nominal capacity basis, information on utilisation rates is surprisingly scarce.
- **Emissions from the Bulk and Tanker divisions have stagnated.** NYK and MOL top these sub-sectors with both companies having low intensities whilst also making progress to reduce their intensities relative to their peers.
- **Retrofitting existing fleets could be the most capital efficient strategy to reduce emissions in the short term** - Maersk leads the way having spent $1 billion over a four-year period retrofitting 150 vessels with measures that can deliver emission reductions up to 20%.
- **Turnover of companies' owned vessels have mostly served to reduce the age profile of their fleet.** With Wan Hai and Pacific Basin the only exceptions.
- **Thermal coal and crude oil transport are the services most at risk** from decarbonisation trends with the Tanker company Euronav particularly exposed due to a lack of diversification.

Transition opportunities

- **Little evidence of research into step-change technologies such as hydrogen or ammonia-based fuels** with most companies having already capitalized on low hanging fruits through technical and operational measures.
- **The level of transformative innovation is extremely low.** 15 out of the 18 companies have failed to deploy any technologies considered to be transformative.
- **Maersk and Norden are the only companies actively pioneering 2nd generation biofuels.** NYK are also collaborating on the development of a zero-emission vessel for 2050.
- **Collaboration with OEMs is low compared to other sectors.** From our analysis of the capital goods sector we found that 34% of innovations were directed towards power sector customers compared with 8% for the maritime industry.
- **Radical and transformative marine innovations from the capital goods sector represented only 10% of innovations** compared to 70% for the power sector.
- **The most active area of technical innovation is the development of LNG as a marine fuel.** Ten of the 18 companies are taking steps to facilitate or integrate LNG fuel into the industry.
- **Slow steaming is an important short-term lever capable of delivering emission reductions up to 30%** - 13 of the 18 companies were found to have a slow steaming strategy tied to environmental benefits. K Line, HMM, Euronav and COSCO S.H make reference to "super slow steaming" practices[6].
- **Companies with more sophisticated data management platforms are better positioned to optimize their voyages** delivering efficiency gains. 5 companies have been actively collaborating on the development of advanced voyage data management platforms with technology providers.
- **Less than half of the companies have deployed some form of financial or circular innovation.**
- While most companies have waste management programs only **6 have actively innovated to transition to a more circular model of shipping.**

Governance & Strategy

- **12 of the 18 companies have Scope 1 emission reduction targets** with more than half of these being long term commitments out to 2050. However, these need to be taken in the context of lower board level oversight and limited technology options available to provide a step change in emission reductions.
- **Maersk and HMM have set net zero emission targets for 2050.** Both companies are exploring alternative fuel options with Maersk having a slightly greater emphasis on Biofuels and HMM on Hydrogen.
- **NYK Line and K Line have both set Science-based targets** and Norden and Evergreen Marine have sought to align their targets with the 2018 IMO GHG strategy.
- **U-Ming, Wan Hai and Euronav were the only companies to have climate / environmental committees at the Board Level** with most companies possessing committees at the executive and sub-executive levels.
- **Climate expertise at the board level is low**, with only 9 companies judged to have board members with climate related experience; with NYK ranking top.
- **Of the 15 individuals identified, 67% had low or very low climate related expertise,** with only 5 people deemed to have a medium level of climate experience
- **Only Maersk, NYK, MOL and K Line were official supporters of the TCFD.** These companies made up 4 of the 5 companies that disclosed to CDP's 2018 Climate Change questionnaire; Norden being the fifth.

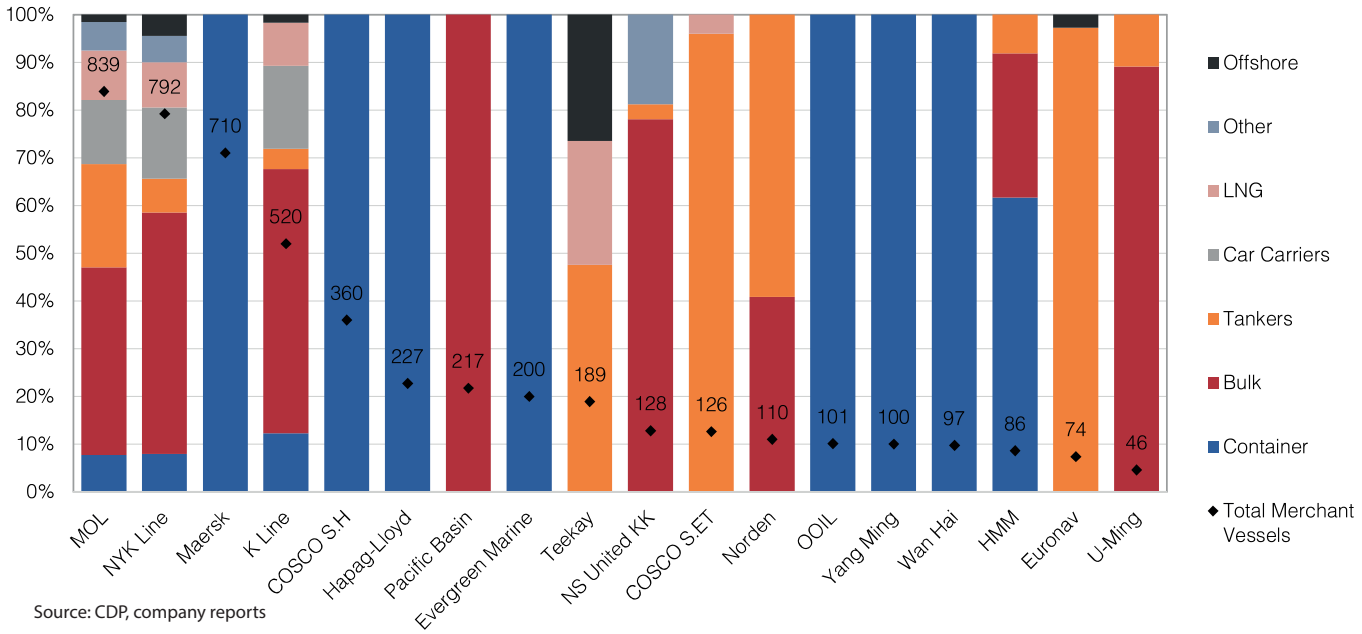
5. Summaries for each company listing strengths and weaknesses can be found in Appendix II on page 53.
6. "Slow steaming" ~20 knots (23 mph), "Super Slow Steaming" ~12 knots (14mph)

Company selection and classification

Companies were selected from among the largest publicly listed shipping companies based on 2018 market capitalization, CDP disclosure and companies' fleet capacities across the Bulk, Container and Tanker divisions (fleet breakdowns shown in Figure 9).

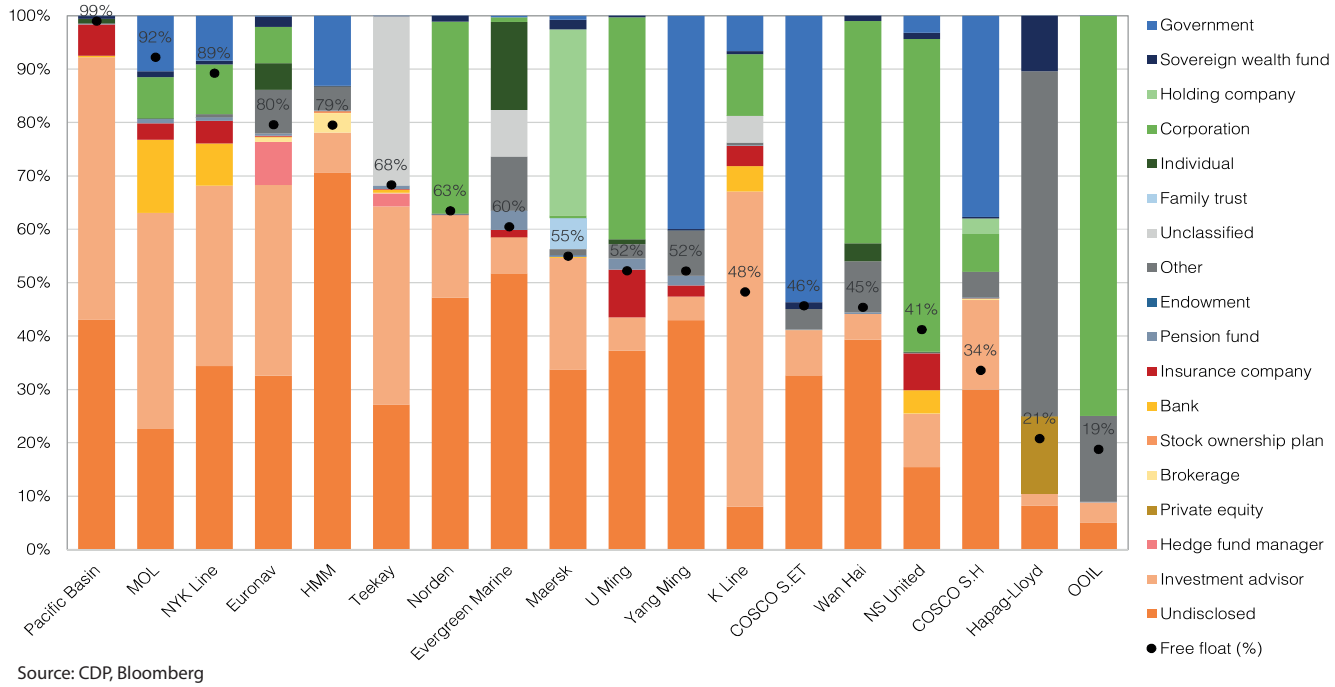
The chosen 18 companies represent approximately US$62 billion in market capitalization and in aggregate represent approximately 47% of the container transport market, 17% for bulk and 13% of the oil tanker market when assessed on a DWT capacity basis.

Figure 9: Fleet breakdown



Source: CDP, company reports

Figure 10: Ownership breakdown and free float percentage



Source: CDP, Bloomberg

Only 5 companies in our sample responded to requests to complete CDP's 2018 Climate Change Questionnaire (A.P. Moller – Maersk, Norden, Mitsui O.S.K, Kawasaki Kisen Kaisha, Nippon Yusen Kaisha). Two companies who did not respond to the 2018 questionnaire have responded to past disclosure requests, these include Hyundai Merchant Marine and Teekay. A large number of companies did not respond to CDP's 2018 CC questionnaire.

Linking our findings to investment choices

We recognize that investment decisions are based on a multitude of different factors and that some of these can be misaligned with emission-reduction efforts. Our League Table identifies company readiness for the transition to a low-carbon economy and the physical impacts of climate change, meaning that companies towards the bottom of our League Table are potentially higher risk investments from a climate change perspective than those towards the top.

Methodology

We score each company based on a number of metrics which are ranked and then weighted within each key area (see Figure 11 for metric weightings within each key area). We then assign traffic light colours based on these weighted ranks. We calculate the overall League Table score by collating the weighted ranks for each key area. Each of the key areas has a separate chapter within this report.

For certain metrics where we have calculated a trend, the continuous compound growth rate (r) (exponential trend) is first calculated over all data points and then converted to an equivalent CAGR using exp(r) -1.

Data is compiled from multiple sources including: CDP questionnaire responses, company annual reports, SEC filings, CSR reports, websites, investor presentations and third party sources such as Bloomberg and VesselsValue.

Figure 11: A summary of key areas, associated metrics and weights within the League Table

Key area in League Table	Financial impact	Metrics	Metric weighting	Key area weighting
Transition risks	Emissions from the sector are coming under greater scrutiny from regulatory bodies, creditors and customers. Companies who are reducing their emissions and have strong balance sheets will have greater resilience in response to these growing pressures. Wider decarbonisation trends in power generation and transportation could have an impact on the demand for some of the commodites transported by companies.	• **Average Age** *Average Age (50%), Retrofitting Activity (50%)*	25%	35%
		• **Fleet turnover**	15%	
		• **Emissions intensity**	30%	
		• **Capital flexibility** *Probability of Default (35%), Gearing (15%), Liquidity (15%), EBIT Margins Adj (15%), % Share of Chartered Vessels (20%)*	20%	
		• **Business resilience**	10%	
Transition opportunities	Reducing emissions by adopting operational measures and collaborating with OEMs to develop the next generation of fuels and technologies will allow companies to better position themselves for a low-carbon economy.	• **Technical innovation scorecard**	60%	30%
		• **Operational innovation scorecard**	30%	
		• **Business innovation scorecard**	10%	
Climate governance & strategy	The ambition of companies' emission reduction targets, the quality of disclosure and the the strength of climate governance provides insight into companies' strategies and preparedness for responding to climate-related risks and opportunities.	• **Emission reduction targets**	30%	35%
		• **Board level climate expertise and management**	30%	
		• **Disclosure scorecard**	30%	
		• **Ship recycling governance**	10%	

Source: CDP

Transition risks

- Emissions Intensities from container transport have reduced but Bulk and Tanker intensities show evidence of stagnation.
- MOL ranks first and are among the top companies for emissions intensity disclosure and performance.
- Teekay are ranked last performing poorly on average age and capital flexibility.

Overview

Shipping is an integral part of the global supply chain with the Scope 1 emissions of the sector forming the Scope 3 emissions of their customers. CO_2 emissions from the shipping sector are not directly regulated in the way that they are in other industries nor is there at present a carbon price or ETS for the industry to provide strong economic incentives to follow a 2°C trajectory. However, as the end markets that shipping companies service are exposed to direct climate regulations, shipping companies will face greater pressure from their customers to demonstrate that they are taking measures to reduce their carbon footprint.

There is also growing momentum from banks and other creditors to the industry to introduce greater transparency on the climate alignment of their ship finance portfolios through initiatives such as the Global Maritime Forum's "Poseidon Principles". Integrating climate risk into lending decisions will require greater transparency from companies on the emissions profile of their operations and apply pressure on companies to ensure they are following a trajectory aligned with the IMO's GHG Strategy.

This is not withstanding a growing pressure from within the IMO. There is at present a lack of climate related regulatory levers that present a legitimate risk to shipping companies, and existing measures such as the Energy Efficiency Design Index (EEDI) are not currently aligned with the IMO's GHG reduction targets. However, there is a growing appetite from IMO member states for such measures to be introduced.

The current emissions profile of companies' fleets is therefore relevant and correlates with the way that regulatory and stakeholder pressure is exerting itself. However, the current emissions profiles of companies' fleets are not necessarily an indicator of the trajectory that they will follow in the future. The long life of shipping assets and the lack of current alternatives to existing fuels mean that investing in new vessels that deliver only marginal efficiency gains will lock in emissions and potentially compromise the ability of companies to meet future targets.

Companies that are sweating existing assets and taking steps to retrofit the existing fleet could allow companies room to conserve CAPEX for the next generation of ships capable of delivering material CO_2 reductions. This strategy would only be acceptable if companies were actively working with OEMs to develop new technologies to provide the step change needed for the the sector to be aligned with 2°C pathway or had a clear articulation of their strategic intention to decarbonise.

Transition risks are assessed in this chapter using the following 5 metrics:

Metric 1) Fleet Average Age (25%): This metric compares the average age of companies Bulk, Container and Tanker Divisions as at 31 December 2017. This metric is also supplemented with companies' retrofitting activity to account for the limitations of using the average fleet age as a proxy for technical efficiency.

Metric 2) Fleet Turnover (15%): This metric ranks companies based on the difference between the weighted average age of their (1) scrapped & sold vessels and (2) purchased & newbuild vessels. Companies with the largest differential between these two measures rank highest.

Metric 3) Emissions Intensity (30%): We assess the emissions intensity level and trend of companies Bulk, Container and Tanker vessels between 2012 – 2017.

Metric 4) Capital flexibility (20%): This metric evaluates the financial performance of individual companies by assessing their profitability, gearing, liquidity and default probability. We also look at the share of chartered to owned vessels as a measure of asset liquidity.

Metric 5) Business resilience (10%): This metric examines companies' exposure to long term climate related risk, focusing on commodity risks associated with changes in end market demand, measured by the IEA's Sustainable Development Scenario (SDS), Below 2°C Scenario (B2DS) and McKinsey's accelerated technology scenario.

Overall highlights

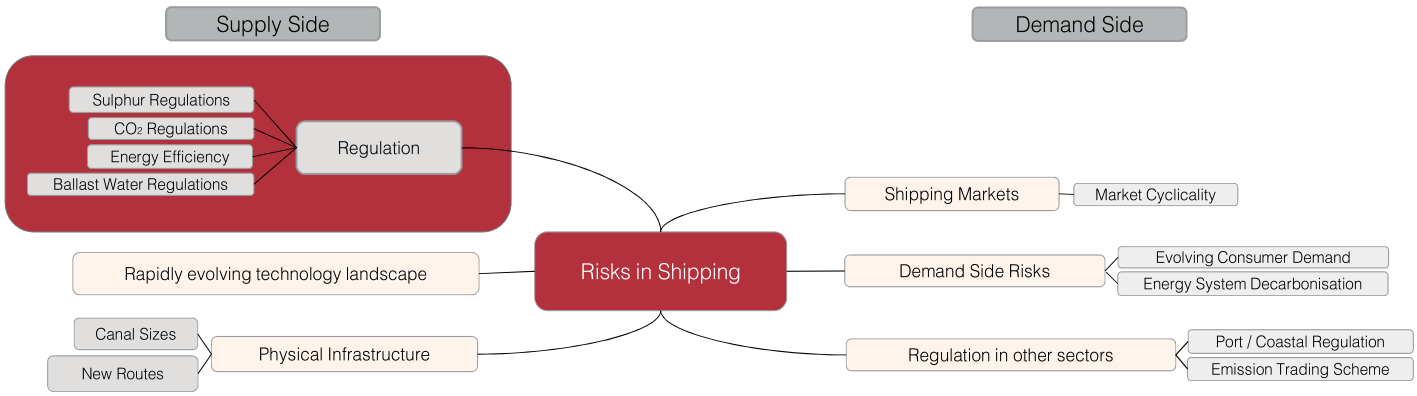
- MOL are ranked in first position. They rank second on the emission intensity metrics having made good progress to reduce their emissions across the bulk, container and tanker divisions. This is reinforced by their fleet turnover over the 2012 – 2018 period with MOL having introduced a large number of newbuild vessels whilst also making efforts to sell and scrap some of their older tonnage.
- The bulk transporter U-Ming is ranked in second position. U-Ming have the second youngest fleet of bulk vessels. Although the emission intensities from their vessels are among the highest they have made significant progress reducing their emissions, with a CAGR of -2.9%. U-Ming's balance sheet is also strong with EBIT margins averaging 8.5% between 2017-18. However, U-Ming are potentially more exposed to long term climate related risk with more than 25% of their shipped products in 2017 coming from coal transportation.
- NYK are ranked in third position. Like MOL, NYK has made good progress reducing the emissions intensity of their fleet and report the EEOI for the divisions in which they operate. Both companies offer a diverse portfolio of transport services, some of which are at risk from long term decarbonisation trends. However, MOL and NYK have two of the largest fleets of LNG vessels in the world. With LNG demand expected to double by 2040, even in a below 2°C scenario.
- Pacific Basin are ranked sixteenth. The emissions profile of their fleet has increased significantly over the 2014-17 period by an average of 8.5% per annum. They are also one of only two companies where the net average age of their fleet turnover is positive with Pacific Basin choosing to purchase a number of second-hand vessels over this period. However, Pacific Basin do transport a number of bulk commodities that are expected to remain resilient to decarbonisation trends in the long run.
- Evergreen Marine and Teekay are ranked last. Teekay performs poorly across the capital flexibility metrics being highly leveraged and having one of the highest default probabilities among the 18 companies. Evergreen Marine have a relatively old fleet of container vessels and have shown little evidence of undertaking retrofitting measures for their vessels.

Figure 12: Transition risks summary

Company	Average Age	Fleet Turnover	Emissions Intensity	Capital Flexibility	Business Resilience	Overall weighted rank	Transition Risk Rank
MOL	10	4	2	8	9	6.37	1
U-Ming	1	5	5	4	15	6.49	2
NYK Line	13	2	1	11	12	6.71	3
Hapag-Lloyd	9	1	13	14	1	7.51	4
K Line	15	3	3	15	11	7.54	5
Maersk	11	9	10	2	8	7.97	6
HMM	3	8	15	16	7	8.31	7
COSCO S.H	8	13	7	10	3	8.40	8
Norden	4	14	8	5	17	8.91	9
Yang Ming	16	6	4	18	6	8.97	10
OOIL	12	11	14	3	5	9.36	11
Wan Hai	14	17	12	1	1	9.39	12
COSCO S.ET	5	16	9	13	16	10.00	13
NS United KK	2	7	18	6	14	10.17	14
Euronav	6	15	11	12	18	10.25	15
Pacific Basin	7	18	17	7	10	11.36	16
Evergreen Marine	18	10	16	9	4	11.44	17
Teekay	17	12	6	17	13	11.50	18
Weighting	**25%**	**15%**	**30%**	**20%**	**10%**		

Note: In calculating the weighted rank in this table, we use the weighted rank for each area. We display non-weighted ranks in this summary for simplicity only.
Source: CDP

Figure 13: Potential drivers of risks faced by shipping companies



Source: UMAS

Fleet average age

Here our analysis focuses on the average age of companies Bulk, Container and Tanker vessels. Since the introduction of the IMO's Energy Efficiency Design Index (EEDI) which requires that all new vessels of a certain size meet a minimum level of energy efficiency, the average age of a vessel can be more tangibly linked to its technical efficiency. Given the technology options available today and limitations in their abatement potential, coupled with the long life of shipping assets, we have not penalised companies with a higher average age if they have shown evidence of engaging in retrofitting activities that improve their technical efficiency. We recognise that devoting capital towards new vessels may result in locked in emissions that will not deliver the emission reductions needed. Conserving CAPEX for transformative technologies in the medium term could leave companies better placed to meet long term reduction targets.

Average Age (50%): We look at the average age of companies Bulk, Container and Tanker fleets as at 31 December 2017 on an average and weighted average (nominal capacity) basis. The age of a vessel is determined by taking the time that has elapsed at the beginning of vessels' build years and the 31 December 2017. For companies who have disclosed fleet lists close to this date, we adjusted the average age assuming the stock of vessels remained unchanged between the date of disclosure and the 31 December 2017. The final rankings are calculated by aggregating the average age in each division by the number of vessels used in the calculation.

Retrofitting Scorecard (50%): Here we use a scorecard approach to look at the retrofitting activity of companies. We looked at the abatement potential of the technologies companies have identified in their reporting, the scope of the companies' retrofitting activities and whether any reference is made to the IMO's Shipping Energy Efficiency Management Plan (SEEMP), part of which includes the adoption of certain technical measures. Where the inclusion of the retrofitting metric improved a companies' overall ranking it was taken into account.

Highlights

- The bulk transporter U-Ming ranks in first position. U-Ming have the third youngest fleet of bulk vessels when measured on a nominal capacity basis. They also have one of the youngest fleet of Tanker vessels but these make up only 13% of their overall fleet. U Ming operate four very old cement carriers that were built in the 1980's – 1990s which acted as drag on the average age of their bulk vessels.
- NS United and Norden are ranked in second and fourth position respectively. NS United have the second youngest fleet of bulk vessels at 6.0 years which make up more than 98% of their fleet. Norden have the youngest fleet of bulk vessels at 5.6 years but rank third for the age of their tanker vessels.
- HMM are ranked in third position. They have the youngest fleet of container vessels with an average age of 7.4 years, these make up around 54% of HMM's total fleet with HMM's bulk vessels also being relatively young compared to their peers. HMM's tanker vessels are among the oldest but these made up only 11% of their vessels in 2017. HMM have also taken significant steps to retrofit vessels within their fleet with the combined abatement potential of the technologies identified close to 19%.
- Maersk rank first for the retrofitting component of this metric. Over the last 4 years they have spent $1 billion retrofitting around 150 vessels with technologies that can deliver efficiency savings up to 20%. This represents around 42% of the vessels that Maersk Owns. These measures include the installation of bulbous bows and derating engines to operate more efficiently at lower engine loads.

Figure 14: Average age summary

Company	Division Breakdown	Average Age	Weighted Average Age	Retrofitting Activity Rank	Retrofitting Rank Impact	Overall Ranking
U-Ming		7.4	5.4	4	↓	1
NS United		6.1	6.2	12	↓	2
HMM		7.7	n/a	2	↑	3
Norden		6.7	6.6	17	↓	4
COSCO S.ET		7.7	n/a	17	↓	5
Euronav		7.9	n/a	9	↓	6
Pacific Basin		8.2	7.6	5	↑	7
COSCO S.H		8.9	n/a	10	↓	8
Hapag-Lloyd		9.2	7.1	8	↑	9
MOL		9.1	8.5	6	↑	10
Maersk		11.7	10.0	1	↑	11
OOIL		9.8	8.0	14	↓	12
NYK Line		9.4	9.6	7	↑	13
Wan Hai		13.8	n/a	3	↑	14
K Line		9.3	8.8	13	↓	15
Yang Ming		10.5	9.8	11	↑	16
Teekay		9.9	9.8	17	↓	17
Evergreen Marine		13.0	n/a	17	↓	18

Bulk
Container
Tanker

Note: n/a due to no available data
Source: CDP, VesselsValue, Company reports, Marinetraffic.com

Figure 15: Average age - Bulk Vessels

Company	Average Age	Weighted Average Age	Vessel Coverage (%)
Norden	5.6	5.5	100%
NS United	6.0	6.1	100%
U-Ming	8.0	5.7	100%
HMM	7.5	n/a	100%
Pacific Basin	8.2	7.6	58%
MOL (i)	9.0	7.8	24%
K Line	9.4	9.0	28%
NYK Line	9.2	9.8	20%

Figure 16: Average age - Container Vessels

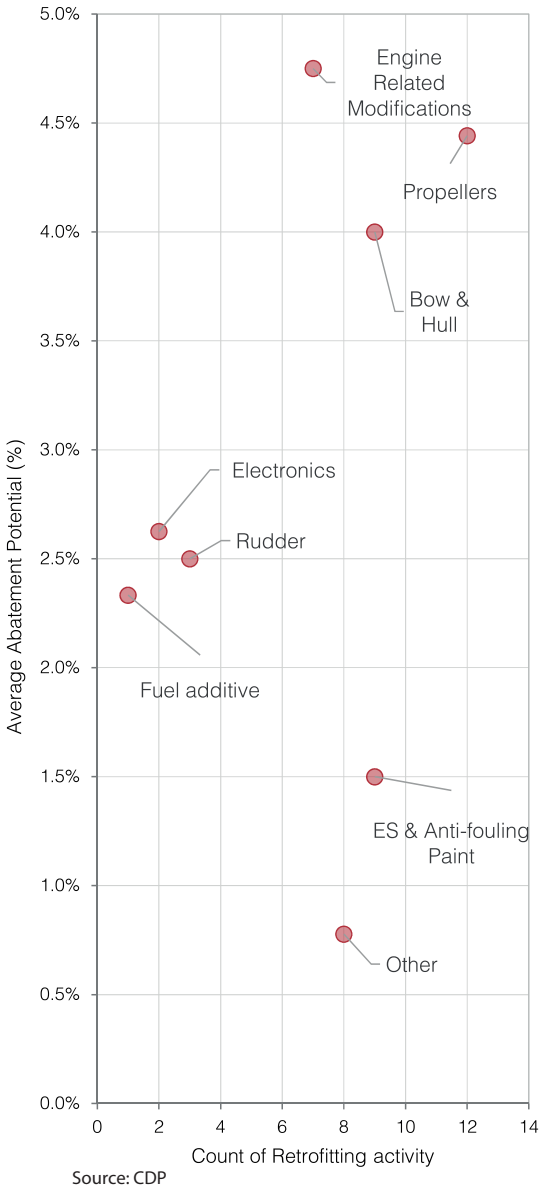
Company	Average Age	Weighted Average Age	Vessel Coverage (%)
MOL (i)	7.6	6.3	31%
HMM	7.4	n/a	100%
Hapag-Lloyd	9.2	7.1	100%
K Line	8.8	8.0	38%
OOIL	9.8	8.0	100%
COSCO S.H	8.9	n/a	100%
NYK Line	9.5	8.7	63%
Yang Ming	10.5	9.8	46%
Maersk	11.7	10.0	32%
Evergreen Marine	13.0	n/a	54%
Wan Hai	13.8	n/a	100%

Figure 17: Average age - Tanker Vessels

Company	Average Age	Weighted Average Age	Vessel Coverage (%)
U-Ming	3.7	3.8	100%
COSCO S.ET	7.7	n/a	100%
Norden	8.0	7.6	100%
Euronav	7.9	n/a	100%
Teekay (ii)	9.9	9.8	100%
MOL (i)	9.7	10.1	40%
K Line	10.1	9.9	41%
HMM	10.1	n/a	100%
NYK Line	9.8	10.7	52%
NS United	13.0	13.0	50%

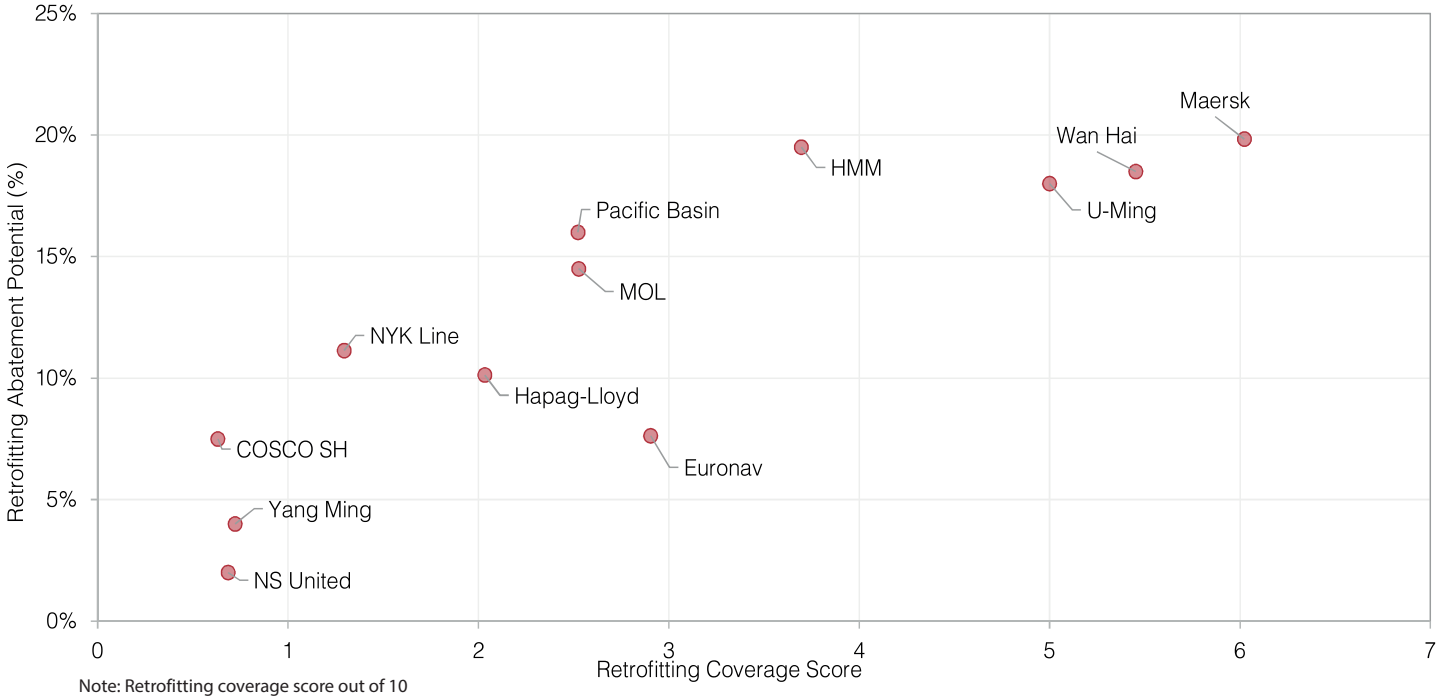
(i) The average age for MOL's full fleet at March 2017 was 7.9 for container, 9.4 for bulk and 8.9 for tanker
(ii) The average age of vessels from Teekay Tanker.
Source: CDP, VesselsValue, Marinetraffic.com

Figure 18: Retrofitting options



Source: CDP

Figure 19: Retrofitting: abatement vs coverage



Note: Retrofitting coverage score out of 10
Source: CDP

Fleet turnover

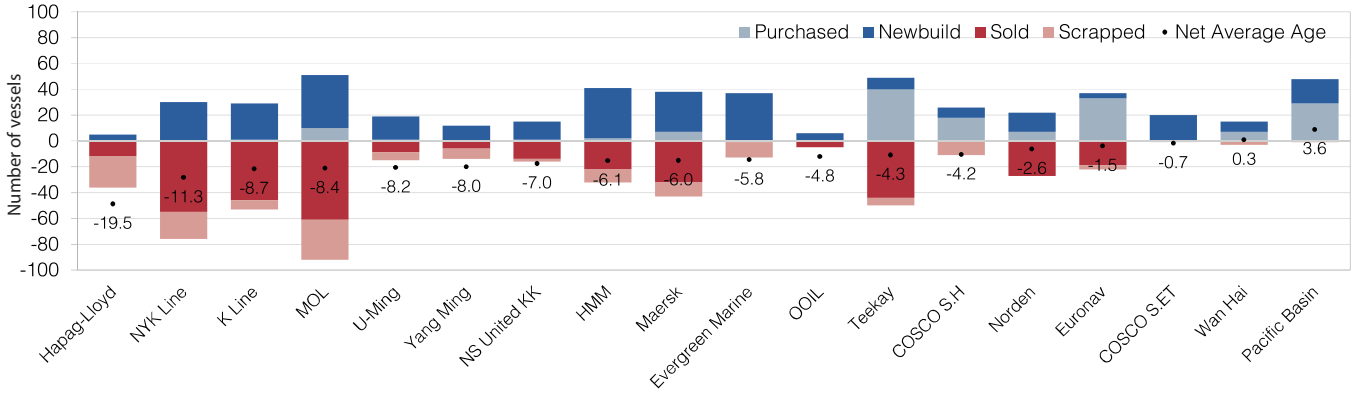
Here we assess the changes in the stock of Bulk, Container and Tanker vessels owned by companies, focusing on the age of the vessels scrapped, sold and purchased, whilst also looking at the newbuild vessels introduced into the fleet. This is assessed over the period 2012 – 2018 and does not account for chartered flows or the effect of M&A activity over this period. In this metric the vessel age is used as a proxy for their technical efficiency, with younger vessels usually being more efficient than older vessels. Companies that are scrapping and selling older vessels and introducing newer vessels into their fleet will rank highest.

Fleet Turnover: We look at the average age (normal) of Purchased + Newbuild vessels and Sold + Scrapped vessels at the point at which they enter or exit the fleet. The average age for all four of these flows is weighted relative to the total number of vessels in each category and the percentage they account for as a percentage of all flows for the company over the period. The weighted Average for (1) Purchased + Newbuilds and (2) Scrapped + Sold are subtracted from each other leaving us with the net weighted average age of all flows over the period.

Highlights

- Hapag Lloyd are ranked in first position. They have sold and scrapped close to 40 vessels with a very high average age relative to the total flows over this period. Total inflows are relatively low compared to other peers with just 5 newbuild vessels introduced into the fleet. This is partly due to M&A activity over this period. More recently Hapag Lloyd's acquisition of UASC in 2017 integrated 58 relatively young vessels into the fleet making fleet expansion less of a priority.
- NYK are in second position. They have sold a large number of Bulk and Tanker vessels over this period which together account for 74% of scrapped and sold flows. This contrasts to the inflows where container vessels made up 60% of vessels introduced. The net weighted average age of all flows was -11.3 years.
- K Line and MOL are ranked in third and fourth position respectively. K Line have sold and scrapped a large number of bulk and container vessels. For MOL the outflows have mostly been driven by scrapped Bulk and Tanker vessels. Both companies have a net weighted average age of -8.7 and -8.4 respectively.
- Wan Hai and Pacific Basin are ranked last and are the only companies where the net weighted average age is positive. Wan Hai purchased 7 carriers over this period with an average age of 13.1 years. But this has been offset somewhat by the introduction of 8 newbuild vessels into the fleet over the same period. Pacific Basin have purchased a large number of second-hand vessels with an average age of 6.7 years, but this has also been partially offset by 19 newbuild vessels incorporated into the fleet over this period.

Figure 20: Fleet turnover: consolidated 2012-2018



Source: CDP, VesselsValue

Figure 21: Fleet turnover: Bulk Carriers

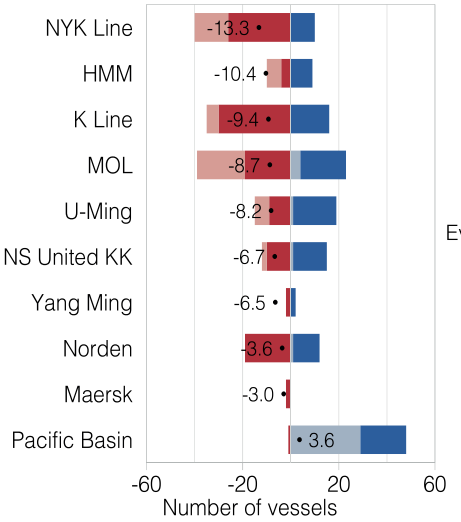


Figure 22: Fleet turnover: Containerships

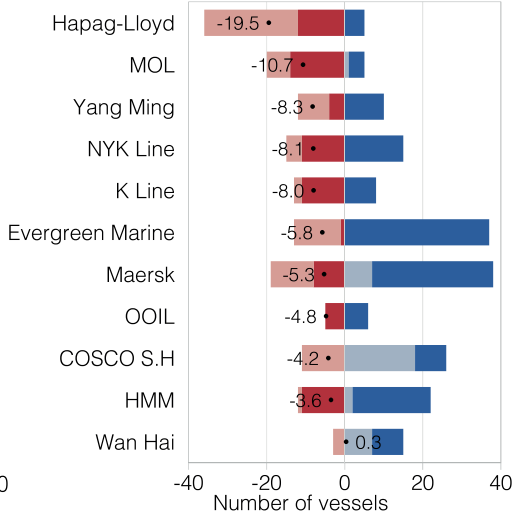
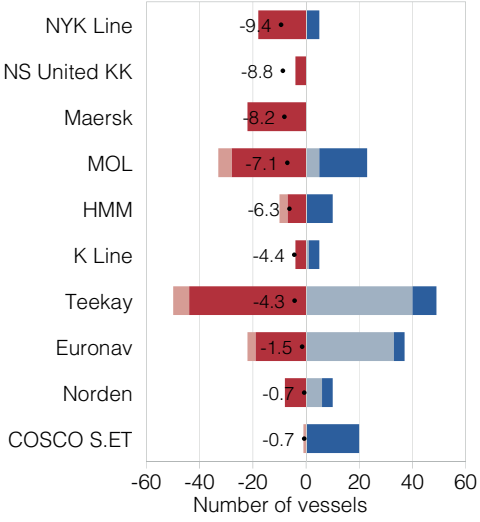


Figure 23: Fleet turnover: Tankers



Source: CDP, VesselsValue

Emissions intensity

In this metric we assess the emissions intensity of companies Bulk, Container and Tanker vessels over the period 2012 – 2017. We have collected the annual emission intensities disclosed in company reporting and have liaised with companies where this information has not been available publicly. In this report these intensities have been shown on a gCO_2/t.km basis or a gCO_2/TEU.km for the container companies. Where companies have disclosed this information using different units (e.g. gCO_2e, miles, nautical miles etc.) we have made appropriate adjustments.

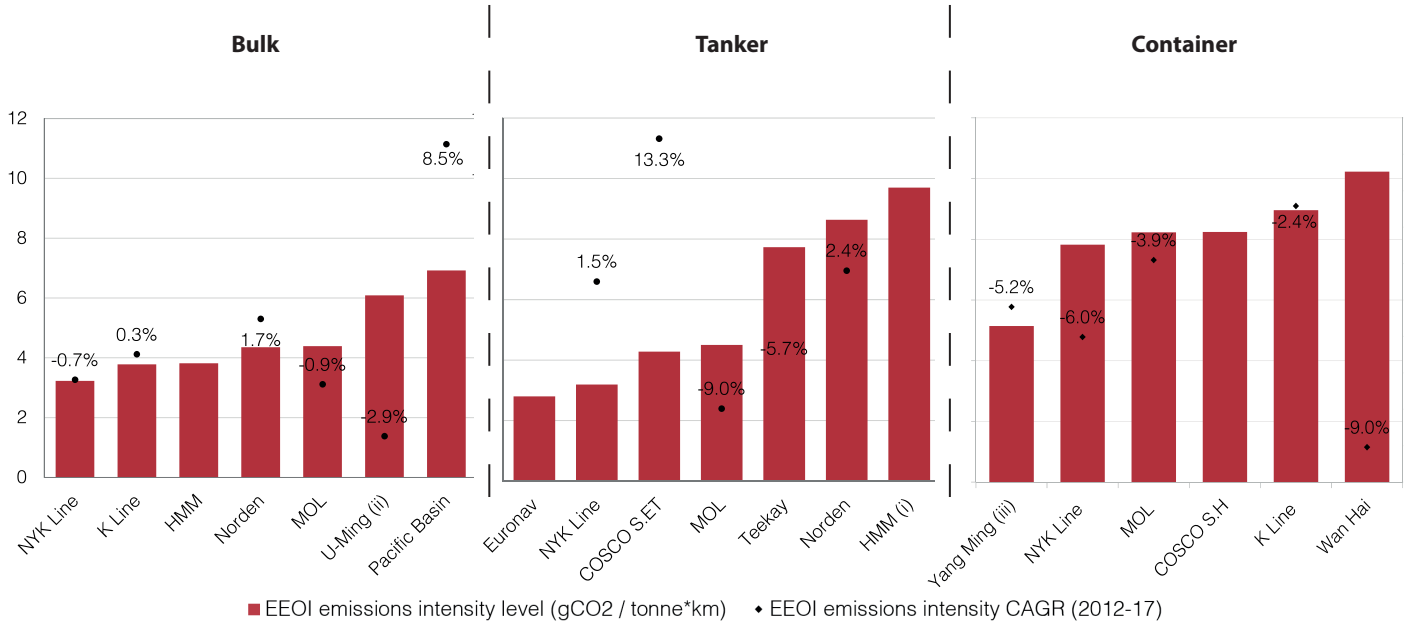
We have chosen to aggregate the company rankings in each respective division by using companies' fleet numbers as at 2017 (or the last reported calendar year for which emission intensities were disclosed). We use this as a proxy for companies' exposure to each division and multiply the company ranking in the Bulk, Container and Tanker division by their level of exposure to each market giving the overall fleet emissions weighted rank.

Figure 24: Emissions intensity summary

Company	Bulk Emissions	Exposure (i)	Container Emissions	Exposure (i)	Tanker Emissions	Exposure (i)	Overall weighted rank	Rank
NYK Line	1	72%	2	17%	2	11%	3.1	1
MOL	3	59%	1	22%	1	19%	4.4	2
K Line	2	68%	4	23%	3	9%	4.8	3
Yang Ming	n/a	0%	3	100%	n/a	0%	6.6	4
U-Ming	5	100%	n/a	0%	n/a	0%	6.7	5
Teekay	n/a	0%	n/a	0%	4	100%	8.0	6
COSCO S.H	n/a	0%	5	100%	n/a	0%	8.4	7
Norden	4	49%	n/a	0%	7	51%	8.6	8
COSCO S.ET	n/a	0%	n/a	0%	5	100%	9.1	9
Maersk	n/a	0%	6	100%	n/a	0%	9.1	10
Euronav	n/a	0%	n/a	0%	6	100%	9.5	11
Wan Hai	n/a	0%	7	100%	n/a	0%	9.6	12
Hapag-Lloyd	n/a	0%	8	100%	n/a	0%	10.7	13
OOIL	n/a	0%	9	100%	n/a	0%	11.8	14
HMM	6	5%	10	90%	8	5%	12.4	15
Evergreen Marine	n/a	0%	11	100%	n/a	0%	12.8	16
Pacific Basin	7	100%	n/a	0%	n/a	0%	14.7	17
NS United KK	8	100%	n/a	0%	n/a	0%	18.0	18

(i) To accurately aggregate companies' emissions from each division, emissions would need to be reported in the same units across all companies and we would require details of the transport work (Cargo x Distance) for each division. Due to inconsistency in the approach taken to calculating emission intensities (some companies reporting based on nominal capacity others based on the actual cargo transported) and no visibility of the transport work for each respective division we have decided to take the approach as described.
Source: CDP

Figure 25: Relative subsector performance in EEOI emissions intensity [(i)]



(i) Trends were calculated using avaliable data points across the period.
(ii) U-Ming intensity is an aggregate of reported figures.
(iii) Yang Ming have disclosed their EEOI intensity in gCO_2 / TEU.km. The CCWG estimate that 1 TEU is equivalent to ~10 tonnes.
Source: CDP, company reports

The emissions intensity conundrum

Distinguishing between the absolute emissions of a company and their emissions intensity is essential for understanding the efficiency of companies' operations. Emissions intensities are designed to assess the emissions produced relative to a specific activity or process. Within the context of shipping, where cargo is transported over large distances, the best intensity measures will be those that most closely reflect this activity.

However, the absence of any internationally agreed standards on intensity reporting has led to a range of intensity measures being used within the industry. While internally companies may track their performance across several indicators, when it comes to their emissions reporting there are often differences in the methodologies used to calculate emissions intensities, or a lack of clarity provided on the methodology that has been taken. This makes it challenging to benchmark company performance in a meaningful way.

Having a harmonised approach for measuring efficiency is not just necessary for benchmarking company performance but also for policy makers; serving as a foundation upon which to build policy. To effectively manage emissions, it is necessary to measure them but within the context of the shipping sector what ought to be measured?

Both the IMO and the European Union have introduced data collection systems for the industry to provide greater clarity on the efficiency of the sector. However, the IMO Data Collection System (DCS) and the EU Monitoring Reporting and Verification (MRV) system initially took different approaches to the data that companies would be required to report. Both systems recognised the importance of collecting information on fuel consumption / emissions and the distance travelled between destinations. However, while the IMO DCS only required companies to report the nominal capacity of their vessels, the EU MRV required that companies disclose the actual volume of the cargo transported. This distinction would allow for the calculation of two very different measures of efficiency.

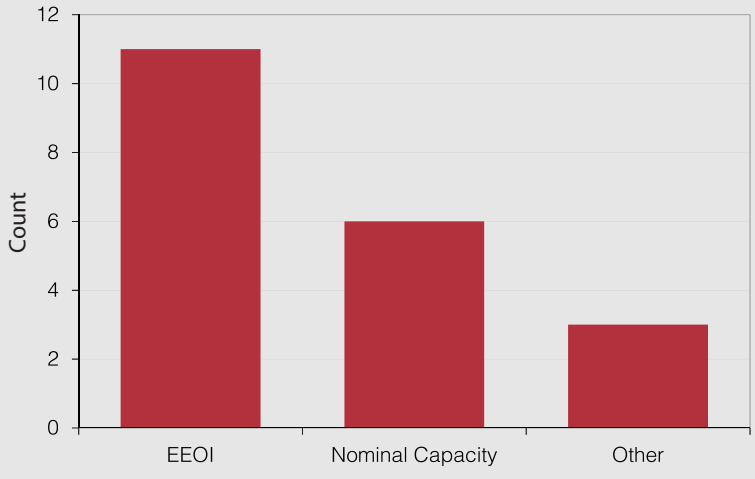
Nominal capacity-based measures – Units: gCO2 / DWT.km

Data collected as part of the IMO DCS would allow for the calculation of nominal capacity-based measures. These measures assume that vessels are always fully loaded across all voyages. They reflect both the technical characteristics of a vessel (e.g. size, efficiency of hardware etc.) and most of the operational factors impacting the emissions profile of a given voyage (e.g. speed, weather conditions etc.). However, they do not account for how companies are utilising the capacity of their vessels. Organisations such as the Clean Cargo Working Group (CCWG) calculate emissions intensities for container companies on a nominal capacity basis and provide average utilisation factors for specific trade routes, so that intensity measures more representative of company activity can be estimated.

Energy Efficiency Operational Indicator (EEOI) – Units: gCO2 / t.km

As part of the IMO's Shipping Energy Efficiency Management Plan (SEEMP) it proposes a voluntary intensity measure that companies can use to measure their fleet efficiency. Crucially the EEOI accounts for the volume of cargo transported and therefore takes into consideration how efficiently companies are utilising the capacity of their vessels. The lower the utilisation rate of a vessel the higher the emissions intensity will be. It therefore presents a more holistic picture of how efficiently vessels are transporting their cargo and reflects the full technical and operational factors at play, providing a true measure of transport work.

Figure 24: Emissions intensity reporting methodology (i) (ii)



(i) Prior to requests for additional data from companies
(ii) Does not sum to 18 due to some companies reporting across multiple measures
Source: CDP, company reports

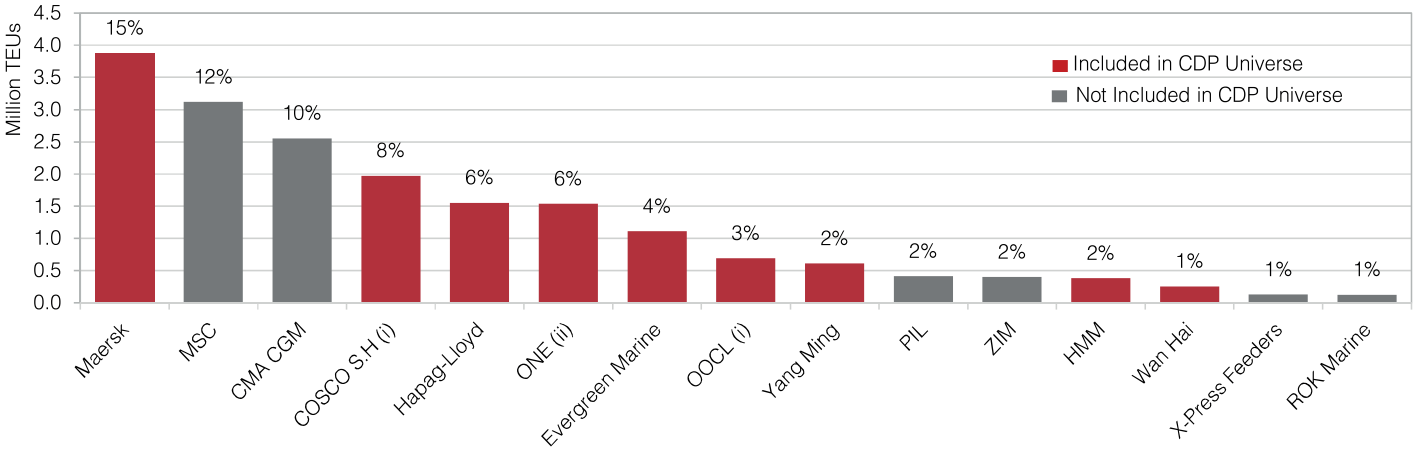
These two measures of efficiency were the most commonly reported across the 18 companies in the report. 11 of them disclosed emissions intensities using a method consistent with the IMO EEOI. Six companies disclosed nominal capacity-based measures and three other companies disclosed intensities using other approaches.

To reduce the administrative burden for companies both the IMO DCS and the EU MRV converged in their data collection approach with the reporting of cargo in the EU MRV now a voluntary option for companies. However, this does not change the fact that cargo-based measures of intensity such as the EEOI will continue to be a superior measure of efficiency for the industry.

Container

There are 11 companies with container divisions in their fleet. As of June 2018 these companies accounted for 47% of global container shipping capacity. There is a lack of consistency in the way that emission intensities have been reported within the container division with some companies reporting on a nominal capacity basis and others based on the volume of cargo transported.

Figure 27: Top 15 container liners by shipping capacity 2018 (TEUs)



(i) As of April 2018 K Line, NYK and Mitsui O.S.K formed a joint venture to form the Ocean Network Express (ONE)
(ii) COSCO S.H acquired a majority stake in OOIL in July 2018
Source: CDP

We assessed companies with container divisions across four metrics:

EEOI Emissions Intensity (50%): We assess companies based on the level and trend of the emissions intensities disclosed using a methodology consistent with the IMO's Energy Efficiency Operational Index (EEOI) over the period 2012-2017. This emissions intensity measure is based on the cargo transported and presents a more holistic picture of the emissions profile of companies' activities. Companies that have not reported their emissions intensities using this measure rank last.

CCWG Dry Cargo Intensities (30%): We assess companies based on the level and trend of the emissions intensities reported by the Clean Cargo Working Group (CCWG) over the period 2012 - 2017. The emission intensities calculated by the CCWG are based on the nominal capacity of companies' vessels and not the cargo transported. Companies who have disclosed their emission intensities using the EEOI measure but have not disclosed the intensities calculated by the CCWG have been neutralised.

CCWG Reefer Cargo Intensities (10%): This metric is calculated in a manner consistent with the calculation of the CCWG Dry Cargo Intensities. Here we assess the emissions intensity of companies refrigerated cargo transport.

Average Roundtrip Utilization Rate (10%): Here we rank companies' roundtrip utilisation rates. The higher the utilisation rate the more effectively companies are utilising the capacity of their fleet. Companies who did not disclose this information ranked last.

Figure 28: Container emissions intensity summary

Company	EEOI Rank	Boundary	CCWG Dry Cargo Emission Intensity Rank	CCWG Reefer Cargo Emission Intensity Rank	Utilization Rank	Overall weighted rank
MOL (i)	4	Owned + Chartered	6	3	1	5.49
NYK Line (i)	2	Owned + Chartered	5	2	4	5.76
Yang Ming	1	Owned + Chartered	9	7	4	6.57
K Line (i)	5	Owned + Chartered	7	1	2	7.20
COSCO S.H (ii)	6	Unclear	3	5	4	8.40
Maersk	7	-	2	4	3	9.10
Wan Hai	3	Owned	11	8	4	9.64
Hapag-Lloyd	7	-	1	9	4	10.73
OOIL (ii)	7	-	4	9	4	10.77
HMM	7	-	10	6	4	12.35
Evergreen Marine	7	-	8	9	4	12.80
Weighting	50%		30%	10%	10%	

(i) As of April 2018 K Line, NYK Line and Mitsui O.S.K formed a joint venture to form the Ocean Network Express (ONE)
(ii) COSCO S.H acquired a majority stake in OOIL in July 2018
Source: CDP

Highlights

- MOL are ranked in first position with NYK following closely behind. MOL are one of only six container companies to report their emissions using the EEOI methodology. Both MOL and NYK's performance across the EEOI and CCWG methodologies are very close with NYK outperforming MOL. However, MOL's disclosure of their roundtrip utilisation rates pushed them into first position.
- Yang Ming are ranked in first place overall on the EEOI measure with an emissions intensity of 5.1 gCO2/t.km. In 2017 the average capacity of Yang Ming's fleet was just above average whilst the average age was among the highest in the container division. The emission intensities are low and may reflect limited reefer cargo transportation compared to their peers as well as operational factors.
- Among the companies that have disclosed CCWG intensities, Hapag Lloyd are ranked in first position with a dry cargo intensity of 45.7 gCO_2/TEU.km and a CAGR of -7.2% since 2012. Hapag Lloyd are followed closely by Maersk who are ranked in second position.
- Both OOIL and Evergreen Marine do not provide enough clarity on the methodology that has been used to calculate their emission intensities. We have assumed that the reported figures are based on a nominal capacity basis consistent with the CCWG methodology, of which both companies are members.

Figure 29: EEOI emissions intensity - Container

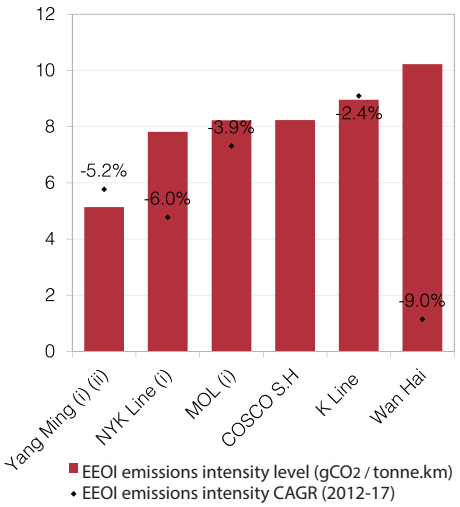


Figure 30: CCWG dry cargo emissions intensity - Container

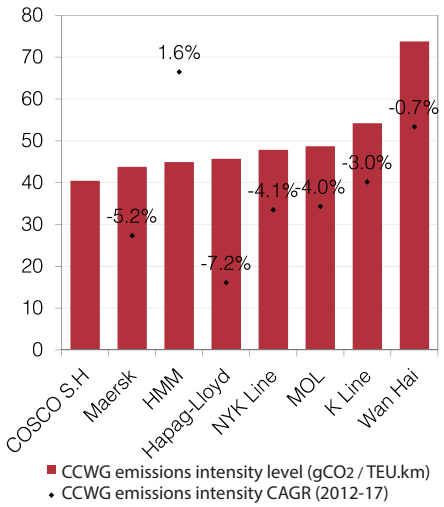
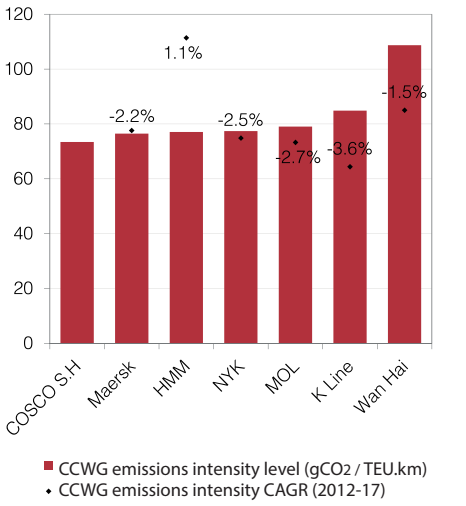


Figure31: CCWG reefer emissions intensity - Container

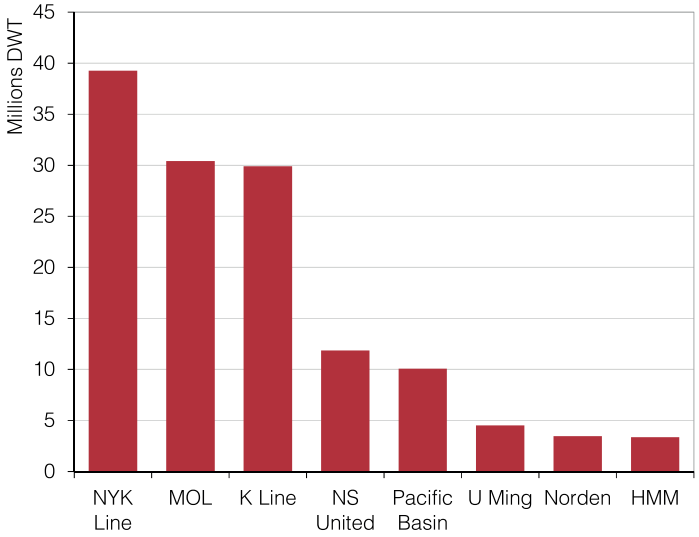


(i) Trends were calculated using avaliable data points across the period
(ii) Yang Ming have disclosed their EEOI intensity in gCO_2 / TEU.km. The CCWG estimate that TEU is equivalent to 10 tons
Source: CDP

Bulk

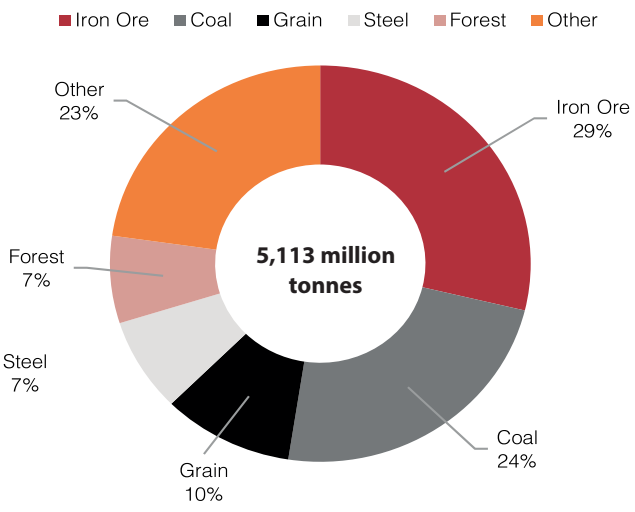
There are 8 companies with significant bulk transport activity. These companies transport a diverse range of commodities and account for around 17% of global shipping capacity. In 2017 the transportation of major and minor bulk products accounted for almost 50% of all global shipping activity (UNCTAD 2018).

Figure 32: Bulk shipping capacity by DWT



Source: CDP, company reports

Figure 33: Dry bulk trade 2017



Source: CDP, UNCTAD

EEOI Emissions Intensity (100%): We assess companies based on the level and trend of the emissions intensities disclosed using a methodology consistent with the IMO's Energy Efficiency Operational Index (EEOI) over the period 2012-2017. This emissions intensity measure is based on the cargo transported and presents a more holistic picture of the emissions profile of companies' activities. The emissions intensity level and trend receive a 50% weighting.

Figure 34: Bulk emissions intensity summary

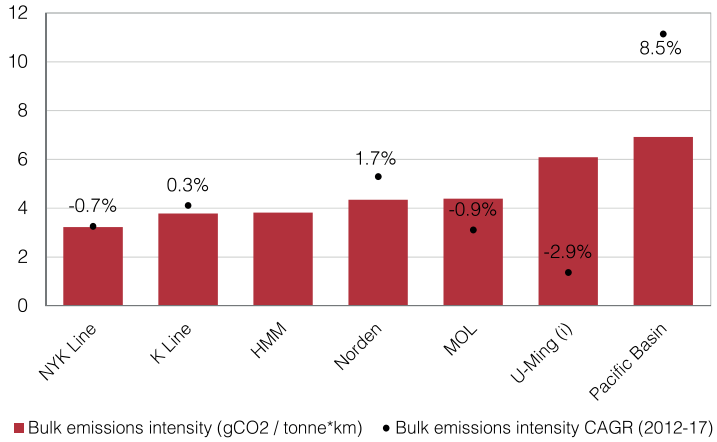
Company	EEOI Rank	Boundary	Vessels Included in calculation	Overall weighted rank
NYK Line	1	Owned + Chartered	Capesize, Panamax, Handymax, Woodchip carriers	2.21
K Line (i)	2	Owned + Chartered	Capesize, Panamax, Coal Carriers, Wood Chip Carriers	3.90
MOL	3	Owned + Chartered	Capesize, Panamax, Handymax, Small Handy, Woodchip carriers	4.44
Norden	4	Owned + Chartered	Panamax, Supramax, Handysize	5.76
U Ming (ii)	5	Owned	Capesize, Panamax, Supramax, Cement Carrier	6.74
HMM (iii)	6	Owned	Capesize, Supramax	9.59
Pacific Basin	7	Owned	Panamax, Supramax, Handysize	14.65
NS United	8	-	-	18.00

(i) K Line aggregate their bulk and tanker emissions together. The vessels included in the calculation column reflect K Line's bulk vessels only.
(ii) U-Ming intensity is an aggregate of reported figures.
(iii) A utilisation factor has been applied to HMM's emissions intensities which have were reported on a nominal capacity basis.
Source: CDP

Highlights

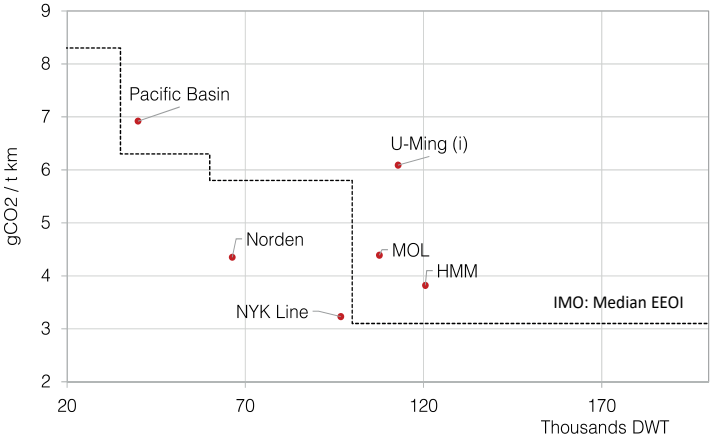
- NYK are ranked in first position with an emissions intensity of 3.2 gCO_2/t.km, the lowest within the sector. However, reductions in NYK's emission intensities have stagnated with a CAGR of -0.7% over this period. This is despite an 11% increase in the average capacity of NYK's fleet of Bulk vessels where larger vessels are typically more efficient on an intensity measure.
- K Line are ranked in second position with an intensity of 3.8 gCO_2/t.km and are followed closely by MOL. Similar to NYK, emissions intensity reductions have stagnated with K Line's actually increasing by 0.3% over this period. K Line has aggregated their Bulk and Tanker emission intensities together. However, the intensities disclosed are more representative of K Line's bulk emissions given that the share of bulk to tanker vessels was 88% in 2016.
- HMM were the only company that disclosed their intensity figure on a nominal capacity basis which assumes vessels are fully loaded at all times. HMM owned 3 bulk vessels in 2017. Based on studies by the IMO the average allocative utilisation of bulk vessels of a similar size to HMM's ranged from 56-57%. We applied the median utilisation rate to estimate HMM's emissions intensity as 3.6 gCO_2/t.km in 2017.
- Of the companies that have disclosed their emission intensities Pacific Basin are ranked last. They have the highest emissions intensity in the Bulk division which sits at 6.9 gCO_2/t.km. Pacific Basin's emission intensities have increased by a CAGR of 8.5% between 2014 – 2017. However, if we were to account for the differences in the average capacity of companies' fleets as illustrated in Fig 36, Pacific Basin's EEOI is only slightly above the average EEOI for bulk vessels of a similar size [7].
- NS United are ranked in last position and are the only company that have not disclosed the emissions intensity of their fleet.

Figure 35: Bulk emission intensity and trend 2012 - 2017



(i) U-Ming intensity is an aggregate of reported figures
Source: CDP

Figure 36: Bulk emissions intensity relative to EEOI median

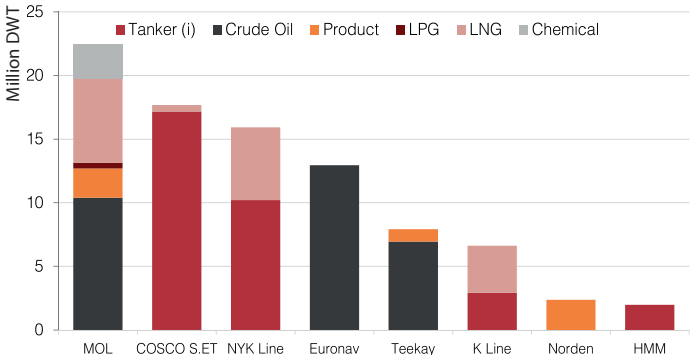


Source: CDP, IMO MEPC 68/INF.24

7. The average vessel capacity is calculated by dividing the total DWT capacity of a companies' fleet by the number of vessels operated. This does not correspond to the average DWT of the vessels operated over the course of the year and therefore doesn't directly relate to the emission intensities disclosed. To calculate this more accurately would require detailed information on companies' fleet activities.

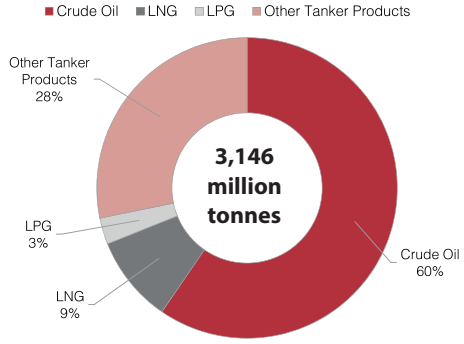
Tanker

Figure 37: Tanker shipping capacity by DWT



Source: CDP

Figure 38: Tanker product trade



Source: CDP

EEOI Emissions Intensity (100%): We assess companies based on the level and trend of the emissions intensities disclosed using a methodology consistent with the IMO's Energy Efficiency Operational Index (EEOI) over the period 2012-2017. This emissions intensity measure is based on the cargo transported and presents a more holistic picture of the emissions profile of companies' activities. The emissions intensity level and trend receive a 50% weighting.

Figure 39: Tanker emissions intensity summary

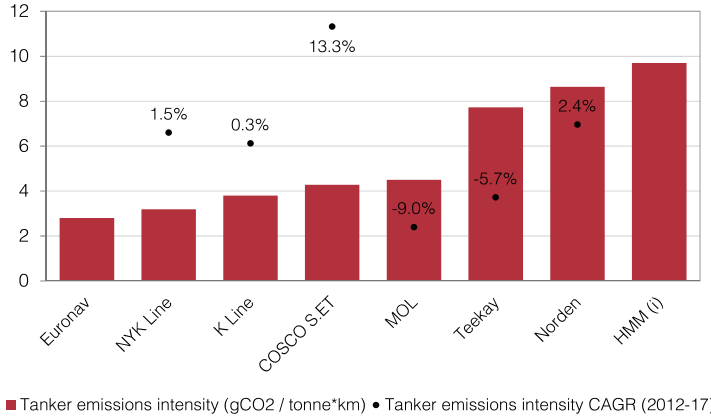
Company	EEOI Rank	Boundary	Vessels Included in calculation	Overall weighted rank
MOL	1	Owned + Chartered	Oil Tankers, Product Tankers	3.09
NYK Line	2	Owned + Chartered	Oil Tankers	4.43
K Line (i)	3	Owned + Chartered	Oil Tankers, Product Tankers	4.84
Teekay (ii)	4	Owned + Chartered	Oil Tankers, Product Tankers, LPG, LNG	7.99
COSCO S.ET (ii)	5	Owned	Oil Tankers, LPG, LNG	9.07
Euronav	6	Owned + Chartered	Oil Tankers	9.50
Norden	7	Owned + Chartered	Product Tankers	11.39
HMM	8	Owned	Oil Tankers	16.88

(i) K Line aggregate their bulk and tanker emissions together. The vessels included in calculation column reflect K Line's tanker vessels only.
(ii) COSCO S.ET and Teekay have aggregated their tanker emission intensities with their LPG and LNG vessels.
Source: CDP

Highlights

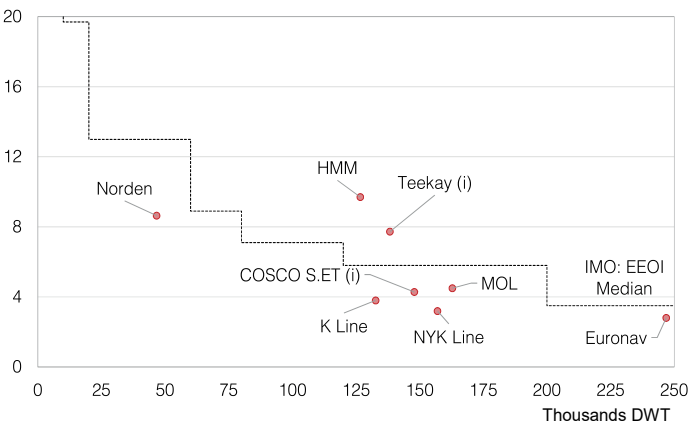
- MOL are ranked in first position. They have reduced their emissions intensity by a CAGR of -9.0% since 2012 from a high of 7.4 gCO_2/tonne.km in 2012 to 4.5 gCO_2/tonne.km in 2016. The intensities disclosed are emission intensities for MOL's Crude and Product Tankers.
- NYK are ranked closely behind in second with a lower intensity of 3.2 gCO_2/tonne.km [8]. However, NYK has seen its emissions intensities increase by a CAGR of 1.5% since 2012.
- Other notable companies include Euronav who have the lowest emissions intensities in the group at 2.8 gCO_2/tonne.km . This is likely a consequence of the size of their vessels with the average capacity of their fleet more than 50% larger than their closest peer with an average DWT of 250,000 tons. However, Euronav only recently started to report their emission intensities in 2017 and have been ranked last on the trend component of this metric.

Figure 40: Tanker emissions intensity and trend 2012 - 2017



(i) Based on studies by the IMO the average utilisation of tanker vessels of a similar size to HMM's ranged from 43-48%.
Source: CDP

Figure 41: Tanker emissions intensity relative to EEOI median



(i) Includes emissions intensities from LPG and LNG vessels and therefore position relative to EEOI median is not representative of oil tanker performance.
Source: CDP, IMO MEPC 68/INF.24

8. Euronav have disclosed an emissions intensity of 3.3 gCO_2e/t.km. To calculate the intensity on a gCO_2/t.km basis we have assumed that Euronav's primary fuel is HFO. The carbon content of HFO is ~85.1%. we have applied this factor to the emission intensity Euronav have disclosed.

Capital flexibility

As environmental regulations dominate the agenda for the shipping sector, the cost of compliance is a key concern for shipping companies. The impending IMO 2020 Sulphur cap and the Ballast Water Management Convention may create a high cost, capital-intensive environment for shipping companies in the short to medium term. While not directly related to climate change, these regulations have the potential to challenge the resilience of companies' balance sheets which could compromise their ability to finance expenditure on low-carbon technologies.

There is also growing momentum from creditors to ensure that their shipping portfolios are aligned with the IMO's decarbonisation trajectory through initiatives such as the Poseidon Principles.

Companies that are highly liquid with low levels of debt and high margins are better positioned to secure finance to help meet the costs of transitioning to lower carbon vessels. In this section we identify companies that are more exposed to the financial risks of transitioning with a view that healthier companies are more likely to have access to low cost finance to help aid the transition.

We assess companies by evaluating five key financial metrics:

1 Year Default Probability (35%): This metric evaluates the credit risk of companies by assessing the risk of defaulting within a 1-year period. This uses Bloomberg's quantitative estimate of an issuer's probability of default and is a forward-looking measure that estimates the short-term credit risk of a company. We rank companies based on their risk of default as at April 2019.

Gearing – Net Debt / Shareholder Equity (15%): This metric evaluates the financial leverage of a company. It typically shows the degree to which a company is financing its operations via debt. A lower ratio indicates a company may have financial flexibility to withstand business changes in the shipping market. Typically, banking loan agreements will often require companies to operate within specified gearing ratios. We rank companies on the levels of financial gearing as at FY 2018 Q4.

Liquidity – Current Assets / Current Liabilities (15%): This metric evaluates the ability of a company to meet its short-term liabilities. A higher current ratio indicates that a company is better placed to meet its short-term obligations from current assets. We rank companies on their level of liquidity using the latest reported financial year.

Profitability – EBIT Margin Adjusted (15%): We take the average EBIT Margin adjusted for FY17-18 to assess company profitability.

Chartered Share of Fleet (20%): This metric looks at the share of vessels chartered by companies. Companies that charter a large share of their vessels may find it easier to change the composition of their fleet.

Figure 42: Capital flexibility summary

Company	Defaut Probability	Gearing	Liquidity	EBIT Margin Adj (%)	Chartered Share of Fleet (%)	Overall weighted rank	Capital Flexibility Rank
Wan Hai	1	3	5	6	14	6.1	1
Maersk	5	2	3	4	10	7.2	2
OOIL	10	5	1	10	13	8.1	3
U-Ming	2	4	8	3	15	8.1	4
Norden	12	1	6	12	5	8.4	5
NS United KK	7	11	11	5	6	9.0	6
Pacific Basin	13	6	9	7	11	9.6	7
MOL	11	13	14	13	3	9.8	8
Evergreen Marine	8	10	10	11	12	9.8	9
COSCO S.H	9	17	17	8	1	10.2	10
NYK Line	6	14	13	14	7	10.3	11
Euronav	3	7	2	17	17	10.7	12
COSCO S.ET	4	9	18	2	16	10.9	13
Hapag-Lloyd	14	8	16	9	9	11.1	14
K Line	15	15	7	15	4	11.2	15
HMM	17	12	4	18	2	11.6	16
Teekay	18	16	12	1	18	13.7	17
Yang Ming	16	18	15	16	7	14.0	18
Weighting	**35%**	**15%**	**15%**	**15%**	**20%**		

Source: CDP

Highlights

- Wan Hai and Maersk are ranked in first and second position respectively. Both companies perform well across most of these measures with respectable EBIT margins, low levels of debt and high current ratios. Wan Hai also have one of the lowest probabilities of default and have been given one of the highest investment grade ratings.
- OOIL are ranked in third position with a lower leverage ratio relative to the peer group at 49% and the highest current ratio. They also benefit from a very low probability of default and are well positioned to raise funds required to meet decarbonisation goals.
- In 2018 the state backed container liner COSCO S.H acquired a majority stake in OOIL for $6.3 billion. This acquisition was secured through external debt financing which has contributed to an increase in their debt-to-equity ratio from 85% in 2017 to 180% in 2018. COSCO S.H has been able to maintain respectable margins at 3.3% over the last couple of years and as a state-owned enterprise may be better positioned to manage these high levels of debt. COSCO S.H rank tenth overall.
- The specialised energy transport companies Euronav, COSCO S.ET and Teekay own a significant share of their vessels. Chartering can be seen as a way of hedging against future risks by minimising the risk of stranded assets in the event of changes in the demand for transport services. It also affords companies greater flexibility to change the composition of their fleet in the event that climate regulation steps up. These companies are arguably at a higher risk if regulatory pressure accelerates or if there are structural changes in demand for the commodities they transport.
- The average EBIT Margins sit at 2.5% for the 18 companies highlighting the poor market conditions depressing freight rates across the industry. Teekay stands out as one of only two companies generating margins in the double digits. However, they are highly leveraged with a debt-to-equity ratio of 159%.
- The container liner Yang Ming rank last with high leverage at 349% (Q4 2018) and have struggled to generate profits in recent years. Cashflow is likely to remain an issue in 2020 with Yang Ming choosing to switch to higher cost Very Low Sulphur Fuel Oil (VLSFO) to comply with the IMO 2020 SOx cap. Yang Ming may also struggle to meet its short-term liabilities using its current asset base in the event of insolvency, with a current ratio of 0.7. Gaining access to finance in the market is likely to cost more than their peers with a higher default probability. However it is worth noting that the Taiwanese government holds a 33% stake in the company which might alleviate concerns about their access to capital.

Figure 43: Debt to shareholder equity (FY18 Q4)

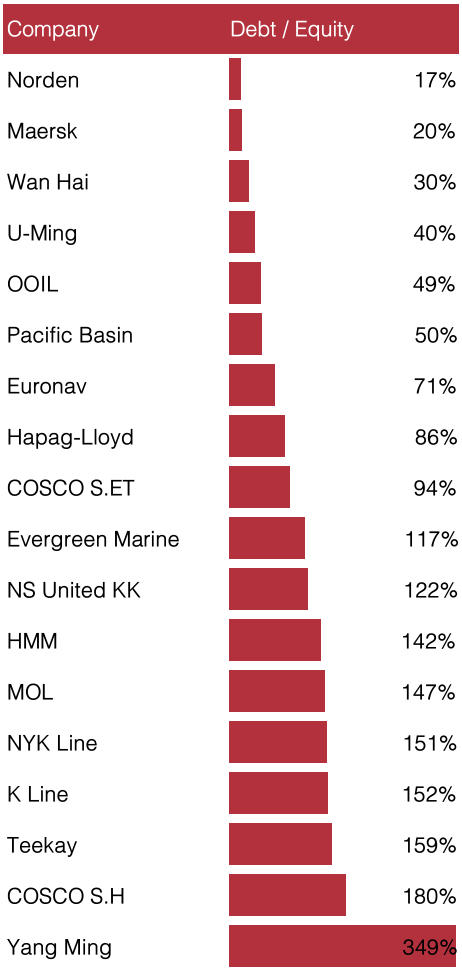


Figure 44: Liquidity ratio (current)

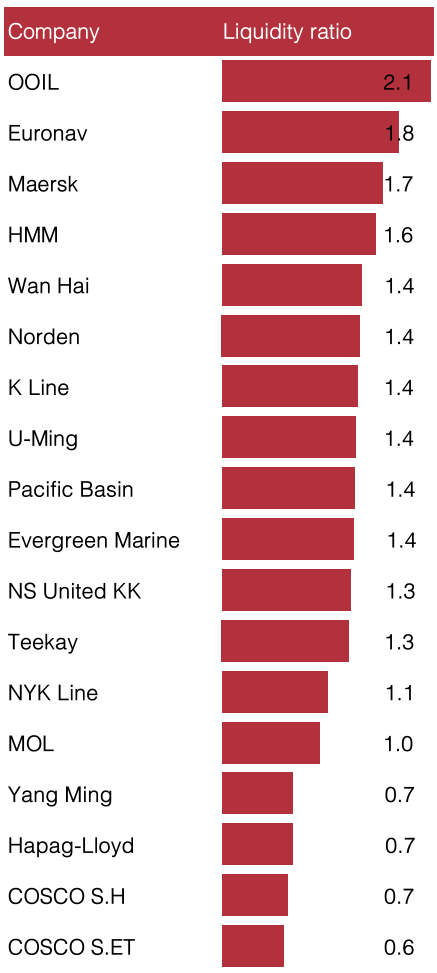
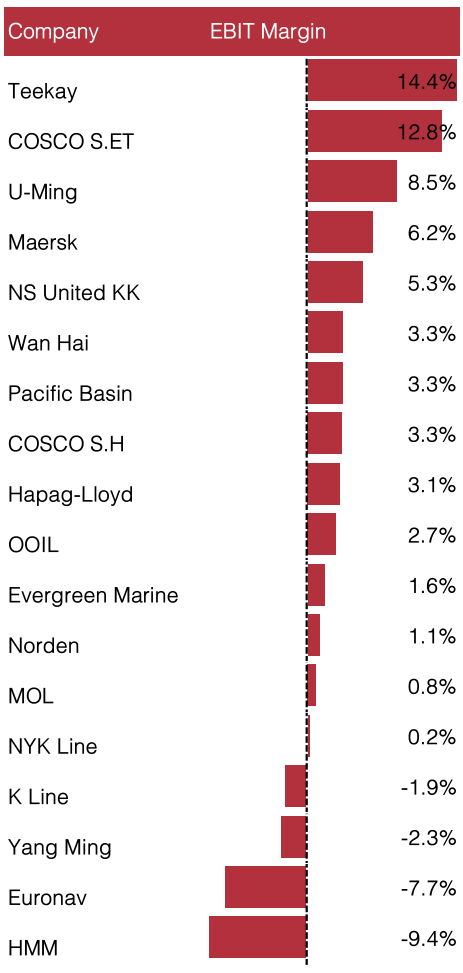
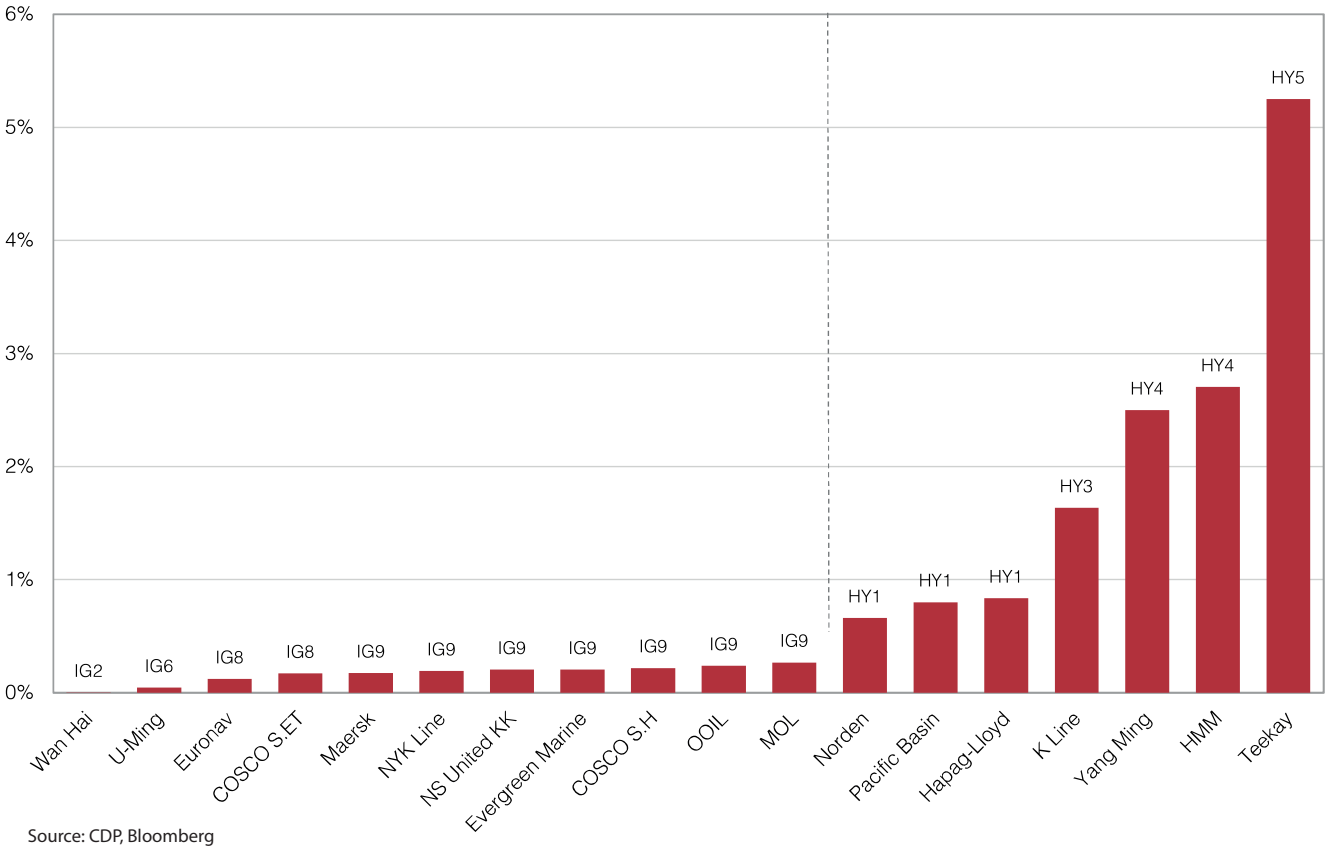


Figure 45: Adjusted EBIT Margin (average FY17-18)



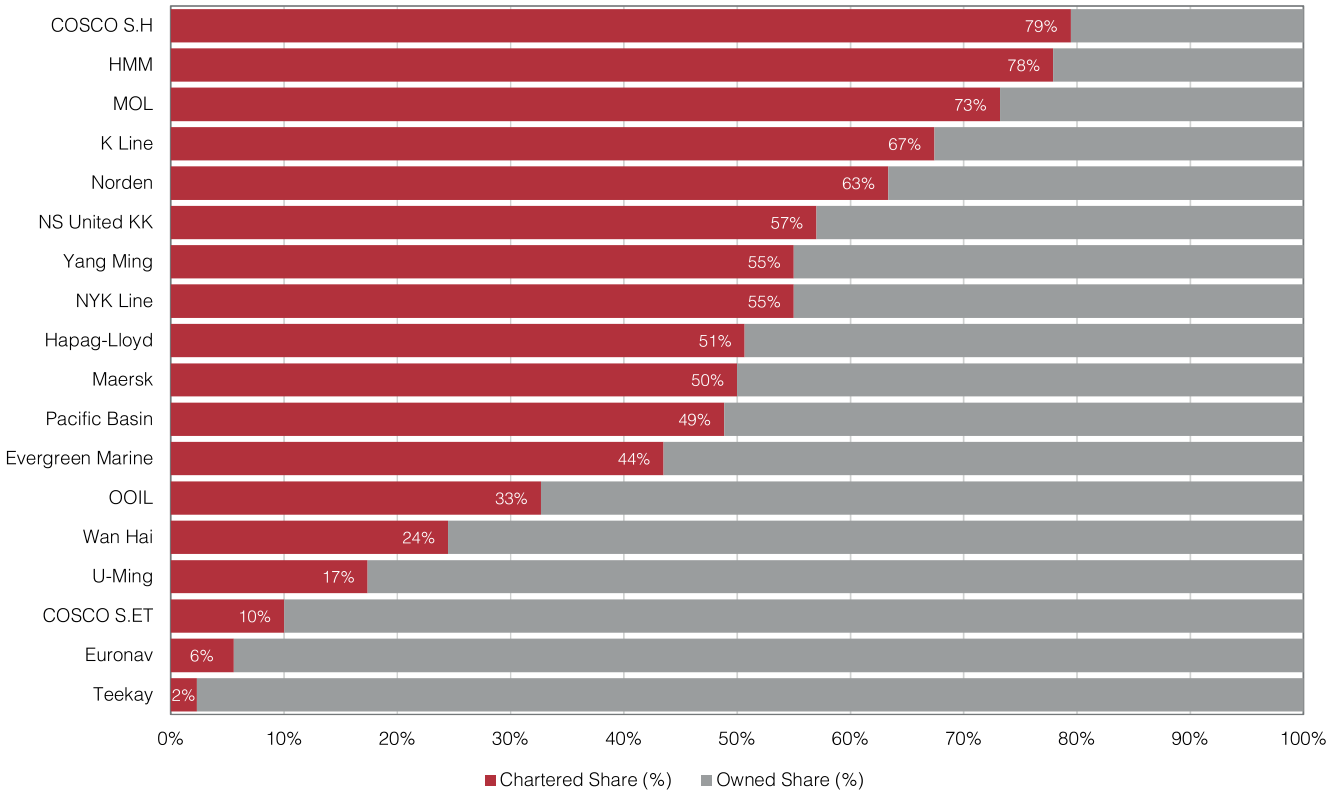
Source: CDP, Bloomberg

Figure 46: Default probability over 1-year



Source: CDP, Bloomberg

Figure 47: Ratio of chartered vs owned vessels



Source: CDP, company reports, VesselsValue

Reshoring: fact or fiction?

Over the last two centuries trade has grown significantly, completely transforming the global economy. The sum of worldwide exports up to 1870 accounted for less than 10% of global output. Today about a quarter of total global production is exported. Globalization has allowed manufacturers to optimize profitability by retaining high value activities (R&D, marketing, financing) in high-cost labor markets and moving low-value activities to countries where labor costs are low. This takes advantage of economies of scale in maritime transportation, deregulation in landside transport, financial services and telecommunications, and the connectivity enabled by the internet to generate wealth for shareholders and owners[9]. But this model of centralized, low-cost manufacturing is now being called into question with growing attention being directed towards reshoring and nearshoring activities.

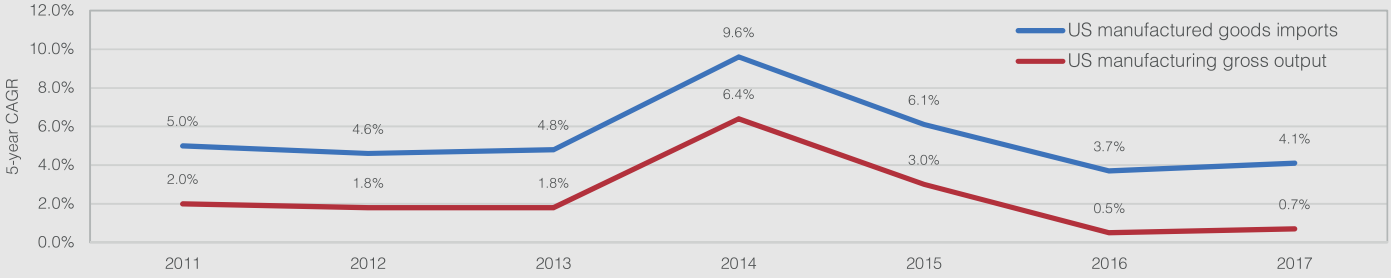
In the U.S. the combined reshoring and related foreign direct investment (FDI) announcements surged in 2017, adding over 171,000 jobs, bringing the total number of manufacturing jobs brought to the U.S. from offshore to over 576,000 since the manufacturing employment low of 2010. This trend is growing with 2017 delivering a 52% increase on 2016 figures [10]. In the U.K., reshoring has been steadily on the rise. A survey by EEF, the manufacturers' federation in 2014, found that one in six UK companies had reshored production in the previous three years. Since then, many analysts have pointed to BREXIT as providing opportunities to accelerate this trend driven by a weakening sterling. Last year, UK manufacturers had their busiest year in 29 years with exports booming. EY estimates suggest this could provide a £15billion boost to the economy and create 315,000 jobs.

Reshoring is partly being driven by rising incomes in emerging economies making the economics of offshoring less appealing. Wages for manufacturing jobs in China for example tripled between 2005 and 2016 [11]. In addition, political uncertainty and volatile markets make foreign investments in some emerging markets riskier than home grown operations.

Consumer trends are also supporting this transition with preferences beginning to favor locally produced products over foreign imports. A recent report produced by consumer insights provider IRI found that over 70% of European consumers expressed a clear preference for locally sourced products. In the U.S. a similar study conducted by Consumer Reports showed that up to 80% of Americans are willing to pay extra for products that are manufactured in the U.S. Consumer Goods companies are responding to these trends by investing in local supply chains. AB InBev, for example designed an entirely new brand, Eagle Lager, which centers around local supply of sorghum crops in Uganda and supporting local livelihoods. This is also true of retailers with Morrisons recruiting more than 200 local food suppliers in an effort to cut food miles and respond to consumer feedback.

The disruptive potential of these trends on container trade demand is not clear-cut. While jobs and manufacturing capacities are being expanded in OECD countries and consumers are beginning to seek out local offerings, there is still a long way to go before the complete reversal of offshoring. Last year, A.T Kearney found that the relative growth of imports from the low-cost country trading partners had outpaced relative growth of US manufacturing gross output in four of the past five years [12]. This echoes research conducted by the Hackett Group which found that the net amount of manufacturing coming back to developed countries barely offsets the amount that continues to be sent offshore.

Figure 48: Reshoring vs offshoring 2011-17



Source: CDP, A.T. Kearney, 2017

For reshoring to have a material impact on global trade there must be a much more significant shift in the cost structures of decentralised manufacturing. Breakthrough technologies such as 3D printing and robotics could provide opportunities to bring down the cost of local production, potentially stimulating reshoring activity. Increased automation of production processes through the growing use of robots for example may erode the labor cost advantage of emerging countries as labor costs will represent a smaller share of total costs. However, when and how these technologies will scale is uncertain. Adidas's newly opened, highly automated "speedfactory" in Atlanta provides a vivid illustration of the possibilities and limitations of reshoring. The factory is three times faster and also more flexible than at Adidas's Asian plants allowing it to make short-run products designed for local markets. However, it is constrained in the volume of production it can manufacture. Ninety percent of Adidas' production landscape remains Asia-based and the CEO has stated that this is unlikely to change.

On the other hand, digitalization could also offer solutions which may reinforce offshoring activities. Blockchain, autonomous vessels, port automation and Internet-of-Things technologies all offer opportunities to bring down the costs of maritime transportation, bolstering the business case for centralized manufacturing. Blockchain is likely to streamline global trade by providing greater security and trust between trading parties, reducing the need for third party intermediaries. The development of autonomous vessel technologies such as the Maritime Autonomous Surface Ship (MASS) and increased port automation are also likely to drive down operational costs and increase efficiency making shipping faster and more competitive.

Ultimately, the shipping sector is at risk of disruption by digitalization; however, the exact effect of this on demand is uncertain. While reshoring activities are materializing at a small scale, for these to outstrip capacity additions in low-cost labor markets, digitalization will need to completely restructure the labor market for manufacturing.

9. UNCTAD, 2018, Review of Maritime Transport
10: Reshoring Initiative, 2018: Reshoring Initiative 2018 Data Report
11. Euromonitor, 2017: China still lucrative for business despite rising wages
12. A.T Kearney, 2018: 2018 Reshoring Index

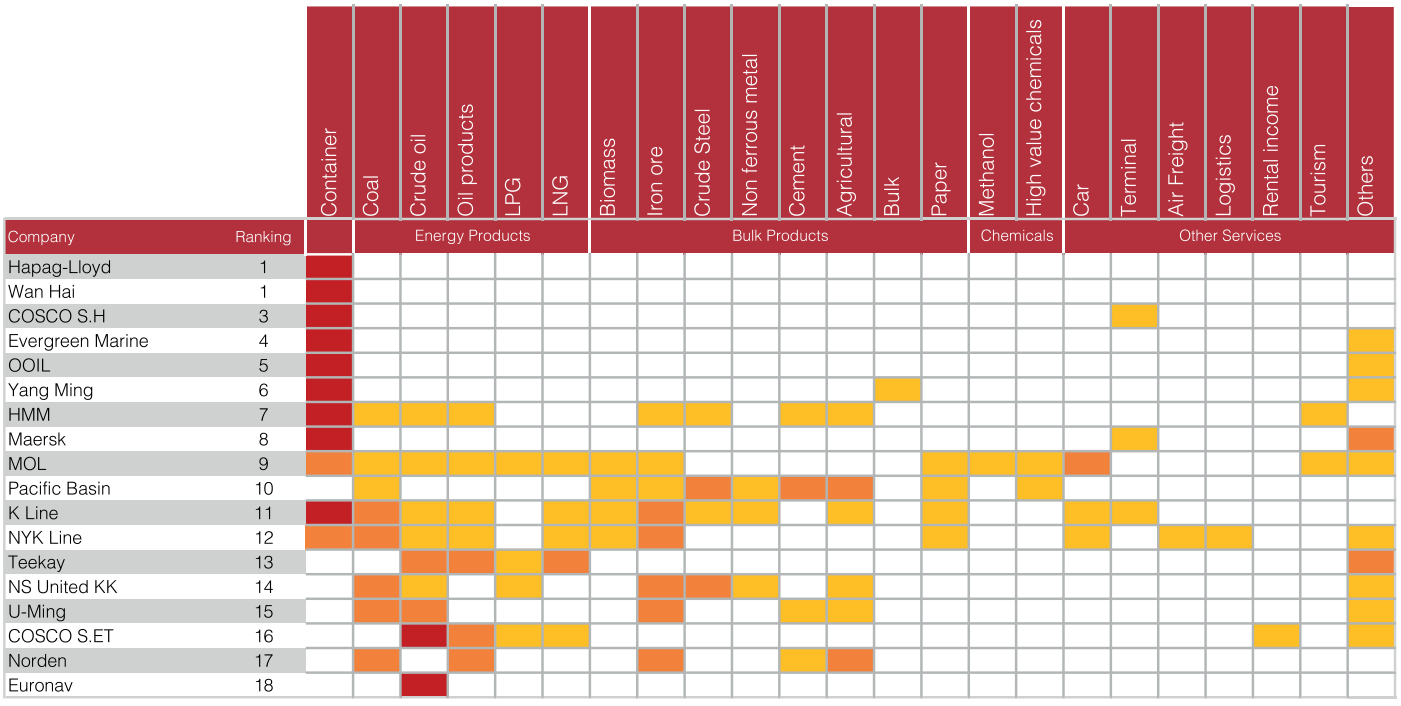
Business resilience

Long Term Climate Risk (100%): Using the IEA's Sustainable Development Scenario (SDS), Below 2 Degrees Scenario (B2DS) and Mckinsey's accelerated technology scenario we look at changes in demand out to 2040 for the services and commodities companies transport and map their growth potential to companies' current service offerings. Company exposure is determined by their revenue breakdowns. Where detailed revenue breakdown was not available other proxies were used (e.g. cargo breakdown, fleet breakdown).

Highlights

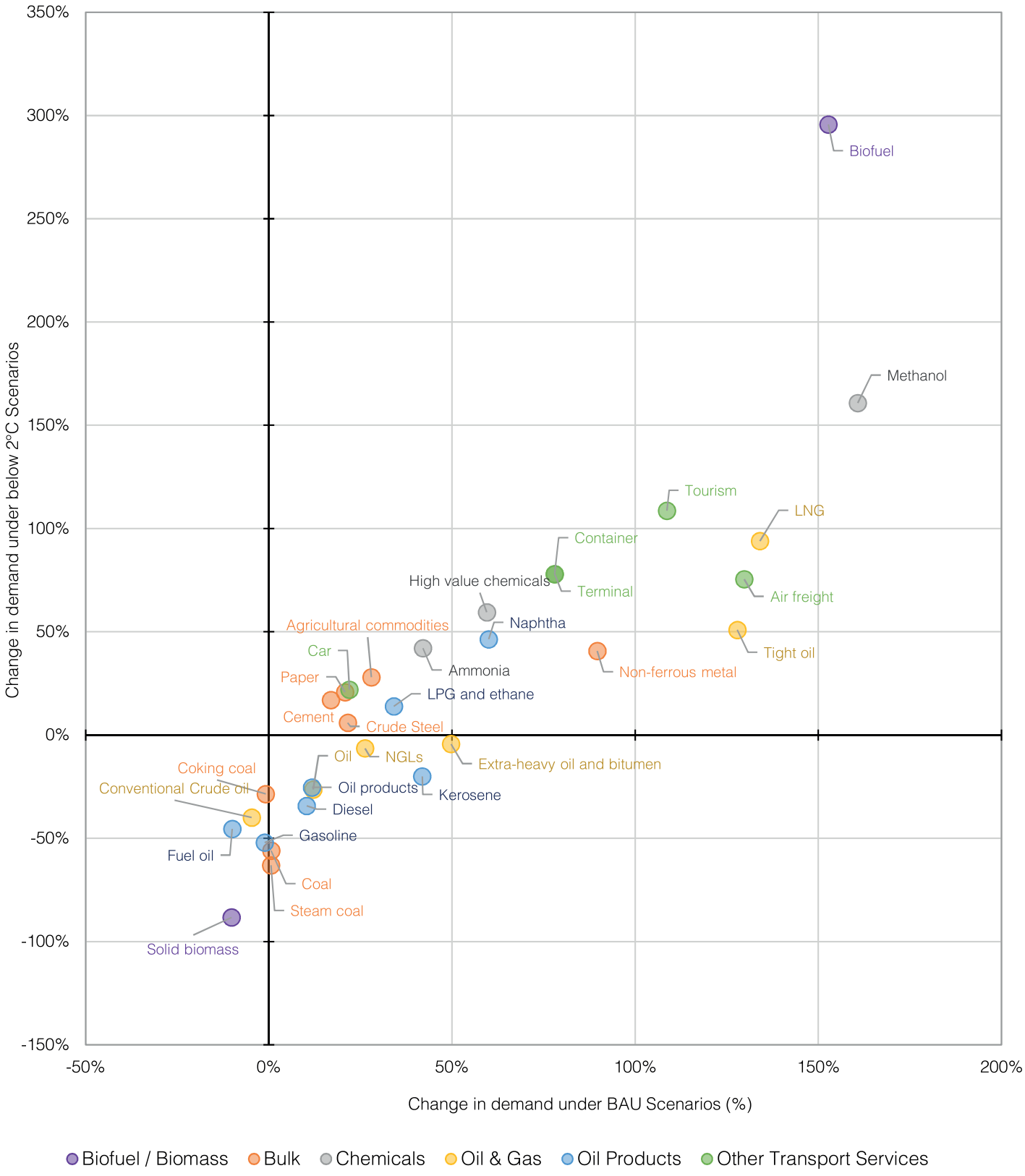
- Hapag-Lloyd and Wan Hai are ranked joint first, followed by COSCO S.H, Evergreen Marine, OOIL and Yang Ming. All six companies generate over 90% of their revenues from the container shipping business. The container trade is forecast by McKinsey (2017) to increase between 1.9% - 3.2% p.a. out to 2066, indicating a high-level of opportunity for companies operating container transport services. Since container vessels are used to transport a wide variety of products they are more resilient to long-term climate related risks. Similarly, we expect the demand for terminal services will grow with demand for container transport.
- Under the IEA's WEO 2018 BAU scenario, demand for most conventional energy sources including coal, oil and some oil products will increase out to 2040. However, in the SDS, growth in renewables, electric vehicles and the circular economy will accelerate impacting the demand for fossil fuels and raw materials. Bulk and tanker companies that are highly exposed to these commodities are potentially at risk from a shift towards a decarbonisation trajectory below 2˚C.
- Euronav, Norden, COSCO S.ET, U-Ming and NS United KK make up the bottom five. All five companies have a heavy reliance on transporting conventional energy sources and raw materials such as iron ore. Euronav derive a large percentage of their revenue from transporting crude oil with demand expected to fall 40% by 2040 under the SDS. In 2017 COSCO S.ET received 80% of their revenue from transporting crude oil and oil products. U-Ming and NS United transport significant volumes of coal and iron ore products. Under the SDS both steam coal and coking coal demand is expected to fall 63% and 28% by 2040. Iron ore growth remains relatively flat out to 2040.
- Like Euronav, Teekay derives a large percentage of its revenue from energy transportation. However, Teekay are more diversified with a growing fleet of LNG vessels making them well placed to capitalise on growing demand for LNG which is expected to double by 2040 under the SDS.
- According to the UN Food and Agricultural Organisation (FAO) the global production of food will need to increase by over 1% each year up to 2050 to meet growing the demand. The geographical patterns of agricultural production and trading flows will change significantly in the future due to climate change, demographic changes and potentially geopolitics. In this analysis, we assume that climate change will not have an additional impact on the overall demand for agricultural produce out to 2040.

Figure 49: Company exposure to commodity risks



Source: CDP, company reports

Figure 50: Change in demand for commodities by 2040: BAU vs B2DS



Note: For Energy products (Oil & Gas products, Coal etc.) the IEA WEO NPS scenario has been used as the BAU scenario and the SDS scenario for the below 2°C scenario. These scenarios target a 4°C and 1.75°C trajectory by the end of century. For bulk products such as crude steel, cement etc. The IEA RTS scenario and B2DS scenarios have been used. These scenarios target 2.7°C and 1.8°C respectively. For Iron Ore, Mckinsey's Accelerated technology scenario has been used. This has not been plotted on the chart as the demand projections could not be associated with a particular global average temperature trajectory. With the exception of Air Freight, demand for transport services such as Car Carriers, Containers, Terminals etc. are assumed to be unaffacted by decarbonisation trends and are threrfore assumed to follow analyst's current growth forecasts.
Source: CDP, IEA

Transition opportunities

- 15 out of the 18 companies have failed to deploy any technologies considered to be transformative.
- Collaborative innovation with OEMs is low relative to other sectors such as power.
- NYK Line ranks first for Transition Opportunities, collaborating on the development of a zero emissions vessel.
- NS United ranks last for Transition Opportunities, deploying only incremental technical and operational innovations.

Overview

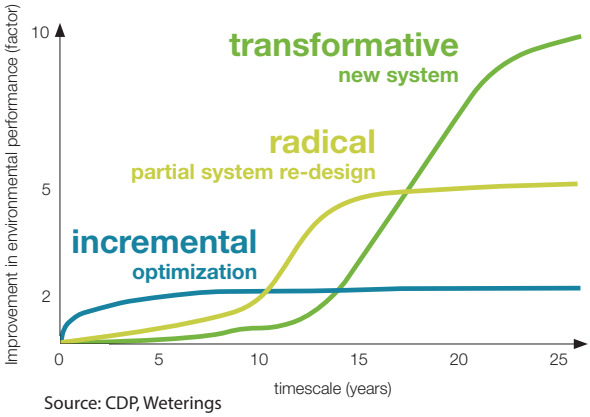
There are a spectrum of technical, low-carbon innovations available to shipping companies, from incremental technologies associated with improvements in vessel energy efficiency through to more transformative technologies associated with the design of entirely new propulsion and fuel systems. The decarbonization impacts of these technologies are wide ranging. While energy efficiency technologies will play a role in the shipping sector's transition to a low-carbon sector, new propulsion and fuel technologies are critical in driving the step change required for meaningful decarbonisation. The former often involves only marginal changes to current design delivered either via new vessels or through retrofitting activities. The latter demands a more systemic transformation often requiring conventional energy systems to be entirely overhauled in favour of renewable or fuel-cell alternatives. This requires collaborative innovation across the value-chain, particularly with the OEMs responsible for designing new vessels. At the cutting edge of this innovation are technologies such as liquid hydrogen, ammonia and fuel cell systems, electric propulsion systems and biofuels which offer the sector a carbon neutral pathway.

Shipping companies can also deploy operational innovations to drive decarbonization. These are largely associated with incremental energy efficiency improvements; however, some operational strategies such as slow steaming have been found to offer more significant decarbonisation potential. Studies suggest slow steaming could drive a 30-40% reduction in fuel consumption for bulk fleets and 50% and above for some container ship fleets (Newcastle University, 2014). However, lower ship speeds are likely to necessitate the provision of more capacity offseting the gains associated with slow steaming. Driving operational efficiency also relies on the collection and analysis of real-time vessel, route and weather data. Companies with more sophisticated data management platforms are therefore better positioned to optimize their voyages resulting in efficiency improvements. More specifically, platforms utilising Internet of Things technologies or employing automation are likely to be associated with greater improvements in efficiency.

Finally, other forms of business innovation exist which offer shipping companies decarbonization opportunities, namely the deployment of financial or circular solutions. Green bonds provide an innovative financial mechanism that allows leading shipping companies to raise capital for low-carbon projects. Circular innovations such as projects to reduce food waste in logistics and ship recycling activities also have the potential to deliver decarbonization benefits.

All these forms of innovation offer decarbonization opportunities for shipping companies across a spectrum – from incremental to transformative. In this section, we assess where on this spectrum the companies in our universe are positioning themselves by investigating the extent of their innovation efforts. We have broadly defined three innovation categories – technical, operational and other (namely financial and circular solutions) and have compiled a list of low-carbon innovations across the entire portfolio of each company. We have then applied a transformative change theory which defines technological changes as 'incremental, radical or transformative' depending on their impact and distribution (see Figure 49).

Figure 51: Transformative innovation framework



Source: CDP, Weterings

The highest ranking transformative innovations were:

- Liquid hydrogen / hydrogen fuel cells
- Liquid ammonia / ammonia fuel cells
- Bio-fuels
- Electric propulsion

Figure 52: Transformative innovation framework

Innovation	Definition	3 horizons equivalent
Incremental	Incremental innovations' occur more or less continuously in any industry to improve price and performance.	The 'first horizon' system losing strategic fit and therefore dominance over time
Radical	'Radical innovations' are discontinuous events, which are unevenly distributed over sectors and over time. Whenever they occur they are important as the potential springboard for the growth of new markets, and for the surges of new investment associated with booms. They often involve a combined product, process and organizational innovation.	The 'second horizon' of innovations seeking to exploit the opportunities emerging in a changing world
Transformative	'Transformative innovations' are far-reaching changes in technology, affecting several branches of the economy, as well as giving rise to entirely new sectors. It can be distinguished from 'radical' innovations in that while the latter disrupt existing technical competences, the former also involve substantial changes in markets and linkages with users.	The 'third horizon' in tune with deeper trends in society that eventually emerges as the new dominant system

Source: CDP, Weterings

Using this framework we assess companies across three metrics:

Metric 1) Technical innovation (60%): We looked across the entire portfolio of each company and compiled a list of technical low-carbon innovations across two categories – energy efficiency technologies and propulsion/fuel technologies. Each innovation was then assigned an innovation impact score based on an assessment of whether the innovation was incremental, radical or transformative as per the definitions in Figure 51. These scores were aggregated to produce a final technical innovation score for each company.

Metric 2) Operational innovation (30%): We looked across the entire portfolio of each company and compiled a list of operational low-carbon innovations across two categories – voyage optimization and port activities. Each innovation was then assigned an innovation impact score based on an assessment of whether the innovation was incremental, radical or transformative as per the definitions in Figure 51. These scores were aggregated to produce a final operational innovation score for each company.

Metric 3) Business innovation (10%): We looked across the entire portfolio of each company and compiled a list of operational low-carbon innovations across two categories – financial innovation and circular innovation. Each innovation was then assigned an innovation impact score based on an assessment of whether the innovation was incremental, radical or transformative as per the definitions in Figure 51. These scores were aggregated to produce a final business innovation score for each company.

Figure 53: Transition opportunities summary table

Company	Technical innovation scorecard	Operational innovation scorecard	Business innovation scorecard	Overall weighted rank	Rank
NYK Line	1	1	3	3.8	1
Maersk	2	3	1	4.4	2
MOL	2	3	2	4.7	3
K Line	4	6	4	8.7	4
OOIL	4	8	4	9.1	5
Hapag-Lloyd	6	9	9	10.7	6
Evergreen Marine	8	3	9	10.7	7
HMM	16	2	4	11.1	8
Norden	8	6	4	11.2	9
U-Ming	7	13	9	12.3	10
COSCO S.H	11	9	9	12.8	11
Wan Hai	11	11	9	13.4	12
Yang Ming	15	11	9	13.8	13
Pacific Basin	8	16	9	14.3	14
COSCO S.ET	11	17	4	14.8	15
Teekay	11	18	9	15.3	16
Euronav	17	13	9	15.7	17
NS United KK	18	15	9	16.5	18
Weighting	**60%**	**30%**	**10%**		

Note: In calculating the weighted rank in this table, we use the weighted rank for each area. We display non-weighted ranks in this summary for simplicity only.
Source: CDP

The future of shipping

2050 Objectives: what will be required to get there?

The shipping industry is the provider of crucial services that enable the standards of living we have today. Yes, there are other modes of transport, but nothing that enables the scales of transport globally of the raw materials, food, energy products and manufactured goods that enable the global economy to operate.

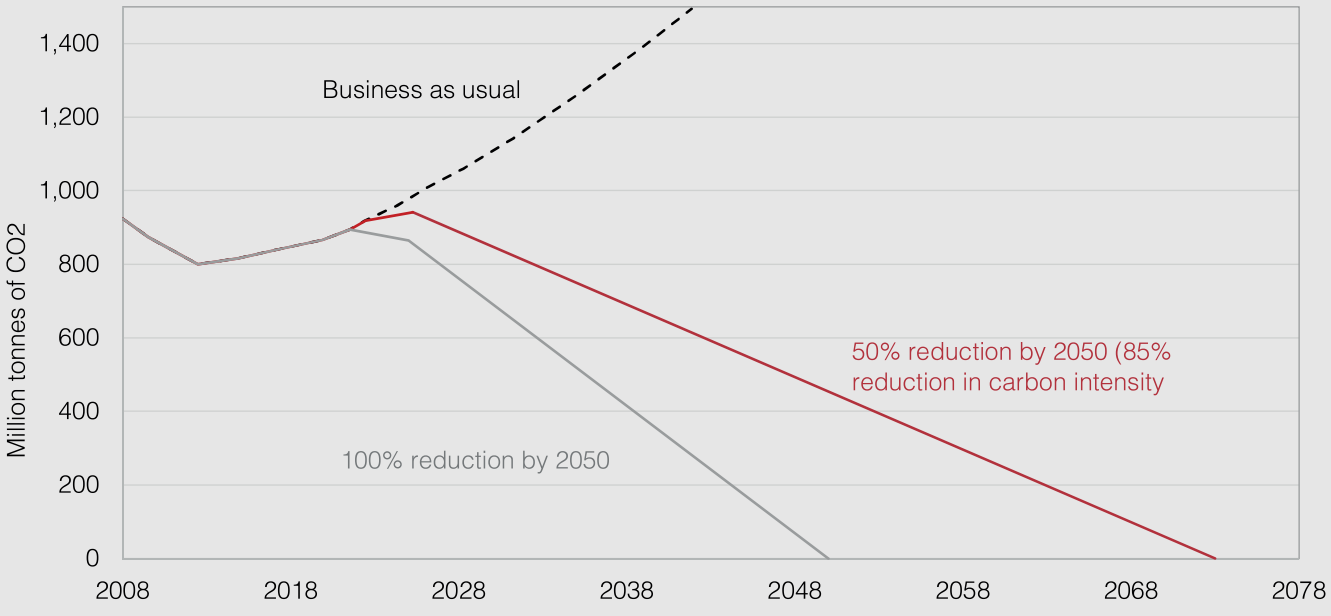
Fuel costs, competition and regulation have helped to drive technological progress in the global fleet of over 50,000 ships, to an efficient fleet with lowered environmental impacts. Regulation mainly in the form of the UN agency IMO's MARPOL convention sets global standards on a wide number of air, water and other environmental impacts.

However, technology has remained grounded in the use of oil products as fuels, and the internal combustion engine to convert those fuels into useful propulsion or electrical power on board. This has meant that even though significant progress has been made, the sector remains a major source of GHG emissions, and air pollutants. And with expectations for continued growth in world trade these emissions are expected to grow if no further action is taken.

The GHG responsibility has started to be acknowledged with the adoption of the IMO's Initial GHG Strategy in 2018. This Strategy answered a key question on the scale and speed of GHG reduction, something which when ambiguous had meant many parties were focused on debating whether shipping needed to decarbonise rather than looking for solutions.

The Initial GHG Strategy retains some ambiguity by stating that shipping's GHG emissions must reduce by at least 50% by 2050 on 2008 levels, and includes an unequivocal statement about the fact the sector is looking to phase out its use of fossil fuels. There is also clear language that links the GHG strategy to the temperature goals of the Paris Agreement, which leaves pending a discussion as to whether the ultimate objective that will be agreed when the Strategy is revised in 2023, will be aligned more to the 1.5 degree temperature rise goal which would likely mean GHG reduction from shipping to zero by 2050 or even sooner.

Figure 54: Pathways for international shipping's CO_2 emissions



Source: IMO

The 50 to 100% reduction in GHG emissions by 2050 needs to be set against a backdrop of expected growth in trade and therefore demand for shipping. Increasing demand for shipping is the main reason why even with further efficiency gains the sector is expected to have growth in GHG emissions out to 2050. This means that to achieve even a 50% absolute emission reduction, an individual ship's average improvement needs to be much higher (e.g. if continued trade growth of approximately 3% p.a., an individual ship might need more like an 85% reduction in emissions).

The Initial Strategy sets the high-level objectives and guiding principles, and a list of potential candidate policies. It is expected that to reach these objectives, there is a need for both policy that further increases efficiency, particularly of the existing fleet. And for policy that can enable a switch away from the use of fossil fuel. Uncertainty is likely to remain in both of these areas of policy for at least the next 3 years (possibly longer for clarity on how the shift away from fossil fuels will be incentivised).

What the role of disruptive technologies/fuels might be?

The backdrop to these IMO Objectives is that both shipping, and the infrastructure that supports shipping operations (ports, cranes, bunkering/refuelling infrastructure) are long-life assets often lasting 20-50 years. This means both that it can take a long time for the fleet to change technology/fuel especially if it is only done through changes in new ships. This also means that decisions made now are already at risk either of producing technology lock-in that hinders shipping's transition, or of exposing owners and financiers to risks of stranded assets (an asset that needs to be prematurely written down or off due to obsolescence).

These risks can be seen more clearly when looking at the role of disruptive technologies/fuels. The large majority of a ship's energy demand is currently associated with propulsion. If continuing to use fossil fuels, the potential for further reduction of GHG emissions in this system is limited to:

- Modifications to internal combustion engines
- Modifications to the hull and propeller
- The use of new technologies to provide additional energy (for example wind assistance or solar)
- Modifications to logistics and operations

The potential GHG reductions for all these options are worth pursuing but will not get close to the scale of GHG reduction needed to fulfil the IMO Objectives. This is why the focus in the sector has shifted to the question of which disruptive energy/fuel source (e.g. those that are not fossil fuels), and their associated technologies. For this there are three options:

- Battery electrification (using batteries to store energy on board)
- Bioenergy
- Synthetic liquid or gaseous fuels (e.g. fuels produced from renewable electricity or other sustainable processes, often referred to as e-fuels such as e-ammonia, e-methanol etc.

For much of the global fleet, battery electrification is not viable without a development in technology faster than is currently expected. The reason for this is that the range/endurance of deep-sea shipping makes the capital cost and volumes of batteries needed uncompetitive.

Bioenergy is technically a solution and is attractive because many variants are comparatively straightforward swaps with conventional fuels requiring little change in onboard or infrastructure technology. But there is a significant challenge associated with the practicality of securing the volume of bioenergy required by shipping (currently international shipping is estimated to use around 300Mt of conventional fuel a year [13]), given expectations of growth in population and land use for food, and bioenergy's important competing role in helping to achieve negative emissions through its use on land (e.g. Bioenergy with CCS).

This explains why a major focus at present is on the candidate synthetic liquid or gaseous fuels. The raw material for all of these is hydrogen, which can either be used as is (stored on board as a high pressure gas or liquefied), or processed through industrial chemistry to produce alternatives (e.g. synthetic ammonia or methanol). The advantage of these alternatives is that they can be easier to store and handle on ships and in infrastructure, including options which are more compatible with the existing technology.

Hydrogen, methanol and ammonia, three synthetic fuel options which are most commonly considered, could all be used in intrnal combustion engines similar to those used in the existing fleet. Or with fuel cells (converted back into hydrogen on board in some cases), to produce electricity which propels the ship using electric motors. Costs, performance and emissions of both internal combustion and fuel cell options are different and changing, particularly as fuel cell applications with large power outputs mature. Significant investment in research and development both for fuel production and onboard use, along with trials and pilot studies are needed in order to refine this list of options into either a single fuel or a small list of options that will mature to become available globally at the required volumes.

Already, many are pointing to ammonia use with an internal combustion engine as the most cost-effective option for the foreseeable future [14]. But with further RD&D expected to focus on the question of the most competitive future source of energy for shipping (Maersk has announced it is investing $1bn, other work is already ongoing, [15]) and shipping energy being a market worth approximately $1tn per annum, this area of fuels and energy is likely to be a significant source of disruption for the sector.

13. IMO, 2014: Third IMO GHG Study
14. Energy Transition Commission, 2018: Mission Possible - Reaching net zero carbon emissions from harder to abate sectors by mid-century
15. A.P. Moller-Maersk, 2018

Current obstacles to getting there and what needs to be done

1. Uncertainty

The investment environment faces two critical sources of uncertainty, in:

- The specifics and timing of the policy to shift from fossil fuel, and
- The identification of the most competitive long-run solution

Whilst those uncertainties sustain, investment carries significant risk. Although there is already evidence that some stakeholders (e.g. financiers[16]) are able to form strategy on the basis of the IMO's decarbonisation objectives, without needing to wait for policy specifics.

To address the uncertainty obstacle, investment into renewable/sustainable hydrogen production, as the common building block behind all the synthetic fuel options seems lowest risk. The basic plant can be built upon these foundations for additional processing of the hydrogen, as clarity emerges on the most favourable long-run synthetic fuel. For ships, design that retains flexibility of fuel use (e.g. plenty of space for different alternative fuel solutions, and access to machinery to enable retrofit) is another way to handle these risks.

However, the best way to reduce both these uncertainties is for the IMO to advance and clarify the policy measure it will use to enable a shift from fossil fuels, and by the coordination and collaboration across the sector on zero emission fuel research and development.

2. Incrementalism and LNG

Related to uncertainty, there is an understandable temptation to jump on fuel/technology options which are perceived to be the 'best' solution today, even if they are not credible long-term solutions. The best example of this obstacle is the promotion of LNG as the next marine fuel. This is a form of incrementalism whereby a small reduction in GHG (5-10%[17]) is used to justify the choice, despite the fact that LNG is still a fossil fuel and consumption of 1 tonne of LNG produces approximately the same 3 tonnes of CO_2 equivalent GHG's as oil derived fuels. Its justification is built into a narrative because it also helps reduce air pollution emissions, is a cargo carried in many ships (and therefore familiar to many operators), and there are global supply chains that can be tapped into that are developing because of its wider use as an energy commodity. Unlike some of the technology options (wind assistance) that have good long-term potential, the specifics of how LNG is stored and used on ships do not naturally lead on to reuse of the infrastructure and fleet without significant modification. For these reasons, it is a dead-end rather than the 'transition' it is often marketed as.

Investment activity now into a solution which is a known dead-end (e.g. without any long-run role), has a high risk of producing technology lock-in (as those investments have lives beyond the timescale needed to transition away from fossil fuels), as well as diverting capital away from the much-needed effort to transition from fossil fuel. The most effective solution to address the obstacle is to ensure a greater transparency and understanding of the time-scale of viability for LNG as a marine fuel (relative to zero emission options), and the likely impact of forthcoming regulations and zero emissions options on LNG-related asset values. However, the best way to counter the risk of a significant diversion of effort and attention towards LNG is for there to be mature and competitive zero emission alternatives that could be selected in preference, and/or the clear policy driver that will guarantee the competitiveness of zero emission alternatives (e.g. a carbon price).

3. Over-reliance on bioenergy

Similar to the temptation to see LNG as a solution, bioenergy is attractive as a solution. However, as pointed out there are significant risks to supply especially if all of shipping's energy demand is assumed to be met using bioenergy. The challenge for the sector is how it can continue to explore this potential energy source without it becoming a justification that undermines investment in currently more expensive alternatives such as synthetic fuels from hydrogen.

One of the risks to supply of bioenergy is around the regulation specifying the type of bioenergy that can be classified as "sustainable" without any of the adverse impacts (e.g. land-use change, impacts on food price, ecosystem loss) that are known risks in current bioenergy production. The sooner long-run sustainable global specifications and regulation on bioenergy can be developed, the greater the clarity on the potential production and therefore supply volumes and the easier for the shipping (and other) sectors to assess bioenergy's potential contribution. In the meantime, assuming that bioenergy has only a small role to play as a shipping fuel is the best way to manage this obstacle.

16. Poseidon Principles, 2019
17. American Bureau of Shipping, 2019: Low-carbon Shipping Outlook

4. Cost/economics

The production of hydrogen from renewable electricity and its onwards processing currently would result in fuel and operating costs for ships that were significantly higher than those of existing ships using fossil fuels. This means that unless the market itself rewards the use of non-fossil fuel (e.g. a sufficient premium paid by the end consumer for a zero GHG product), the sector will need to have a clear incentive/regulation to close the cost gap.

The obvious policy tool to address this obstacle is carbon pricing which would have an effect to increase the cost of fossil fuels relative to non-fossil fuels and therefore help make non-fossil fuels more competitive. Carbon pricing could also help raise revenues that if deployed in, for example, blended finance could help de-risk the deployment of zero-emissions fleet and infrastructure. However, arguably simpler policy that bans the use of fossil fuel (or requires progressively lower fossil fuel content) is an alternative, if more blunt, way to overcome the cost/economics obstacle.

One important element related to cost is safety, and many of the zero emission options present a number of safety related risks. Whilst work is ongoing to develop engineering and operational solutions that could manage these risks, factoring in some expectation that there will be a cost premium associated with their management can help to manage their potential to present a future obstacle.

In the longer-run, There is uncertainty as to whether cost/economics will remain an obstacle, as both the costs of renewable electricity and the costs of hydrogen/alternatives production are expected to reduce due to economies of scale, technology cost reductions gained through research development and deployment experience.

5. Infrastructure/fleet combined transition

Also referred to as the "chicken and egg" problem, whereby ships that operate globally need global availability of a fuel, but those building the infrastructure need evidence of a sufficient demand before investing and producing that availability. Given the lead time in construction of infrastructure and fleet, and the uncertainty in policy and technology development, it is hard for all stakeholders to coordinate to get the timing 'right' such that supply and demand for zero emissions energy grow smoothly and in-line with the global objectives on GHG reduction.

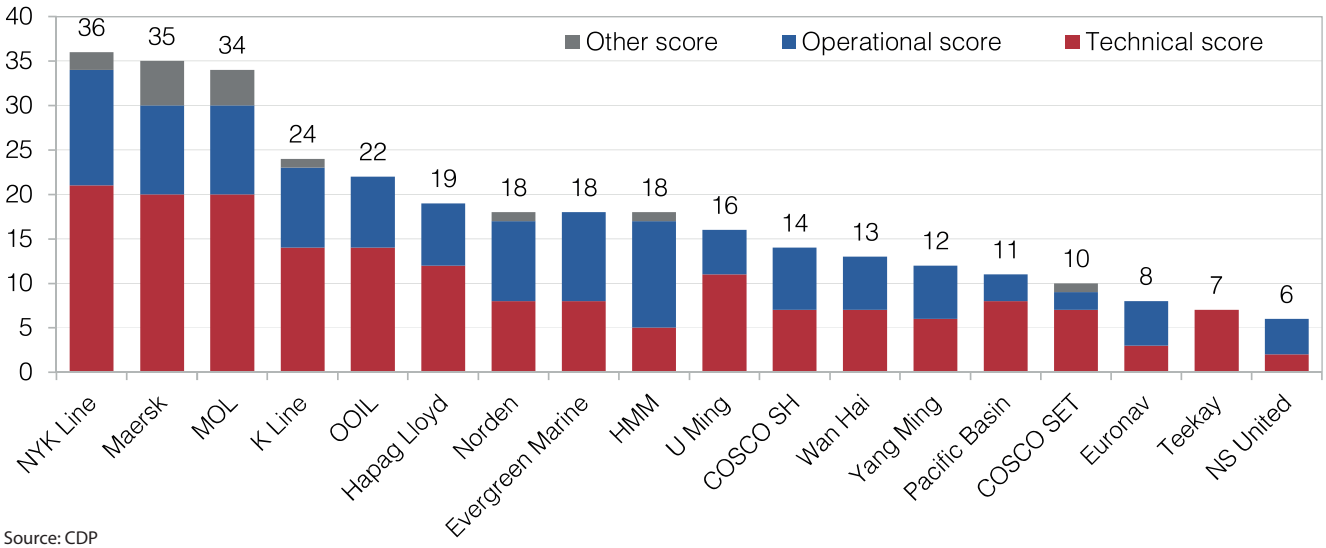
There are advantages to leveraging existing infrastructure either related to marine or other global supply chains (methanol and ammonia have pre-existing applications in other sectors which mean they are already globally traded). However, even leverage of existing infrastructure is unlikely to be sufficient in itself to manage this obstacle.

Policy both at the IMO and at national government level (that can influence both infrastructure and domestic fleets), can help to stimulate the coherent development of zero emissions fleet and infrastructure, and such policy could be integrated with the policy solution to the cost/economics obstacle. However, policy from both may still present uncertainty if remaining 'technology neutral' in order to leave selection of the lowest cost option to the market. In these circumstances, collaborative networks that bring the different stakeholders within shipping together have a very important role to play. These networks can help by unpicking the various system-wide opportunities for cost reduction of different fuel/energy/technology pathways, along with planning an incremental way in which investments aligned to zero-emissions futures can be deployed and scaled.

Overall highlights

- There is an innovation gap between the cutting-edge carbon neutral technologies available to the sector and the forms of innovation companies are investing in. No companies disclose any active innovation in step change technologies such as hydrogen and ammonia fuel cells or electrical propulsion.
- The level of transformative innovation is extremely low. With the exclusion of NYK Line which is collaborating on the development of zero emission vessels and Norden and Maersk which are pioneering bio-fuel based carbon neutral voyages, no other companies are investing in technologies that are considered to be transformative.
- The extent of collaborative innovation between shipping companies and capital goods companies is low relative to other sectors such as the power sector. From our analysis of the capital goods sector we found that 34% of innovations were directed towards power sector customers compared with 8% for the marine end market. Of power sector innovations, over 70% were radical or transformative. For marine innovations, less than 10% were radical and none were considered to be transformative.
- NYK Line ranks first overall with the highest score across technical and operational innovation. They are investing heavily in LNG as a marine fuel and collaborating on the design of an emission-free vessel.
- NS United rank last for transition opportunities. All of their innovations are considered to be incremental and are associated with small energy efficiency improvements driving limited decarbonization.

Figure 55: Overall innovation scores

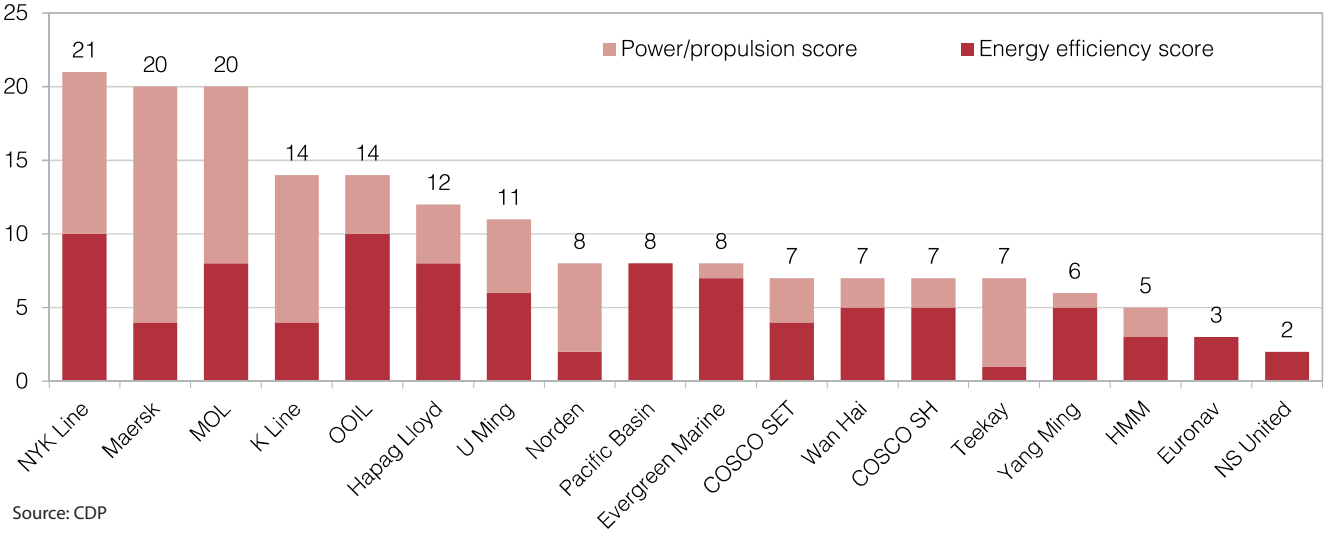


Source: CDP

Technical innovation

- On average companies have invested in almost double the number of energy efficiency technologies relative to propulsion and fuel technologies. Scores for propulsion and fuel technologies are on average higher; however, as these technologies are more likely to be considered radical or transformative.
- While companies such as HMM have disclosed plans to invest R&D into the development of hydrogen fuel cell technologies, no companies are currently actively innovating in this area.
- The most active area of technical innovation across the universe of companies was the development LNG as a marine fuel and collaborating on the design of LNG-bunkering vessels. Ten of the 18 companies were investing in this type of innovation.
- NKY Line ranks first for this metric, jointly leading the group in terms of energy efficiency technologies alongside OOIL and ranking third in terms of propulsion and fuel technologies. NYK Line is particularly active in the development of LNG as a marine fuel, co-developing the brand "Gas4Sea" to sell LNG marine fuel worldwide.
- Maersk ranks first in terms of propulsion and fuel technologies investing in both biofuels and LNG as a marine fuel.
- NS United ranks last in terms of technical innovation, delivering no propulsion and fuel innovations. The energy efficiency technologies rolled out by the company were considered to be incremental in nature.

Figure 56: Technical innovation scores



Source: CDP

Figure 57: Technical innovation highlights

Company	Technical innovation highlights	Energy efficiency	Power/ propulsion	Technical innovation score
NYK Line	- Co-developed the brand "Gas4Sea" to sell LNG marine fuel worldwide - Collaborated on the developed of Japan's first LNG-fueled tugboat - Completed the world's first LNG-fuel supply ship to provide fuel to LNG-fueled carriers	10	11	21
Maersk	- Involved in testing Algae based biofuels with the U.S. Navy - Signed a memorandum of understanding with Qatar petroleum and Shell to develop LNG as a fuel	4	16	20
MOL	- Collaborating on the Wind Challenger Project focusing on using advanced sails to provide propulsion - Signed a long-term charter contract for a large LNG bunker vessel	8	12	20
K Line	- The DRIVE GREEN HIGHWAY is K Line's flagship project bringing together advanced energy saving technologies in a 7,500 unit car carrier vessel - To establish a fuel supply system, K Line established two joint venture corporations to run the LNG bunkering business together with another partners	4	10	14
OOIL	- All of OOIL's new vessels will be LNG-ready - Invested in a new fleet with lower energy consumption levels achieving a Energy Efficiency Design Index (EEDI) value 48% better than the EEDI baseline requirement level	10	4	14
Hapag-Lloyd	- Already have 17 "LNG-ready" container vessels - Collaborating with Kuhne + Nagel to reduce CO_2 emissions in joint container transport as part of their Carbon and Sustainability Pact	8	4	12
U-Ming	- Collaborating to demonstrate the feasibility of LNG-fueled bulkers in a "green corridor" iron ore and coal trade between Australia and China - Invested in two VLOC's that are LNG ready	6	5	11
Norden	- Successfully tested CO_2 neutral biofuel derived from used cooking oil - Offering a carbon neutral transport solution to customers which neutralizes the CO_2 emission from the transport by replacing the fossil fuel consumed during the transport with an equivalent amount of CO_2 neutral waste biofuel.	2	6	8
Pacific Basin	- Investing in energy efficiency technologies including propeller and rudder efficiency improvements - Advances to conventional engines including installing electronic control for better efficiency	8	0	8
Evergreen Marine	- Collaborating with Samsung Heavy Industries of Korea to develop new ships to optimize the composition of the fleet and form part of the ship revitalization program - Advances to conventional engines including modifying main engine with electronic fuel injection	7	1	8
COSCO S.ET	- Investing in dual fuel power systems - Investing in a range of energy efficiency technologies including new tail shaft sealing systems	4	3	7
COSCO S.H	- Cosco Shipping Lines are integrating LNG-ready vessels into their fleet and have made 11 orders for LNG-ready ULCV - Designed a green ship, Kilimanjaro that realizes intelligent energy efficiency management.	5	2	7
Teekay	- Integrating E-shuttles into fleet which operate on LNG as a primary fuel but also utilise the volatile organic compounds from the boil off gas of cargo as a secondary fuel.	1	6	7
Wan Hai	- Investing in a range of energy efficiency technologies including propeller and rudder improvements - Main diesel engines adapted for the latest electronic oil lubricator systems	5	2	7
Yang Ming	- Investing in energy efficiency technologies including propeller and rudder efficiency improvements - Invested in advances to conventional engines including engine derating and EGB modification	5	1	6
HMM	- HMM's Greenship Collaboration with KR is exploring LNG Fueled Ship feasibility - HMM has developed an energy efficiency IoT monitoring system	3	2	5
Euronav	- Investing in a range of energy efficiency technologies including propeller and rudder improvements	3	0	3
NS United	- Adopted a range of energy efficiency technologies.	2	0	2

Source: CDP

The wind in our sails

This summary of future propulsion options is meant to demonstrate the task that ship owners, operators, and builders have before them. There is currently a transition period underway, still based on fossil fuels, which aims to improve the carbon profile of the existing fleet of ships without the need for massive investment in new infrastructure or technologies. However, there is also an ambition for a low-carbon shipping fleet that emits at least 50% less CO_2 compared to 2008 levels in the next 30 years. As the lifespan of some vessels can exceed this age it is important for the industry to work towards this future at pace.

The following is an exploration of the transition and ambitious fuel and propulsion technologies as they stand today for ocean-going cargo ships, using Heavy Fuel Oil (HFO) as a reference point. There will be a focus on their potential to reduce a range of emissions, the maturity of the technology as well as their advantages and disadvantages compared to HFO [18].

It is fortunate that the spread of alternative technologies and fuels that might drive a low-carbon transition is wide and varied, as the unique advantages and drawbacks of each will draw them to their economical niche in the different categories of cargo and passenger transport. It is reasonable to believe that some of the following alternative fuels and technologies can be used concurrently or interchangeably. Some examples include dual or tri-fuel engines that can accept a variety of different alternative liquid fuels, or the use of hybrid battery/engine/renewable solutions on the same vessel.

All ahead slow: Transitional fuel and propulsion options

Liquid Natural Gas (LNG): Similar in composition to the natural gas used for residential heating and power generation, LNG has great potential to reduce SOx and NOx emissions and emits around 25% less CO_2 to HFO when combusted. However, the energy intenisive liquefaction process means that emission reductions across the full life-cycle of LNG are reduced to around 5-10% compared to HFO. This is not accounting for the impact of methane slip which can further erode these gains. The drawbacks of LNG include capex costs that are higher than Low-sulfur HFO fuel which can deliver similar SOx and NOx reductions. However, it is a mature fuel which is already in use in vessels, and engines have been developed that can switch between Low-Sulfur HFO (LSHFO), Marine Gas Oil (MGO), and LNG according to the needs of the operator. The price of LNG is competitive with both LSHFO and MGO and operating costs are not much different than current HFO ships[18].

Methanol: A liquid fuel that marine engines can be modified to use. Methanol can be created through different feedstock sources that for the moment consist of natural gas, but can also include biomass and can be synthesized from CO_2 and Hydrogen. The burning of Methanol through a conventional combustion engine promises to lower SOx almost completely, and NOx by a significant degree. However, significantly reducing CO_2 emissions compared to HFO rely on the use of biomass or electrolysis to generate methanol rather than natural gas [19]. An advantage of methanol is that it is a well-known fuel with a long history of safe handling and transportation, along with existing infrastructure in place to fill bunkers with minimal modifications [20]. It also has lower capex costs than other transition fuels like LPG and LNG [21], although fuel costs for methanol made from renewables will be more costly (DNV GL assessment of selected alternative fuels and technologies). Compared to LNG it is also less mature, having only a handful of ships exclusively using methanol as a fuel.

Liquified Petroleum Gas (LPG): Widely used as propane for applications in vehicles, heating, and industry, LPG has not yet made inroads as a transition fuel in the maritime industry. Like other transition fuels LPG can be used in current engines with some modifications and must be kept onboard in liquid form within a pressurized tank in the same manner as LNG. LPG has the potential to eliminate SOx emissions and to reduce NOx emissions; however, its ability to reduce CO_2 emissions is limited compared to LNG [22]. The advantages of LPG include the fact that it is a widely available fuel with already established infrastructure. Capex is similar to LNG, while opex is similar to HFO [23]. The disadvantage of LPG is that for marine applications it is not as mature as methanol and LNG.

Anchors aweigh: Ambitious fuel and technologies needed to meet IMO target by 2050

Battery: The benefits of battery powered vessels would be low or zero emission vessels, especially if batteries were charged from renewable energy sources. Batteries also allow for smoother propulsion operations and have been proven to be safe [24]. There are efforts to replicate the benefits and success of electric vehicles within the marine industry with most activity focusing on electrifying small passenger ferries and cargo barges. However, a fully electric ocean-going cargo ship is unlikely with rapid advances in battery technology. At present the cost, space and weight of the batteries needed with even the best energy density configuration would make such a ship uneconomical [21].

Fuel cells: Working in a similar fashion to vehicle-based systems, marine fuel cells would convert a liquid energy carrier such as hydrogen or ammonia into usable electricity. The Tail-To-Pipe (TTP) emissions would only be water vapor, although achieving net-zero emissions across the life-cycle would only be achievable if the hydrogen or ammonia was produced using renewable energy. Using hydrogen as an input to a fuel cell would require high capital costs and its operating costs would be higher than that for diesel-fueled vessels [25]. An extensive refuelling and transportation infrastructure would also need to be created at ports. However, hydrogen would require more bulky and complex supporting structures compared to ammonia, which is emerging as a better suitor for fuel cells due to its wider availability, less demanding transportation requirements, and higher energy density [26].

18. DNV GL, 2018: Assessment of selected alternative fuels and technologies
19. IMO, 2016: Methanol as Marine Fuel: environmental benefits, technology readiness and economic feasibility
20. FCBI Energy, 2015: Methanol as Marine Fuel
21. DNV GL, 2018: Complete Alternative Fuels Guidance Paper
22. WLPGA, 2017@ LPG for Marine Engines
23. DNV GL, 2019: Batteries and Hybrid Shipes
24: Smil, Vaclav., 2019: Electric Container Ships are stuck on the horizon
25. Sandia National Laboratories, 2018: Diesel doesn't float this boat
26. Wittrig, S., Undated: Ammonia fuel opportunities

Hydrogen/Ammonia Combustion Engine: Besides their potential for use in fuel cells, both hydrogen and ammonia can be used for energy within conventional internal combustion engines. Touted as a bridge fuel to a fuel-cell based propulsion system, using hydrogen or ammonia in engines could achieve the same emission reductions as fuel cells. Capex would be higher than HFO, but the design of a hydrogen or ammonia-fuelled engine would follow the same principles and keep the same physical footprint as a conventional engine as it only needs to be hardened against the very cold liquified hydrogen fuel [27] or the toxicity of ammonia. Opex for hydrogen would be fairly high as the fuel is expensive to produce, while ammonia would be priced more competitively than even current alternative fuels [26]. As is always the case, the sources of hydrogen and ammonia must be generated using renewable sources in order to meet IMO 2050 emission targets. An extensive refuelling and transportation infrastructure would also need to be created at ports.

Mixed renewable: Renewable energies like solar and wind are also seen to have potential in powering a zero-emission vessels. Options for wind power include rigid sails covered in solar panels, Flettner rotors, and large kites that can provide pulling power or electricity through a turbine. Capital costs would be significant due to the extra physical installation of renewable energy systems, although operating costs would be negligible. The advantages of this technology is its lower maintenance and potential self-sufficiency. The disadvantage is that the arrangement would not be possible for all types of vessels (e.g. container ships) and the fact that experts do not see even mixed renewables as having enough power to propel a large ocean-going vessel entirely on its own.

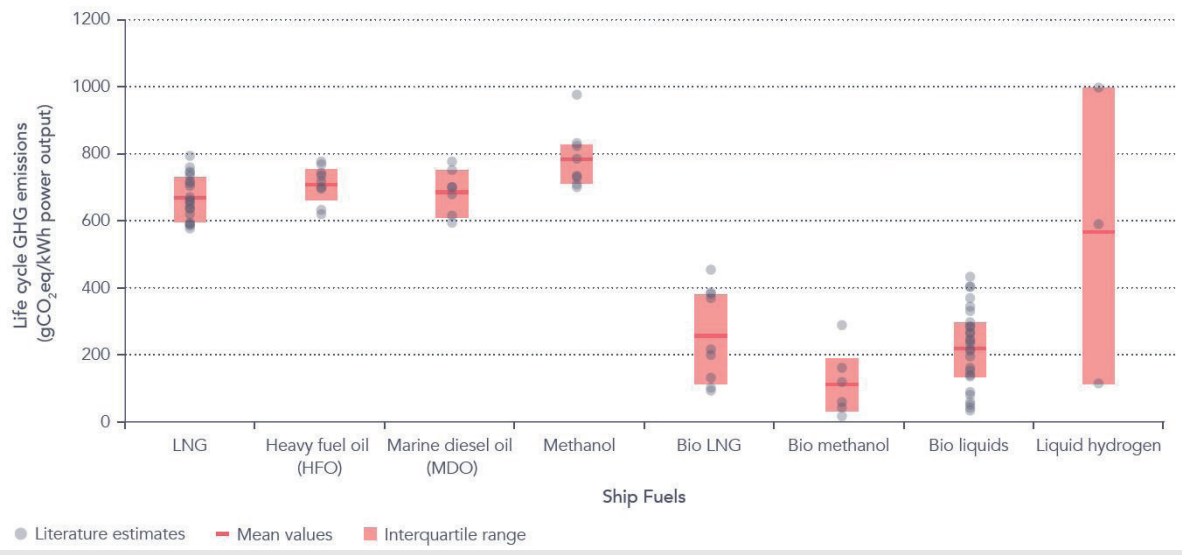
Biofuel: With the goal of limiting the cost of converting port infrastructure and ship design, while still meeting a target of 50% carbon emission reductions by 2050, biofuels have held a long history of potential as the least costly and complicated fuel for the sector. Biofuels would reduce SOx emissions and potentially lower NOx emissions. The fuel's CO_2 emissions are in theory limited to the cultivation and transport of the biomass. The variety of potential feedstocks are so wide that everything from algae to corn can be used, each with different characteristics with regards to energy density, growth patterns and cost. For marine engines bio-diesel, bio-LNG, and bio-methanol would be the preferred types of biofuel, and can be created as a "drop in" fuel for use in current marine engine designs. Therefore, capex promises to be fairly insignificant. However, at the moment more biodiesel is needed to meet the same energy content of conventional diesel and it costs 15-20% more per gallon than diesel [28]. In addition to this there are questions about the scalability of biofuels and the potential impact on land availability.

Figure 58: Alternative fuel matrix

Fuel/engine type	CO_2 life-cycle reduction	SOx reduction	NOx reduction	CAPEX	OPEX	Maturity
LNG						
Methanol						
LPG						
Battery						
Nuclear						
Fuel cell (natural gas)						
Fuel cell (electrolysis)						
Electro fuels (H2/NH3)						
Renewable						
Biofuel						

Source: CDP, DNV GL ■ High ■ Medium ■ Low

Figure 59: Comparison of life-cycle emissions across fuels



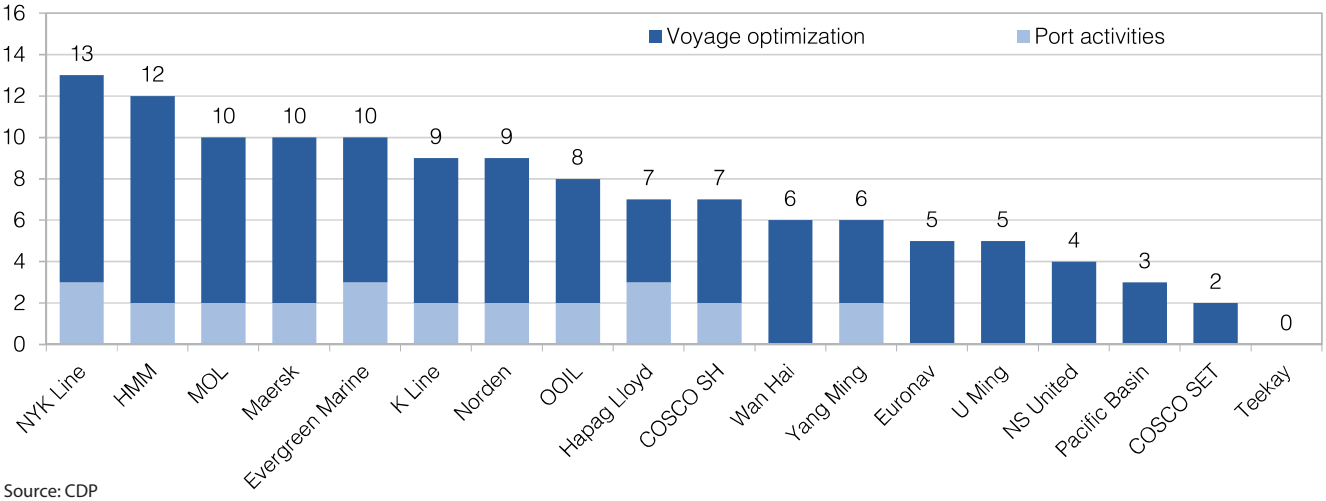
Source: Imperial College

27. NH3 Fuel Association, 2014: Liquid ammonia for hydrogen storage
28. United States Department of Enery, 2019: Alternative fuels data centre

Operational innovation

- Voyage optimization measures were adopted across the board (with the exception of Teekay due to lack of disclosure). Conversely, less than half of the companies engaged in port activities to drive decarbonization.
- Thirteen of the 18 companies have developed slow steaming strategies tied to environmental benefits; however, the scope of slow steaming is varied with most companies being confined by commercial timelines. K Line, HMM, Euronav and COSCO Shipping Holdings disclose the adoption of super slow steaming strategies but details regarding the coverage of these strategies is limited.
- Eight of the 18 companies have been actively collaborating on the development of advanced voyage data management platforms with technology providers. NYK Line, Norden, Maersk and MOL are investing in technologies that are equipped with autonomous capabilities.
- Eleven of the 18 companies have vessels designed for cold ironing – the use of onshore power supply when berthing which has decarbonization benefits where these sources of energy are cleaner than onboard power supplies.
- NKY Line ranks first for this metric, leading the group in terms of voyage optimization. They are heavily investing in the development of advanced digital technologies to optimize vessel performance.
- Teekay ranks last for this operational innovation. They do not disclose any operational measures designed to drive fuel savings or decarbonization publicly.

Figure 60: Operational innovation scores



Source: CDP

Figure 61: Operational innovation highlights

Company	Slow steaming strategy	Cold ironing	Advanced data platform	Autonomous capbilities	Port activities score	Voyage optimization score	Operational innovation score
NYK Line	✓	✓	✓	✓	3	10	13
HMM	✓	✓	✓	×	2	10	12
MOL	✓	✓	✓	✓	2	8	10
Maersk	✓	✓	✓	✓	2	8	10
Evergreen Marine	✓	✓	✓	×	3	7	10
K-Line	✓	✓	✓	×	2	7	9
Norden	×	✓	✓	✓	2	7	9
OOIL	✓	✓	✓	×	2	6	8
Hapag-Lloyd	✓	✓	×	×	3	4	7
COSCO S.H	✓	✓	×	×	2	5	7
Wan Hai	×	×	×	×	0	6	6
Yang Ming	✓	✓	×	×	2	4	6
Euronav	✓	×	×	×	0	5	5
U-Ming	✓	×	✓	×	0	5	5
NS United	✓	×	×	×	0	4	4
Pacific Basin	×	×	×	×	0	3	3
COSCO S.ET	×	×	×	×	0	2	2
Teekay	×	×	×	×	0	0	0

Source: CDP

Slow steam ahead

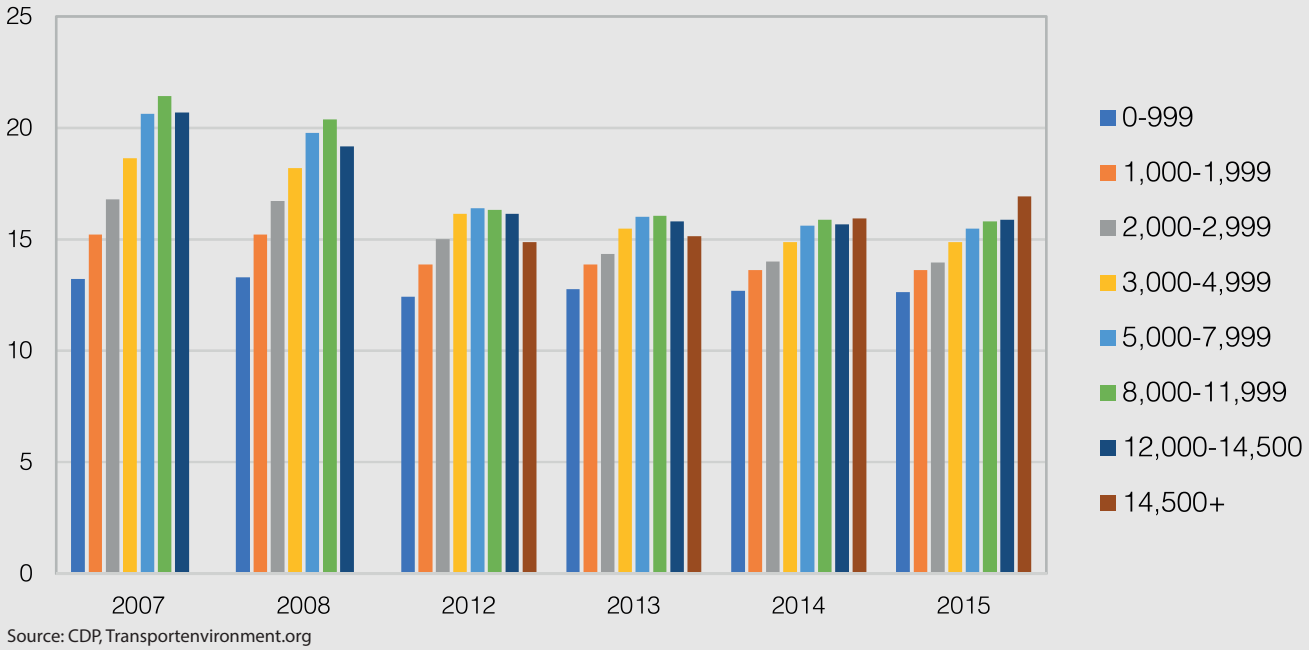
Slow steaming is the practice of reducing the speed at which ships are propelled in order to achieve fuel efficiency gains. These gains are related to the fact that there is not a one-to-one relationship between the speed of a ship and the power required to propel it. In fact, technical analysis suggests that speed reductions of 10-15% can reduce fuel consumption by 30-40% for bulk fleets and potentially more for container vessels. As such, slow steaming offers potentially significant decarbonization opportunities for the shipping sector which are captured in several decarbonization scenarios including the IEA Beyond 2-degree Scenario [29].

As a result, there has been growing international pressure for ship operators to adopt fleet-wide slow steaming strategies. This was reinforced in April 2019 by France's submission to the IMO urging for global speed limits for shipping ahead of the 74th session of the MEPC. The submission described slow steaming as an "excellent transitionary and early measure" to curb the sector's emissions[30]. Following this, 120 shipping companies sent an open letter to the IMO also backing mandatory speed limits. However, this support came largely from bulk and tanker companies with some major container shipping companies publicly denouncing the proposal. Container companies argue that they have already invested in speed reductions and that further slow steaming would not be commercially viable given increasingly tight shipping deadlines. There are also concerns that slow steaming may cause unpredictability for customers and shift demand to other forms of transport including aviation and rail [31].

There are also uncertainties around whether the technical decarbonization potential of slow steaming can be realized in practice. Some analysts argue that lower ship speeds necessitate the construction of more ships and that the GHG emissions associated with the manufacturing processes can offset the benefits of reduced speed [32]. Another consideration for ship operators is the safety implications of slow steaming which require engine modifications and retrofitting to ensure certain engine loads are possible without causing long-term damage.

Some commentators have suggested that slow steaming was initially introduced by ship operators to rebalance the market the economic downturn in 2008. Slow steaming causes volumes from idle ships to be absorbed into service reducing the supply of transport space and putting upward pressure on prices. But while this strategy makes economic sense in a bearish market, there is evidence that ship speeds are increasing as global demand recovers and will return to normal speed or even faster speeds when markets boom (see Figure 62 below).

Figure 62: Historical cruising speed (knots) for different ship sizes (TEU)



Source: CDP, Transportenvironment.org

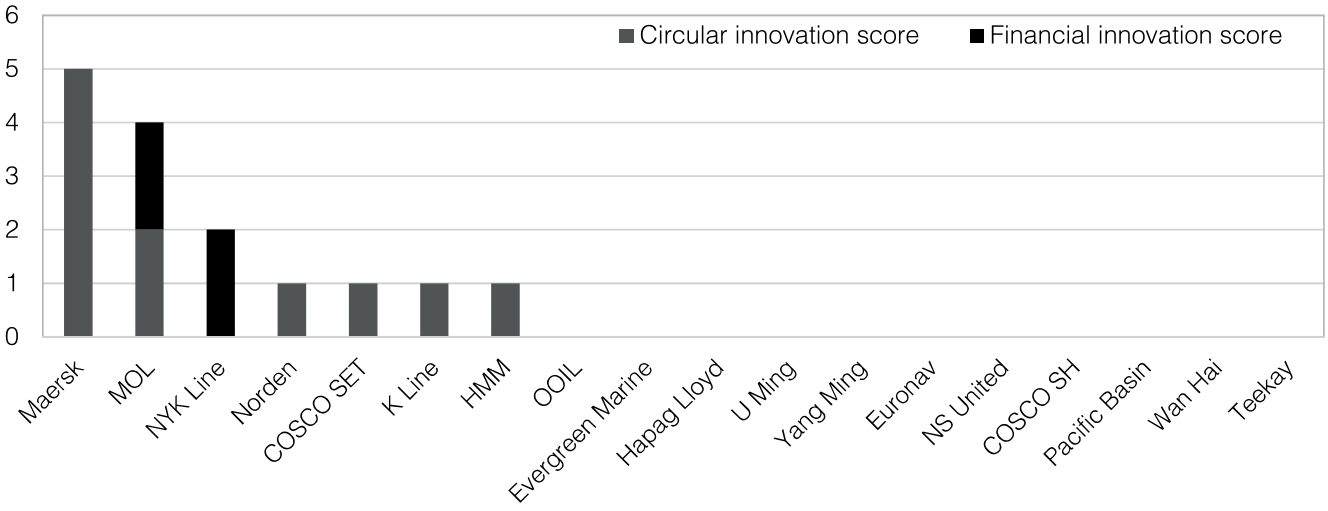
Ultimately, slow steaming strategies are currently dictated by economic and commercial considerations. Decarbonization exists only as a secondary driver which is consistent with the findings of our research. While most companies in our universe have adopted some form of slow steaming strategy, disclosure regarding the coverage and extent of these strategies is limited. Most companies appear to be constrained by commercial timetables, only engaging in slow steaming where there are clear economic benefits. Therefore, for slow steaming to be deployed globally in the context of ever tightening commercial timetables, regulation will need to be a key driver in setting mandatory speed limits.

29. IEA, 2017: Energy Technology Perspectives
30. Financial Times, 2019: Maritime chiefs call for ship speed limit to cut emissions
31. Lloyds Loading List, 2019: 120 shipping companies call for mandatory speed limits for ships
32. Newcastle University et al., 2014: Low-carbon shipping - a systems approach

Business innovation

- Less than half of the companies have deployed some form of financial or circular innovation.
- While most companies have waste management programs particularly focused around the disposal of hazardous materials, active innovation to transition to a more circular model of consumption on and off-shore is limited.
- Maersk leads the group overall driven by strong performance in circular innovation. The company has established numerous partnerships across their value-chain to pilot solutions to reduce food waste in food production, handling and storage.
- MOL ranks second overall driven by circular initiatives including developing a program to recycle used lashing belts which converts waste plastic into a secondary fuel. MOL has also issued a 500 million USD green bond.
- NYK Line ranks third overall and is the only other company across the universe which has issued a green bond.

Figure 63: Business innovation scores



Source: CDP

Figure 64: Business innovation highlights

Company	Business innovation highlights	Circular innovation	Financial innovation	Business innovation score
Maersk	- Collaborated with the Rockefeller Foundation and Technoserve to establish pilot projects in Kenya and Nigeria to reduce food waste in production - Established partnerships to pilot solutions to reduce food waste occurring in handling and storage	5	0	5
MOL	- Developed a program to recycle used "lashing belts," which hold vehicles in place aboard. The plastic is used as secondary fuel, and the metal is turned into scrap that can be reused - Issued a 500 million USD green bond	2	2	4
NYK Line	- Begun to offer green bonds within the Japanese domestic market	0	2	2
Norden	- Partnering with Plastic Change on their Expedition Plastic project, with the goal of mapping the plastic in the oceans and potentially assist with the data collection	1	0	1
HMM	- Hyundai Merchant Marine reuses drain oil by cleaning again. The company treats the sludge by landing to certified subcontractor ashore	1	0	1
K LIne	- In Thailand K Line developed a waste reduction program and achieved a subsequent freight transport increase by selling waste materials	1	0	1
COSCO S.ET	- Collaborating on two research projects with China Oasis to advance sewage treatment technologies	1	0	1

Source: CDP

Climate governance & strategy

- 12 Companies have set Scope 1 emission reduction targets but only three of these are aligned with the IMO's long-term target for 2050.
- The presence of board level climate committee's is low with most companies having climate committees at the executive level.
- Disclosure is poor with only four companies official supporters of the TCFD and five companies who completed CDP's 2018 Climate Change questionnaire.
- Maersk rank first for Climate Governance & Strategy with COSCO S.ET ranking last.

Overview

Companies that have strong governance structures in place where climate related risks are identified and managed at the highest level are better placed to anticipate future risks and adapt their strategy to mitigate them.

Providing clarity to shareholders and other relevant stakeholders on their environmental impact through proper disclosure, demonstrating long term commitments to reduce their environmental impact through target setting and having board level oversight where the executive can be held to account for performance on these matters, offer a more robust governance framework that adds credibility to companies' climate strategies.

In light of the IMO's GHG Strategy targeting a 50% reduction in emissions from a 2008 baseline by 2050, companies will be expected to demonstrate a long-term strategy on how they intend to meet the ambitions of the IMO. While it is positive that the majority of shipping companies in the universe have publicly disclosed Scope 1 emission reduction targets, the presence of board level climate committees within the sector are minimal with most companies managing these risks at the executive or sub-executive level.

As part of our analysis of companies' climate governance & strategy we assess company performance across four key metrics:

Metric 1) Emission reduction targets (30%): We assess the ambition of companies' emission reduction targets with a focus on companies' Scope 1 emission reduction targets. We credit companies who have a science-based target or who have aligned their targets with those set by the IMO as part of their GHG strategy.

Metric 2) Board level climate management (30%): Companies are assessed based on their board and executive climate management performance focusing on the number of directors on the board with climate related experience and the presence of climate-related committees at the board, executive or sub-executive levels.

Metric 3) Disclosure Scorecard (30%): Companies are assessed on their emissions disclosure coverage of owned and charted vessels, whether they disclose to CDP and their CDP score, if they officially support the TCFD and whether they actively perform climate-related scenario analysis.

Metric 4) Ship Recycling (10%): We assess the commitment of companies towards responsible ship recycling. We consider if companies comply with relevant conventions around ship recycling, and whether they are transparent in disclosing their company policies. We credit companies who voluntarily engage in initiatives designed to improve industry-wide ship recycling practices.

Overall highlights

- Maersk and NYK Line come first and second respectively. Maersk have set the most ambitious emission reduction target alongside HMM, aiming for net zero emissions by 2050. Maersk and NYK also top the rankings for board & executive level climate management with highly focused executive climate committees and several board members with climate expertise. Both are also official supporters of the TCFD and are conducting scenario analysis to assess the impact of climate change on their businesses.
- K Line and MOL are ranked in third and sixth position respectively. Both companies are targeting a 50% reduction in emissions intensity by 2050 and have highly focused climate committees at the executive level. Of the five companies that disclosed to CDP's 2018 climate change questionnaire, K Line were one of only two companies to obtain a CDP "A" score.
- Norden are ranked fifth having aligned their emission reduction targets with the IMO 2050 target to reduce absolute emissions 50% by 2050. Norden also have excellent ship recycling governance providing clear disclosure of their recycling policy.
- COSCO S.ET is ranked last. They lack the presence of a climate committee at the board, executive or sub-executive level. There is also no evidence of emission reduction targets having been set nor any detailed information available on their recycling practices.
- 12 of the 18 companies have disclosed Scope 1 emission reduction targets. Seven of these companies have made long-term commitments out to 2050. There is also a trend of companies aligning their targets with the objectives of the IMO GHG Strategy 2018. With both Norden and Evergreen Marine having made this move over the last year.
- Only three companies, U-Ming, Euronav and Wan Hai, have board level climate committees. Five companies have highly climate focused executive committees.
- Seven companies have disclosed details on the scenario analysis they are undertaking. These range from assessing the physical risks from flooding and drought on companies port facilities to assessing the impact of future carbon pricing on fuel costs.

Figure 65: Climate governance & strategy summary

Company	Emission Reduction Target	Board Level Expertise & Management	Disclosure Scorecard	Ship Recycling	Overall weighted rank	Climate governance & strategy rank
Maersk	1	2	3	1	2.59	1
NYK Line	4	1	1	5	3.99	2
K Line	5	6	1	5	6.26	3
HMM	1	11	8	12	7.51	4
Norden	3	12	5	1	8.16	5
MOL	7	3	4	17	8.28	6
Teekay	13	8	9	3	11.30	7
Wan Hai	10	4	10	11	11.33	8
OOIL	11	14	6	13	11.83	9
Pacific Basin	13	9	7	13	11.98	10
U-Ming	8	4	17	7	12.25	11
Evergreen Marine	6	10	10	18	12.41	12
Euronav	13	7	10	9	12.67	13
Hapag-Lloyd	9	15	10	3	12.84	14
Yang Ming	13	15	10	9	14.65	15
COSCO S.H	13	17	10	8	14.69	16
NS United KK	12	12	18	15	15.25	17
COSCO S.ET	13	18	16	15	17.15	18
Weighting	**30%**	**30%**	**30%**	**10%**		

Source: CDP

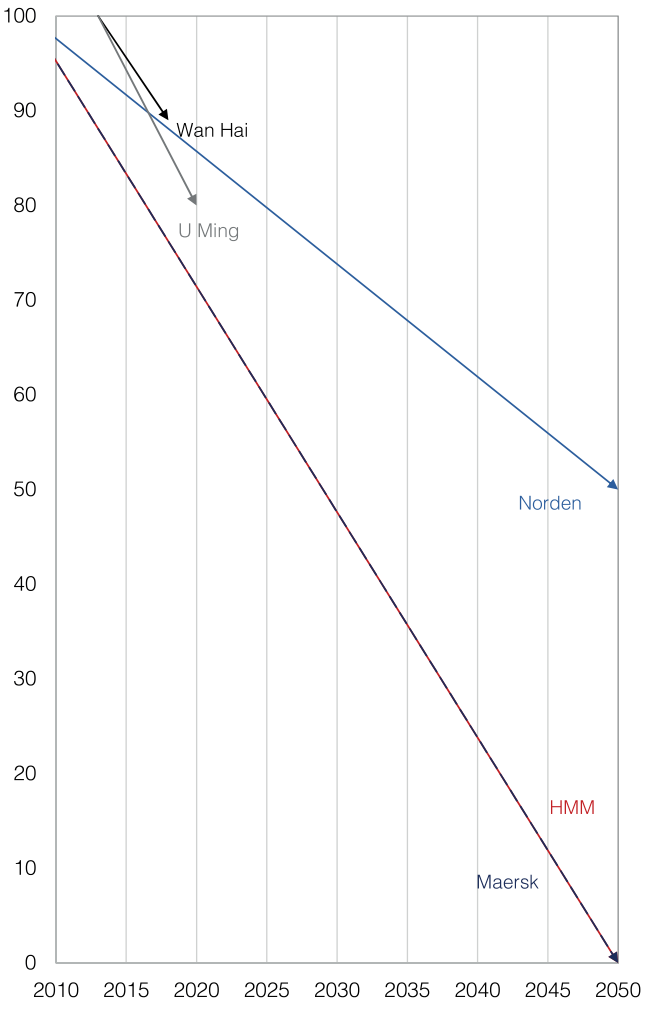
Emission reduction targets

Emission reduction targets provide an indication of the decarbonization trajectories that companies are pursuing. Scope 1 emissions account for a significant percentage of emissions from the sector and are generated upon combustion of the fuel used to power companies' vessels. 12 out of 18 companies in our sample have set Scope 1 emission reduction targets with more than half of these being long term commitments out to 2050. Two companies have had their targets approved by the science-based target initiative and four other companies have set targets that are aligned with or exceed the level of ambition of the IMO's GHG strategy.

Highlights

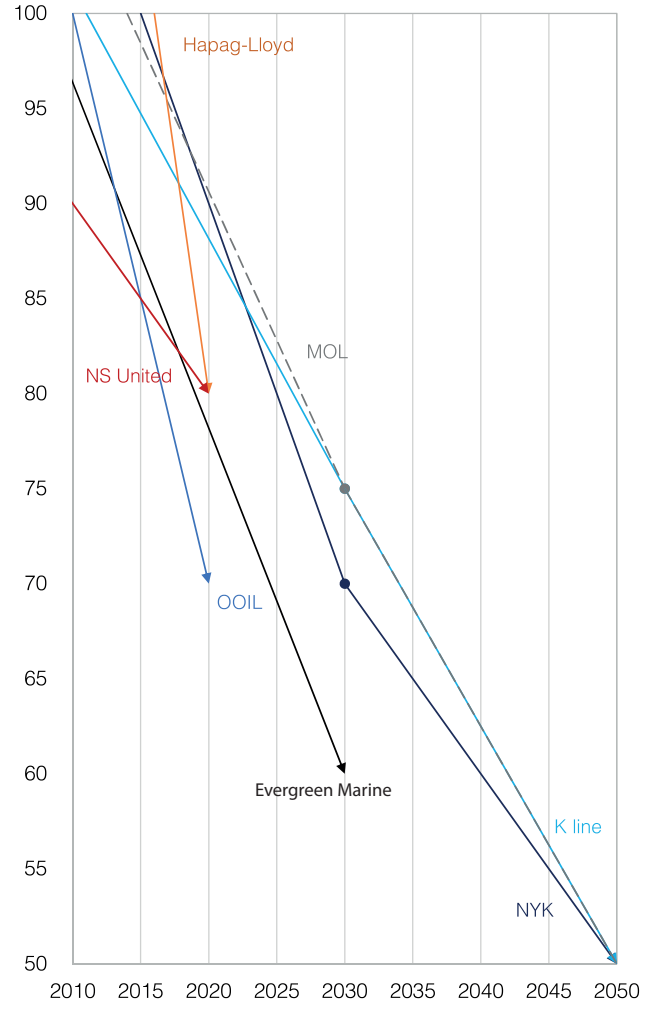
- Maersk and HMM are ranked in first position with both companies targeting net zero emissions by 2050. Maersk and HMM are among the only companies to have made such a commitment but both companies have a slightly different approach on how they intend on working towards this goal. Maersk's strategy emphasises the use of biofuels as a way forward and HMM are planning several R&D projects to commercialise hydrogen fuel cell technology within the shipping industry.
- Norden are ranked in third position. They have chosen to fully align their emission reduction targets with the IMO's GHG strategy and are targeting an absolute emissions reduction of 50% by 2050 (against a 2008 baseline), equivalent to a -1.64% CAGR.
- NYK are ranked in fourth position. NYK have set a science-based target to reduce their Scope 1+2 emissions intensity 50% by 2050 which is equivalent to a -1.96% CAGR. They believe this will have a ripple effect down the supply chain, reducing emissions across Scope 1-3 by 70%. K Line and MOL have set similar targets with different base years and rank fifth and seventh respectively.
- Evergreen Marine are ranked sixth having chosen to align their emission reduction target with the IMO's mid-term target which aims for a 40% reduction in emissions intensity by 2030. This is equivalent to a -2.3% CAGR.
- COSCO S.ET, COSCO S.H, Euronav, Pacific Basin, Teekay and Yang Ming do not appear to have any publicly disclosed emission reduction targets and are ranked last overall.

Figure 66: Scope 1+2 absolute emission reduction targets (base year indexed to 100)



Source: CDP

Figure 67: Scope 1+2 intensity emission reduction targets (base year indexed to 100)



Source: CDP

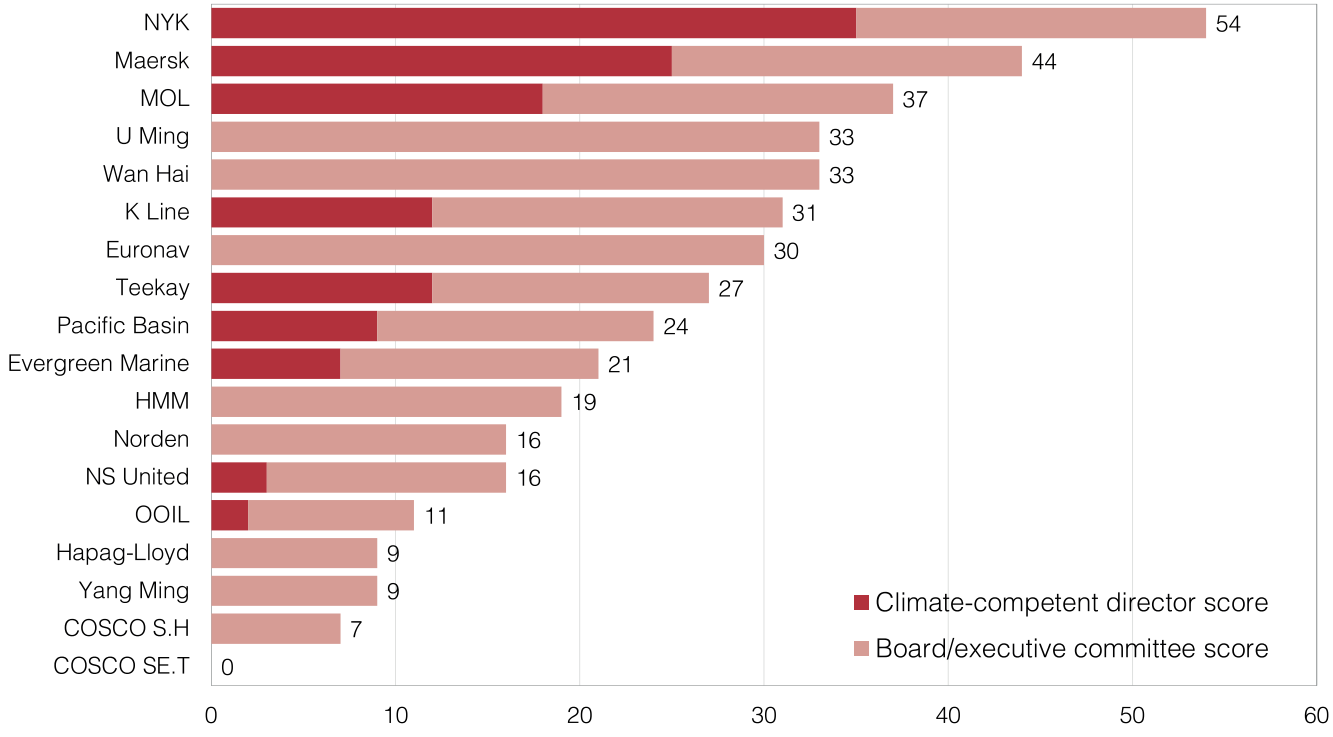
Board-level climate management

Board level climate expertise is fundamental in ensuring that climate related risks and opportunities are considered in senior decision making. This kind of leadership at the board level also gives middle management the license to drive climate programs forward. In this metric, we assess the climate expertise of the board as well as the establishment of climate-related committees at the board, executive and sub-executive levels.

Highlights

- NYK are ranked in first position and have two board members who were judged to have a medium level of climate expertise. CEO Tadaaki Naito was the former chief executive for Environmental Management at NYK. The Director Hiroko Kuniya also sits on the board of several Japanese climate change related organisations including the Renewable Energy Institute Board (a think tank focused on policy research and advocacy measures aimed at promoting renewable energy) and the UN backed Sustainable Development Solutions Network Board - Japan.
- Maersk are ranked second with 4 individuals on the board judged to have climate related experience. Most notable is Director Jacob Andersen Sterling who is Head of Climate Change and Environment at Maersk Line.
- Other notable companies include Euronav, Wan Hai and U-Ming who are the only companies in the sample to have climate committees at the board level.
- Hapag Lloyd, Yang Ming, COSCO S.H, OOIL had highly focused climate committees at the sub-executive level which are chaired by non-executive management.
- COSCO S.ET were the only company where there was no evidence of a climate committee.

Figure 68: Board level climate management scorecard



Source: CDP

Disclosure scorecard

In our disclosure scorecard we assess companies across four sub-metrics:

Official Supporters of the TCFD (25%): We look at whether companies are official supporters of the TCFD.

Scenario Analysis (25%): We look for evidence of companies conducting scenario analysis to assess the impact of climate change on their business.

Emissions Disclosure (35%): We assess the coverage of companies' emissions disclosure and whether the emission intensities disclosed cover their owned and chartered vessels.

CDP Score (15%): We score companies based on the score achieved in CDP's 2018 climate change questionnaire. Companies who have not been contacted to complete the questionnaire were not assessed on this metric.

Highlights

- K Line and NYK ranked joint first. Both companies are official supporters of the TCFD and are conducting scenario analysis to assess the impact of climate change on their businesses. The analysis conducted has focused on the impact of future carbon pricing on fuel costs as well as growing physical risks at sea. Of the companies that have disclosed to CDP's 2018 climate change questionnaire, K Line and NYK Line are the only companies to have received an "A" grade indicating the highest level of corporate disclosure and transparency.
- Maersk are ranked closely behind in third position. Maersk are official supporters of the TCFD and are conducting scenario analysis, using data sets such as the WRI Aqueduct tool and IPCC CMIP5 to assess the impact of water stress, flooding and other physical risks to their APM terminal business.
- NS United are ranked in last position. They have been neutralised for the CDP score component of the scorecard but have failed to provide clarity on the boundary used to calculate their emissions.

Figure 69: Disclosure scorecard

Company	Score (/100)	TCFD	Scenario Analysis	Emissions Intensity Coverage	CDP Score
K Line	100	✓	✓	Both	A
NYK	100	✓	✓	Both	A
Maersk	97	✓	✓	Both	C
MOL	86	✓	Planned	Both	B
Norden	72	×	✓	Both	C
OOIL	60	×	✓	Both	F
Pacific Basin (ii)	50	×	✓	Owned	-
HMM	43	×	✓	Other (i)	F
Teekay (ii)	41	×	×	Both	-
Euronav	35	×	×	Both	F
Wan Hai	35	×	×	Both	F
Yang Ming	35	×	×	Both	F
Hapag-Lloyd	35	×	×	Both	F
COSCO SH	35	×	×	Both	F
Evergreen Marine	35	×	×	Both	F
U-Ming	18	×	×	Owned	F
COSCO S.ET	18	×	×	Owned	F
NS United (ii)	0	×	×	Unclear	-

(i) HMM's emissions intensities calculated by the CCWG cover their owned and chartered vessels. The intensities for their bulk and tanker vessels only cover HMM's owned vessels.
(ii) Pacific Basin, Teekay and NS United did not receive a request to complete CDP's 2018 climate change questionnaire. Weightings were adjusted to account for this.
Source: CDP

Ship recycling governance

The governance around companies' ship recycling policies and practices is an indication of their level of responsibility and dedication towards sustainable ship recycling. In this section, companies that proactively follow industry guidelines and voluntarily engage in transparent disclosure have emerged as clear leaders. For this metric we assess companies across four key metrics:

Compliance with the Hong Kong Convention (50%): We assess to what extent companies are compliant with the UN Hong Kong Convention, differentiating between companies that are partially or fully compliant.

Innovator in Practices (30%): Here we assess whether companies are taking any measures that go above and beyond what is expected of them based on international / domestic regulation.

Recycling Disclosure (15%): We assess companies based on the level of detail provided on their ship recycling practices in their public reporting.

ISO 30000 certification (5%): We assess whether companies require shipyards to have ISO 30000 series certifications which apply international standards specific to ship recycling.

Highlights

- Maersk and Norden are ranked joint first. These companies are committed to ensuring that all vessels are scrapped at facilities compliant with the HKC and publicly disclose details of their recycling policies to enable investors to understand their actions and commitments. Maersk and Norden are the only companies that have articulated a policy designed to stop bad recycling practices for vessels once they have been sold.
- Hapag Lloyd and Teekay are ranked joint second. Much like Maersk and Norden, the disclosure of their recycling policies are clearly detailed with both committed to recycling vessels at HKC compliant facilities. These four companies were also credited for being part of the Ship Recycling Transparency Initiative (SRTI) designed to increase transparency and disclosure of companies' governance and recycling practices.
- Both Evergreen Marine and MOL have been penalised for their association with unethical ship recycling practices as highlighted in a report published by NGO Shipbreaking Platform. According to research by the NGO, MOL is listed among the top 10 worst ship-dumping companies with a lack of due diligence being taken on vessels sold to scrap dealers being to blame. Evergreen Marine have also been highlighted for bad practice by a number of sovereign wealth funds.
- NS United and COSCO S.ET are the only companies that have failed to articulate any details about their ship recycling policies.

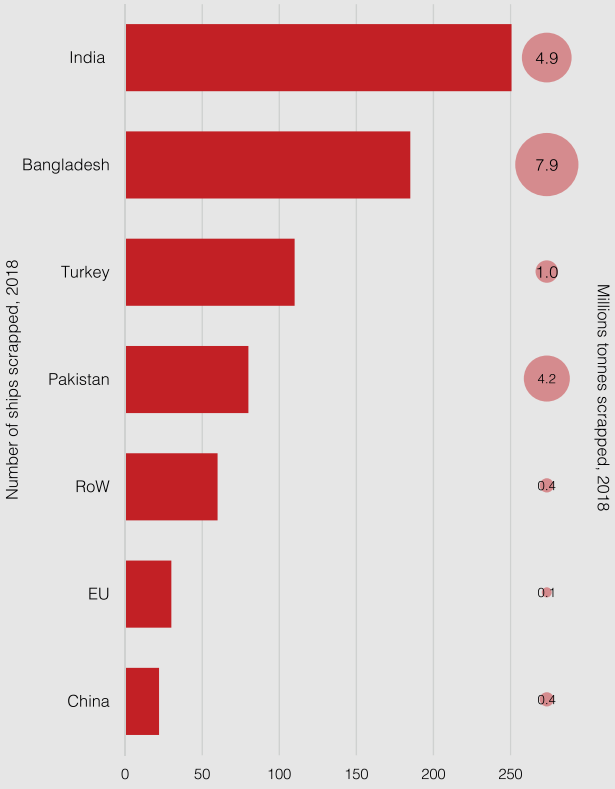
Figure 70: Ship recycling governance scorecard

Company	Ship recycling policy provided in CSR reporting	Non-EU flagged vessels scrapped at "HKC compliant" Facilities	Details provided on how SRF compliance is determined	ISO 30000 certification reuqirement from SRF	Are facilities monitored by company	Policy to mitigate risk of sub-standard recycling once vessels have been sold	Innovators in ship recycling practice	Identified for unethical recycling practices	Score
Maersk	✓	✓	✓	×	✓	✓	✓	×	95
Norden	✓	✓	✓	×	✓	✓	✓	×	95
Hapag-Lloyd	✓	✓	✓	×	✓	×	✓	×	85
Teekay	✓	✓	✓	×	✓	×	✓	×	85
NYK	✓	✓	✓	✓	✓	×	×	×	60
K Line	✓	✓	✓	✓	✓	×	×	×	60
U-Ming	✓	✓	✓	✓	Unclear	×	×	×	55
COSCO S.H	✓	✓	✓	×	Unclear	×	×	×	50
Euronav	✓	✓	×	×	Unclear	×	×	×	45
Yang Ming	✓	✓	×	×	Unclear	×	×	×	45
Wan Hai	×	✓	✓	✓	Unclear	×	×	×	40
HMM	✓	Unclear	×	×	✓	×	×	×	20
Pacific Basin	✓	Unclear	×	×	Unclear	×	×	×	15
OOIL	✓	Unclear	×	×	Unclear	×	×	×	15
COSCO S.ET	×	Unclear	×	×	Unclear	×	×	×	0
NS United	×	Unclear	×	×	Unclear	×	×	×	0
MOL	✓	✓	✓	×	✓	×	×	✓	-5
Evergreen Marine	✓	✓	✓	×	Unclear	×	×	✓	-10

Source: CDP

Ship recycling regulation

Figure 71: Ships scrapped in 2018



Source: CDP, NGO Shipbreaking Platform

Shipbreaking, ship dismantling, recycling and scrapping are used synonymously to define the process of taking a ship apart. With the average expected life of a ship ranging between 20-30 years, each year approximately 1,000 ocean-going commercial vessels come to the end of their service life and require disposal. Given the size of many of these vessels and their complex material composition, it is important the disposal process is undertaken responsibly and with consideration to health, safety and environmental concerns.

Until the late twentieth century, the majority of ship breaking took place in developed countries, with regulations in place to protect workers and the environment. Over time ship breaking has become more prominent in countries such as Bangladesh, India and Pakistan where ships are often dismantled on beaches and piers.

This method of dismantling ships is referred to as beaching, and involves ships being crashed onto the beach and dismantled during a low tide, posing environment, human and safety risks. 'Around 96% of shipbreaking yards in these countries apply the beaching method'. Statistics by Ship Breaking Platform show that of 744 ships that were dismantled worldwide in 2018, 518 were on beaches and just 226 were processed at industrial sites designed for the purpose.

If carried out safely, following industry guidelines, the process of recycling ships allows for materials and equipment to be re-used, making a positive contribution to the global conservation of energy and resources (i.e. steel can be reprocessed, ships' generators reused ashore, batteries used in the local economy etc.). Over the years, international bodies have developed regulations and guidelines to control the practice of ship recycling some of which have come into effect while others are still pending ratification.

Of the regulations and guidelines in place, the following consider environmental issues:

- **The Basel Convention** is a global environmental treaty on hazardous materials and other waste products, which was adopted in 1989 and entered into force in 1992. It aims to protect human health and the environment against the adverse effects resulting from the movement of hazardous waste. As at December 2018, 87 states and the EU parties to the Convention.
- **The Hong Kong Convention** was adopted in 2009 but has not entered into force. The convention recognizes ship recycling as the most environmentally effective way to dispose of ships at end of life. It obliges shipowners to produce and keep on board an Inventory of Hazardous Materials (IHM), requires the creation of a ship-specific recycling plan, states that recycling must take place at an authorized facility.
- **EU Ship Recycling Regulation 2013** brings forward the requirements of the Hong Kong Convention with the aim of reducing the negative impacts of the recycling of EU-flagged vessels. As of 31 December 2018, large commercial EU-flagged vessels can only be recycled at ship recycling facilities that comply with the safety and environmental requirements included in the European List of Ship Recycling Facilities.

In addition to regulations and guidelines, investors in the shipping sector have also shown increasing interest in the ethics of the companies they fund. The establishment on The Responsible Ship Recycling Standards (RSRS) is an example of this effort. These are voluntary principles for financial institutions active in ship financing, to promote responsible ship recycling, and minimize the dangers associated with hazardous materials on board.

With banks recognizing that ship recycling is part of the shipping industry value chain, their internal environmental and social policies commit to implementing the policies, procedures and standards for the financing of shipping assets . According to the NGO Ship Breaking Platform, KLP and Norges Bank have divested from four shipping companies that sold ships to the beaching yards, this includes container-liner Evergreen.

Ship owners have also been active in their role in increasing transparency and responsibility in the ship recycling process. SRTI provides a platform for ship owners to voluntarily provide disclosure around ship recycling practices, thereby increasing transparency and improving decision making for financial stakeholders and cargo owners. The current supporters of this initiative include shipping industry, investors, cargo owners and broader stakeholders.

It is evident that ship recycling is a stakeholder-wide process, and so long as all players in the shipping industry value chain contribute responsibly towards its betterment, the practice has the potential to achieve sustainability.

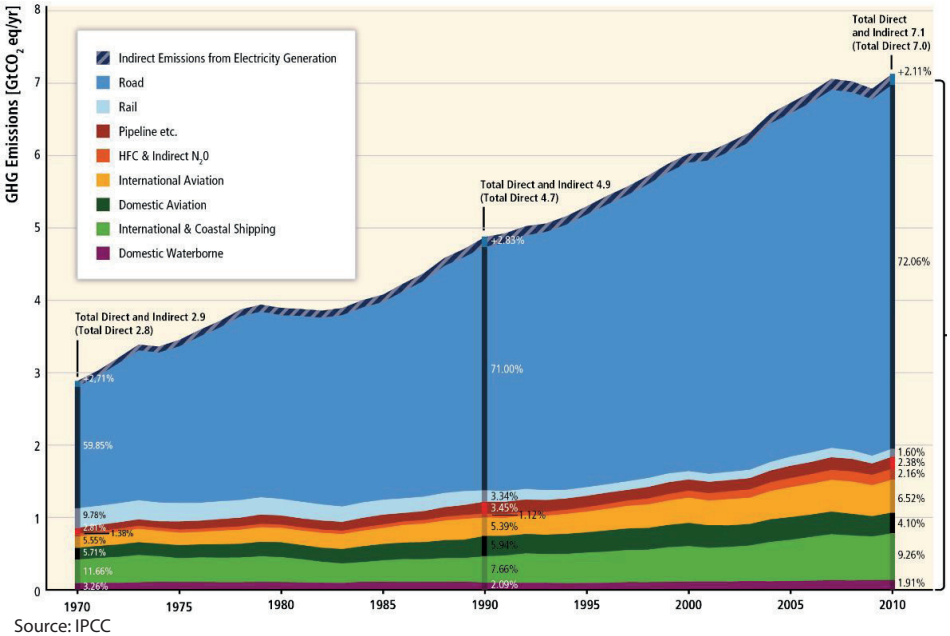
Regulation

- The exclusion of international shipping from the Paris Agreement, and other regional schemes that incentivise emissions reductions, such as the EU ETS, has led to growing pressure on the IMO to introduce stricter measures to reduce emissions from the sector.
- Improving the energy efficiency of new ships and retrofitting existing ships are the principal measures to reduce emissions from shipping. The adoption of more efficient operational practices, switching to low-carbon fuels, and introduction of market-based measures would further reduce the carbon intensity of international maritime transport[33].
- Given the long lifetime of ships, rapid action is required if the sector is to achieve emissions reductions consistent with the Paris Agreement temperature goals. Shipping companies will therefore be affected by further strengthening of regulations in the coming decade.
- In addition to regulatory measures aimed at reducing GHG emissions, the sector will also have to navigate additional legislative measures that seek to strengthen environmental protections and reduce pollution from the shipping industry. The increased regulatory burden will result in added costs for shipping companies, which could filter through the value chain.

IMO's Initial GHG Strategy 2018

Although international shipping provides the most energy efficient mode of transporting freight (when measured per tonne kilometre), international shipping accounts for approximately 2 - 3% of global GHG emissions and emits nearly 800 million tonnes of CO_2 annually [34]. International shipping accounted for around 9% of GHG emissions from the transport sector in 2010 (see figure 72). Demand for maritime transport is set to grow by 60% by 2050, with the fastest rate of increase in the period to 2030, placing further pressure on the sector to reduce its carbon intensity[35].

Figure 72: Shipping's contribution to global emissions



Source: IPCC

However, despite its contribution to global emissions, international shipping was excluded from the 2015 Paris Climate Agreement. This was largely due to difficulties in assigning emissions to a particular country where ships predominantly operate outside national borders.

As a result, responsibility for regulating emissions from international maritime transport falls to the IMO. Recognising the need for consolidated action to reduce emissions from the sector, in April 2018 the IMO introduced its initial roadmap for the reduction of GHG emissions from international shipping. The strategy sets out a vision to:

- Achieve at least a 40% reduction in carbon intensity by 2030, compared to a 2008 baseline, pursuing a 70% reduction by 2050.
- Peak GHG emissions as soon as possible and aim for at least a 50% reduction in total GHG emissions from international shipping by 2050, compared to a 2008 baseline.
- Phase out GHG emissions from international shipping as soon as possible in this century.

33. IEA, 2018: International Maritime Organization agrees to first long-term plan to curb emissions
34. IMO, 2014: Third IMO GHG Study 2014
35. Safety4Sea, 2017: Energy trends in shipping up to 2050

The strategy lists various short-, mid-, and long-term measures that could be introduced in future to meet its targets. The IMO has not yet agreed upon which measures to further develop, however, proposed measures include:

- **Short-term:** technical and operational energy efficiency measures for both new and existing ships, speed optimization and reduction, and research and development activities regarding low- and zero-carbon fuels;
- **Mid-term:** implementation programme to promote uptake of alternative low- and zero-carbon fuels and innovative emissions reduction mechanisms, possibly including market-based measures, to incentivize reduction of GHG emissions;
- **Long-term:** pursue development and provision of zero-carbon or fossil-free fuels, to enable the potential decarbonization of the shipping sector after 2050.

Energy efficiency regulation

Energy efficiency is a principal contributor to decarbonisation of the shipping sector. High-efficiency new ships drive 33% of emission reductions out to 2060 under the IEA's Beyond 2°C Scenario [36]. The IMO's mandatory energy efficiency regulations – the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) – are the principal measures to reduce emissions from international shipping.

SEEMP is an operational measure mandatory for all ships. It provides a mechanism to improve energy efficiency through the monitoring of fleet efficiency over time and encouraging operators to consider technology upgrades and operational practices to optimise energy performance. The Energy Efficiency Operational Indicator (EEOI) can be used as a monitoring tool to measure fuel efficiency and evaluate the effect of changes in operation.

The EEDI is mandatory for new ships only, and its application is intended to encourage more energy efficient ship design via technical innovation and increased use of low- and zero-carbon fuels. The EEDI requires a minimum energy efficiency level per capacity mile (e.g. tonne mile) for different ship types and size segments, with progressive tightening over time. CO_2 reduction levels (gCO_2 per tonne mile) are set until the period 2025 onwards, when a 30% reduction is mandated relative to a reference representing the average efficiency for ships built between 2000 and 2010. The EEDI covers ship types responsible for approximately 85% of CO_2 emissions from international shipping [37]. By April 2018, almost 2,700 new ships were certified as complying with EEDI requirements [38].

Energy savings of up to 10% – the level of compliance in phase 1, which covers the period 2015-2020 – could be achieved via ship hydrodynamic and main engine optimisation, without significant additional shipbuilding costs. Costs associated with achieving the targets set for phases 2 and 3 may be higher, involving new technologies and reduced design speed. However, new ships will bring cost-benefits over the full life-cycle, which could offset additional capital spend: the IMO estimates that uptake of the EEDI and SEEMP could result in average annual fuel cost savings of between USD90 billion and USD310 billion by 2030 for the global fleet [39].

The IMO recognises the need to accelerate emissions reductions to align with the targets set out in its GHG strategy, and in 2018 EEDI requirements were amended for roll-on roll-off cargo and passenger ships [38]. Subsequently, in May 2019 the Marine Environment Protection Committee (MEPC) approved, for adoption in April 2020, stricter phase 3 targets for certain types of ships – including gas carriers, general cargo ships, and LNG carriers – with the entry into effect date brought forward to 2022. The five ship types affected by the 2019 amendment accounted for around 40% of CO_2 emissions from ships subject to EEDI regulations in 2015. The International Council on Clean Transportation (ICCT) estimates that the measure could avert up to 750 million tonnes of cumulative CO_2 emissions between 2022 and 2050 [40].

Mandatory monitoring and reporting

Monitoring and reporting of emissions from shipping are important measures to encourage the reduction of the sector's carbon footprint. From 1 January 2018, the EU's Monitoring, Reporting, and Verification (MRV) regulation has required large ships of 5,000 gross tonnage and above calling at ports in the EEA to monitor, report, and verify CO_2 emissions, fuel consumption, and other relevant information. Data collection takes place per voyage for each ship, and annual emissions reports need to be verified by independent certified bodies and stored in a central database managed by the European Maritime Safety Agency (EMSA) [41].

The IMO's Data Collection System (DCS) has run in parallel to the EU scheme since January 2019, requiring ships of the same size threshold to collect consumption data for each type of fuel oil used. Aggregated data needs to be reported to the flag State after the end of each calendar year and is transferred to an IMO Ship Fuel Oil Consumption Database [37]. Ships included in the scheme account for approximately 85% of CO_2 emissions from international shipping. In February 2019, the European Commission presented a proposal for amending the EU MRV Regulation to take into account the new global IMO DCS, with a view to streamlining and reducing the administrative burden for companies and administrations.

China's Regulation on Data Collection for Energy Consumption of Ships (RDCECS) also entered into force on 1 January 2019. Under the regulation, ships of 400 gross tonnage and above or powered by main propulsion machinery greater than 750 kW propulsion power entering or leaving ports in China should report energy consumption data of their last voyage to China's Maritime Safety Administration (MSA) before leaving a port, or report monthly in lieu of single voyage reports, subject to conditions specified in the regulation.

36. IEA, 2017: Energy Technology Perspectives 2017 Catalysing Energy Technology Transformations
37. IMO, 2019: Energy Efficiency Measures
38. UNCTAD, 2018: Review Of Maritime Transport
39. IMO, 2011: Assessment of IMO Mandated Energy Efficiency Measures for International Shipping
40. International Council on Clean Transport, 2019: Turning the ship, slowly: Progress at IMO on new ship efficiency and black carbon
41. European Commission, 2019: Reducing emissions from the shipping sector

A roadmap to 2050

The IMO's MEPC 74 session took place in May 2019, during which various measures were discussed and agreed which aim to support the achievement of the IMO's Initial GHG strategy goals.

Among the measures, the MEPC agreed the terms of reference for the Fourth IMO GHG Study – which will include an inventory of current global GHG emissions from shipping and future international shipping emissions scenarios out to 2050 – with the final report to be submitted to MEPC 76 in Autumn 2020. A resolution was also adopted to encourage cooperation between ports and international shipping to reduce emissions, encouraging port developments and activities to facilitate GHG emissions reductions. Meanwhile, the MEPC agreed to establish a voluntary, multi-donor trust fund (GHG TC-Trust Fund) to support implementation of the IMO GHG Strategy via provision of financial support for technical cooperation and capacity-building activities.

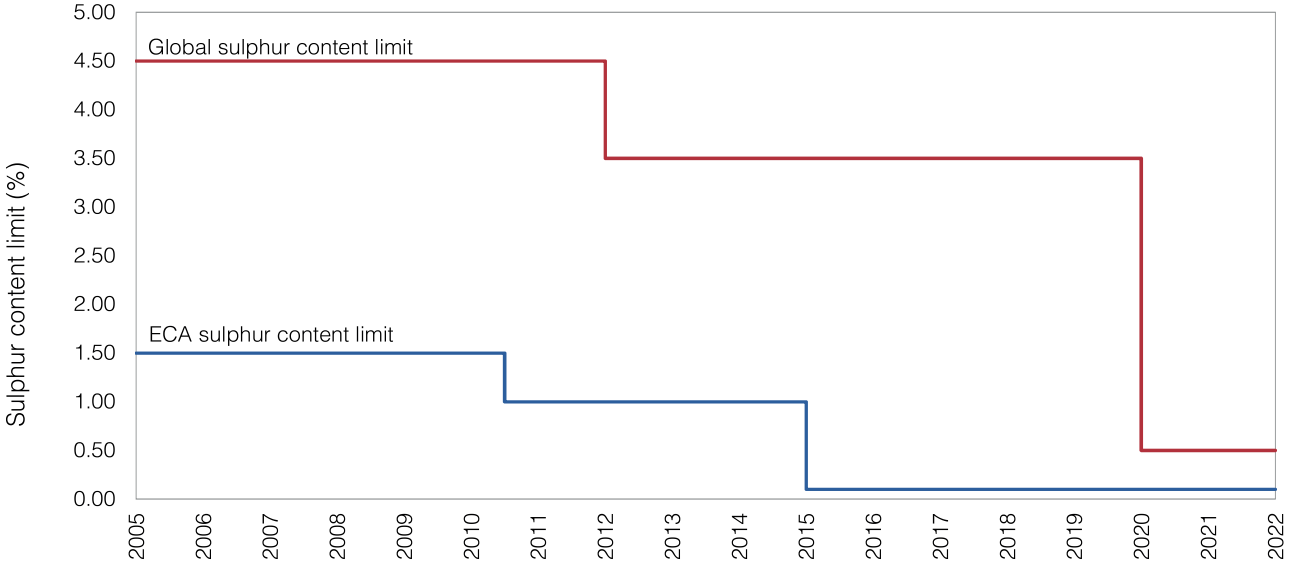
Beyond GHG emissions

Regulatory measures aimed at curbing GHG emissions are being introduced and strengthened at a time when the sector is already having to navigate additional legislative measures to reduce the environmental impacts of marine transport. The increased regulatory burden could result in added costs for shipping companies, which will filter through the value chain.

IMO 2020 Sulphur Cap

Shipping currently contributes around 5-10% of global anthropogenic SO2 emissions. These emissions lead to damaging health impacts, particularly in port cities [42]. The IMO's 2020 Sulphur Cap aims to reduce sulphur oxides (SOx) emissions from ships. From January 2020, the limit for sulphur in fuel oil used on board all ships will be reduced to 0.50% m/m (mass by mass), down from 3.50% currently. In established Emission Control Areas (ECAs), a 0.10% m/m limit will remain in place (see figure 73).

Figure 73: Sulphur content limit



Source: CDP, Seatrade Maritime, OECD

In 2017, the annual average sulphur content of heavy fuel oil used on ships globally was 2.54%. Several measures are available that companies can take to comply with the 2020 cap; however, each involves significant technical or economic obstacles compared to the use of the current composition of HFO. Measures include:

- **Installation of scrubbers:** By retrofitting scrubbers onto existing vessels, companies can continue using HFO. However, SOx scrubbers require a significant investment from companies and come with a long pay-back period. Additionally, scrubbers drive up operational costs and require treatment of wash-water discharge. The long-term availability of HFO would also be an element of uncertainty. Estimated retrofit costs range between $1m to $8m covering the full range of vessel types, with significant uncertainties over uptake given weak markets, competition for CAPEX from installation of ballast water management systems (BWMS), and potential issues of yard capacity to install both scrubber units and BWMS (Clarkson, 2017). As of 2019, just 10% of the global fleet (by tonnage) was equipped with or had ordered scrubber units, of which cruise ships accounted for 61% by tonnage, tankers 14%, container ships 11%, and bulkers 7% [43]. While the use of scrubbers is likely to increase over time, only a small proportion of the global fleet is likely to comply in 2020 using this technology [44].

42. OECD, 2016: Reducing Sulphur Emissions from Ships: The Impact of International Regulation
43. Riviera Maritime Media Ltd, 2019: Scrubber uptake grows six-fold in 2018
44. International Chamber of Shipping, 2018: The Global Sulphur Cap is Coming

- **Low Sulphur Fuel Oil (LSFO):** This option comes with the lowest upfront investment required. However, running costs would be significantly increased and the availability of fuel is uncertain. In fact, there is currently little incentive for refineries to ramp-up investments in low-priced LSFO capacity. Estimates suggest that compliance with the cap could see global shipping fuel costs rise by up to 25%, or USD60 billion, annually from 2020 as demand shifts towards more expensive lower sulphur fuels such as marine gas-oil (MGO) and Ultra Low Sulphur Fuel Oil (ULSFO) [45]. MGOs can be up to 50% more expensive than high-sulphur fuel oils currently in use[46]. From 2020 demand for MGO could increase to 3.4m barrels per day (bpd), compared to around 1.3m bpd currently[47].

- **Alternative fuels – LNG:** LNG has the benefit of very low NOx, SOx and PM and comes with a 20% reduction in CO_2 emissions. It is also relatively cost competitive. However, the retrofit is complex and CAPEX intensive, with bunkering infrastructure at the moment still limited, which raises questions over fuel availability in the future.

The 2020 sulphur cap will have significant effects on shipping costs. The OECD estimates that container shipping costs could rise by between 20% and 85% due to implementation of the sulphur cap, depending on ship size, fuel price, and speed. In the most severe scenario (smallest vessel, highest speed and highest fuel price) the cost per TEU would be approximately USD400 higher [42].

Figure 74: Additional state-level regulatory limits on sulphur

Country	Regulatory measure
China	From January 2019, vessels have been required to switch to a fuel with a sulphur content not exceeding 0.50% prior to entering China's territorial waters. Vessels entering Inland ECAs must use fuel with a sulphur content not exceeding 0.10% from January 2020.
Taiwan	From January 2019, ships not fitted with scrubbers must burn fuel with a sulphur content not exceeding 0.50% when entering international commercial port areas.
Hong Kong	From January 2019, ships not fitted with scrubbers will be required to burn fuel with a sulphur content not exceeding 0.50% within Hong Kong waters, irrespective of whether they are sailing or at berth (previous Fuel at Berth Regulation applied only to ships while at berth).

Source: CDP, Gard AS

Ballast water management convention

The Ballast water management (BWM) Convention entered into force in September 2017, and aims to control the transfer of potentially invasive species. New and existing ships are required to exchange at least 95% of ballast water by volume far away from the coast. New ships must also comply with restrictions on the maximum amount of viable organisms allowed to be discharged, while ships constructed before 8 September 2017 will have to comply no later than 8 September 2024 [48].

The mandatory Code for approval of ballast water management systems (BWMS Code) is scheduled to enter into force in October 2019, and aims to enable administrations to assess whether BWMS meet the standard set out in regulation D-2 of the Convention. The Code also provides a reference for manufacturers and shipowners on the evaluation procedure that equipment will undergo and requirements concerning design, installation, and performance, among other aspects. As of May 2019, the Convention had 81 States Parties representing 81% of the world's tonnage.

45. Wood Mackenzie, 2018: IMO aims to halve global shipping emissions – but what will it cost?
46. IncoDocs Ltd, 2019: IMO2020: How Regulations will Impact the Shipping Industry
47. IFFO, 2018: December 2018 Update
48. IMO, 2016: IMO Frequently Asked Questions Implementing the Ballast Water Management Convention

Appendix I: Company engagement traffic light system

League Table rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Weighting	
Companies	NYK Line	Maersk	MOL	K Line	HMM	Norden	OOIL	U-Ming	Hapag-Lloyd	Wan Hai	Evergreen Marine	COSCO S.H	Yang Ming	Pacific Basin	Teekay	Euronav	NS United KK	COSCO S.ET	Metric	Area
Transition risks rank	3	6	1	5	7	9	11	2	4	12	17	8	10	16	18	15	14	13		35%
Average Age	13	11	10	15	3	4	12	1	9	14	18	8	16	7	17	6	2	5	25%	
Fleet Turnover	2	9	4	3	8	14	11	5	1	17	10	13	6	18	12	15	7	16	15%	
Emissions Intensity	1	10	2	3	15	8	14	5	13	12	16	7	4	17	6	11	18	9	30%	
Capital Flexibility	11	2	8	15	16	5	3	4	14	1	9	10	18	7	17	12	6	13	20%	
Business Resilience	12	8	9	11	7	17	5	15	1	1	4	3	6	10	13	18	14	16	10%	
Transition opportunities rank	1	2	3	4	8	9	5	10	6	12	7	11	13	14	16	17	18	15		30%
Technical Scorecard	1	2	2	4	16	8	4	7	6	11	8	11	15	8	11	17	18	11	60%	
Operational Scorecard	1	3	3	6	2	6	8	13	9	11	3	9	11	16	18	13	15	17	30%	
Business Innovation Scorecard	3	1	2	4	4	4	4	9	9	9	9	9	9	9	9	9	9	4	10%	
Climate governance & strategy rank	2	1	6	3	4	5	9	11	14	8	12	16	15	10	7	13	17	18		35%
Emission Reduction Target	4	1	7	5	1	3	11	8	9	10	6	13	13	13	13	13	12	13	30%	
Board Level Expertise & Management	1	2	3	6	11	12	14	4	15	4	10	17	15	9	8	7	12	18	30%	
Disclosure Scorecard	1	3	4	1	8	5	6	17	10	10	10	10	10	7	9	10	18	16	30%	
Ship Recycling	5	1	17	5	12	1	13	7	3	11	18	8	9	13	3	9	15	15	10%	
Total																				
Green	6	9	6	3	4	3	1	1	3	2	2	1	1	0	1	1	1	1		
Yellow	3	3	4	6	2	4	4	5	2	2	1	3	3	4	2	3	2	1		
Orange	3	0	1	3	5	4	5	3	5	6	6	5	3	4	4	3	2	3		
Red	0	0	1	0	1	1	2	3	2	2	3	3	5	4	5	5	7	7		

This heat map is designed to help investors pinpoint priority areas for engagement

Green = good performance
Yellow = reasonable performance
Orange = monitor performance, possible concern
Red = area of concern, engage with company

We have not assigned a uniform number of green, yellow, orange and red colours across the metrics according to rank. Instead, we have reviewed the results of each metric in detail and assigned the above colours according to the underlying values for each metric

Appendix II: Company summaries

COSCO S.ET

Stock exchange: SSE/HKEX

Average market cap Q4 2018: US$ 2.41 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
600026 CH/1138 HK	18	13	15	18

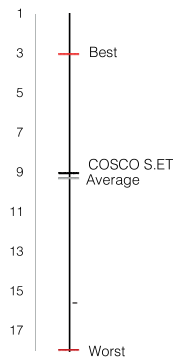
Company strengths

- COSCO S.ET rank fifth in the average age metric, having the second youngest fleet of tanker vessels with an average age of 7.7.
- The company rank fifth out of the eight companies that report tanker emissions intensities, with an intensity of 4.3 gCO_2/ton.km. However, the company's tanker emissions intensity has increased by a CAGR of 13% since 2015.
- While the company lacks the conventional balance sheet to fund the capital required for new low-carbon technologies, the high government ownership should provide better access to funding.

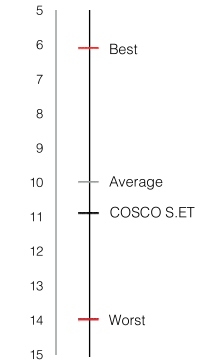
Company Weaknesses

- COSCO S.ET rank last in terms of climate governance and strategy. The company lacks the presence of a climate committee at the board, executive, and sub-executive levels and does not appear to have any publicly disclosed emission reduction targets.
- Despite strong performance in some metrics, COSCO S.ET rank thirteenth in terms of capital flexibility. This is largely driven by the company's low liquidity, relatively high leverage ratio, and low proportion of chartered vessels at just 10%.
- COSCO S.ET rank third from bottom in terms of long term climate risks, reflecting the company's heavy reliance on transporting conventional energy sources. The company's transportation of oil products increases its risk exposure, with crude oil demand expected to fall 40% by 2040 under the IEA's Sustainable Development Scenario (SDS).

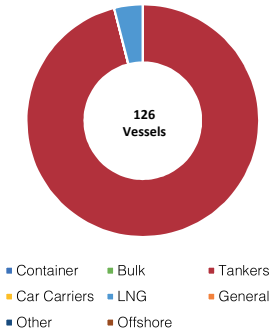
Emissions intensity weighted rank



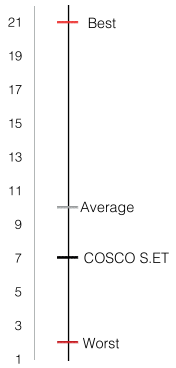
Capital flexibility weighted rank



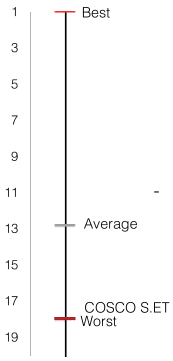
Fleet breakdown



Technical innovation scorecard



Emission reduction target



NS United KK

Stock exchange: TSE

Average market cap Q4 2018: US$ 0.49 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
9110 JP	17	14	18	17

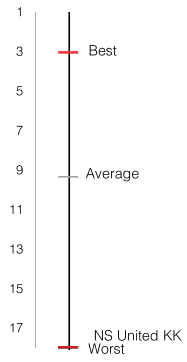
Company strengths

- NS United rank second in the average age metric. The company have the second youngest fleet of bulk vessels at 6 years which make up more than 98% of their fleet.
- NS United also performs well in the fleet turnover metric ranking second amongst the bulk carriers and seventh overall.
- The company performs relatively well across the capital flexibility metrics, ranking sixth in this area. NS United has a reasonably high EBIT margin, low default probability, and a relatively high proportion of chartered vessels, increasing the company's resilience to the financial risks associated with transitioning to lower carbon technologies.

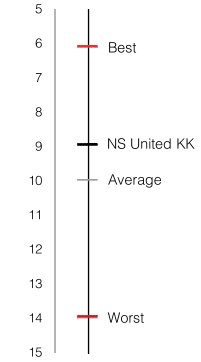
Company Weaknesses

- NS United performs poorly across all three areas of risks, opportunities and governance.
- NS United rank bottom in terms of emissions intensity as one of the only companies not to disclose the emissions intensity of their fleet.
- NS United also ranks bottom in terms of transition opportunities with limited implementation of operational and technical innovations to drive decarbonisation.
- The company suffers from poor disclosure coming bottom in the disclosure scorecard and performs poorly across a number of metrics in climate governance and strategy.

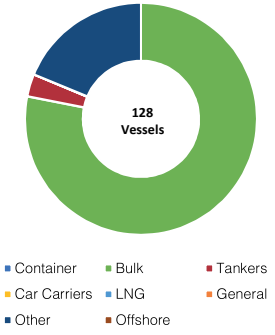
Emissions intensity weighted rank



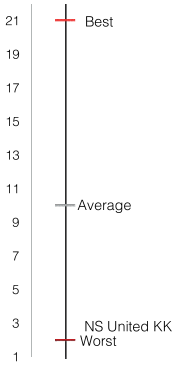
Capital flexibility weighted rank



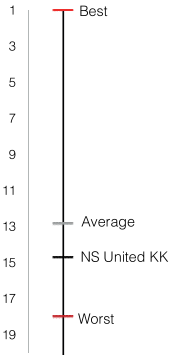
Fleet breakdown



Technical innovation scorecard



Emission reduction taregt



Euronav

Stock exchange: BXS

Average market cap Q4 2018: US$1.57 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
EURN BB	16	15	17	13

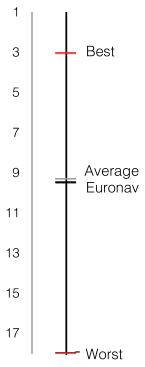
Company strengths

- Although ranking eleventh overall for emissions intensity, Euronav has the lowest tanker emissions intensity in the group at 2.8 gCO_2/t.km but do not perform as well because of the lack of historic data to assess trends.
- The company is in sixth position in the average age metric, with a relatively low average age of the company's vessels at 7.9 years.
- Euronav rank seventh in the board level climate management metric with their Health, Safety, Security and Environmental (HSSE) Committee existing at the board level, though this committee does not appear to have a strong climate focus.

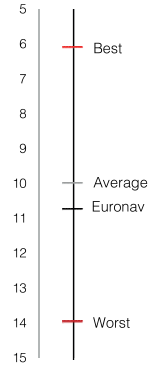
Company Weaknesses

- Euronav is ranked joint last for emission reduction targets with the company not appearing to have any publicly disclosed targets.
- Euronav rank second last in terms of transition opportunities driven by limited evidence of technical or operational innovation.
- The company's low proportion of chartered vessels at 6% combined with relatively low margins limits its capital flexibility to transition to lower carbon vessels.
- Euronav rank last in terms of long term climate risk exposure. This is largely due to the company deriving a significant proportion of its revenue from transporting crude oil, for which demand is expected to fall 40% by 2040 under the IEA's Sustainable Development Scenario (SDS).

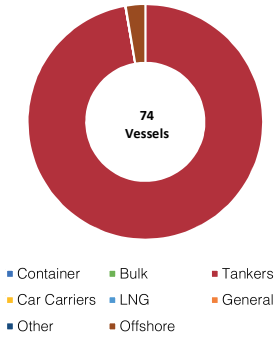
Emissions intensity weighted rank



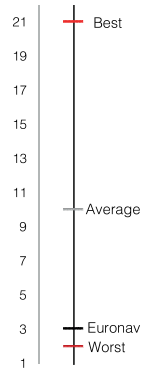
Capital flexibility weighted rank



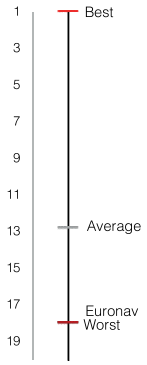
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Teekay

Stock exchange: NYSE

Average market cap Q4 2018: US$0.34 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
TK US	15	18	16	7

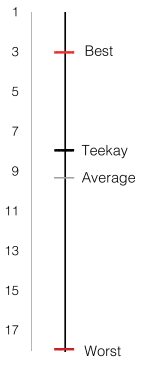
Company strengths

- Teekay's ranking in sixth position in terms of emissions intensity reflects the relatively low emissions intensity of its tanker fleet and the company's progress in reducing its emissions intensity, with a CAGR of -5.7% between 2015-2017.
- Teekay rank seventh in terms of climate governance and strategy, driven by the presence of a climate committee at the executive level and the presence of several individuals on the board judged to have climate experience.
- The company's joint second ranking in the ship recycling metric also contributes to its position in this area. Teekay clearly disclose their recycling policy, are committed to recycling vessels at HKC compliant facilities, and are also part of the Ship Recycling Transparency Initiative (SRTI).

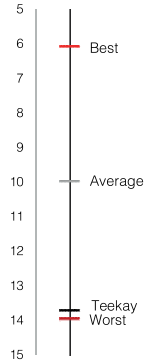
Company Weaknesses

- Teekay perform poorly across the capital flexibility metrics, ranking second from bottom in this area. The company is highly leveraged and have a very low proportion of chartered vessels at just 2%.
- The company does not appear to have any publicly disclosed emission reduction targets and is ranked in joint last position for the target metric.
- Teekay does not publicly disclose any operational measures designed to drive fuel savings or decarbonization, leading to the company ranking last in terms of operational innovation.
- The company rank second from bottom in the average age metric, reflecting both the high average age of Teekay's fleet and limited retrofitting activities; the company ranks joint last for this metric.

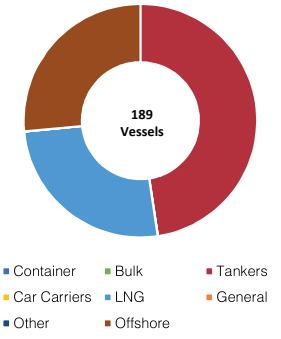
Emissions intensity weighted rank



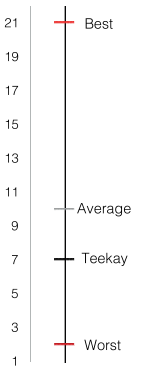
Capital flexibility weighted rank



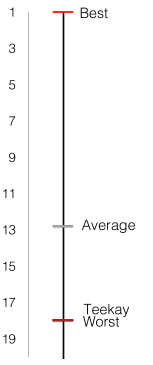
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Pacific Basin

Stock exchange: HKEX

Average market cap Q4 2018: US$ 0.86 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
2343 HK	14	16	14	10

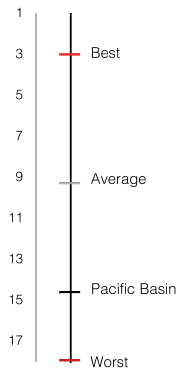
Company strengths

- Ranks seventh in the average age metric, reflecting the relatively low average age of the company's fleet and its engagement in retrofitting.
- Ranks seventh in the capital flexibility metric is driven by a low leverage ratio relative to the peer group at 50.3% and an EBIT margin above the average for the 18 companies. Pacific Basin also have a relatively high proportion of chartered vessels at 49%.
- Pacific Basin has a climate committee at the executive level and an individual on the board judged to have climate experience, which drives the company's ranking of ninth in the board-level climate management metric. However, poor performance in the emission reduction target metric results in the company ranking in tenth position overall in climate governance and strategy.

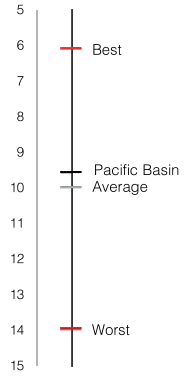
Company Weaknesses

- Pacific Basin rank last in the fleet turnover metric, as one of only two companies where the net average of their fleet turnover is positive at 3.6 years. This is driven by the company's strategy to purchase a number of second-hand vessels over the 2014-17 period.
- Pacific Basin rank second from bottom in terms of emissions intensity. This is driven by the company having the highest emissions intensity in the bulk division, at 6.9 gCO_2/t.km, and the significant increase in Pacific Basin's emissions intensity by a CAGR of 8.5% between 2014-17.
- Ranks joint bottom for emission reduction targets with no targets publicly disclosed.

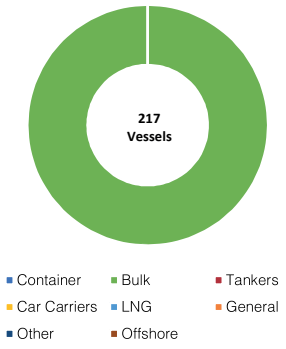
Emissions intensity weighted rank



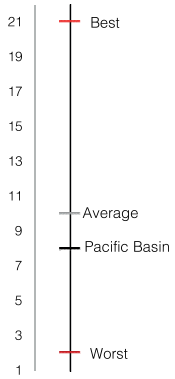
Capital flexibility weighted rank



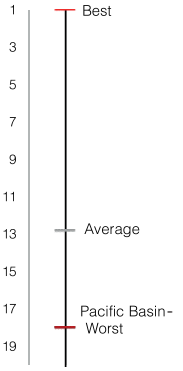
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Yang Ming

Stock exchange: TWSE

Average market cap Q4 2018: US$ 0.67 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
2609 TT	13	10	13	15

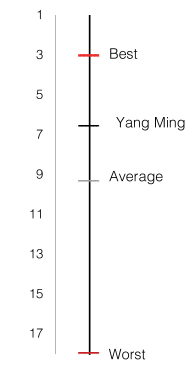
Company strengths

- Yang Ming rank fourth in terms of emissions intensity. The company are in first position overall on the container EEOI measure, with an emissions intensity of 5.1 gCO_2/t.km and a CAGR of -5.2% between 2015-2017.
- The company rank sixth in the fleet turnover metric with a net weighted average age of -8.0. This is driven by newbuild vessels accounting for 46% of all flows.
- Yang Ming's ranking in second position in the long term climate risk metric as it generates a significant proportion of its revenue from the container shipping business. Container vessels are used to transport a wide variety of products and are therefore less exposed to long-term climate related risks

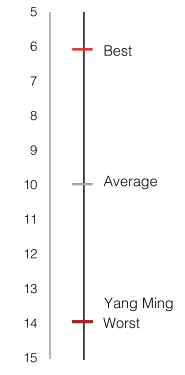
Company Weaknesses

- Yang Ming is ranked in fifteenth position in terms of climate governance and strategy. Although the company has a climate committee at the sub-executive level, it does not appear to have a publicly disclosed emission reduction target and is not conducting scenario analysis.
- Ranks third from bottom in the average age metric. In 2017, the average age of Yang Ming's fleet was among the highest in the container division and the company has engaged in limited retrofitting activities.
- Yang Ming ranks fifteenth in technical innovation investing mainly in incremental efficiency technologies.
- Yang Ming rank last in terms of capital flexibility, with a high leverage at 349% (Q4 2018), a high default probability and a EBIT margins averaging -2.32%, the third lowest of the universe.

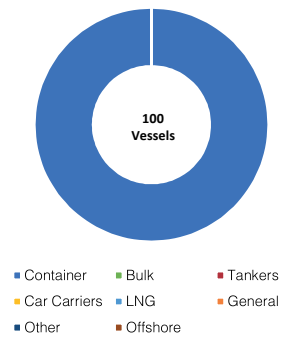
Emissions intensity weighted rank



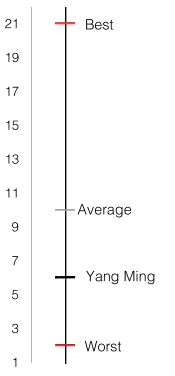
Capital flexibility weighted rank



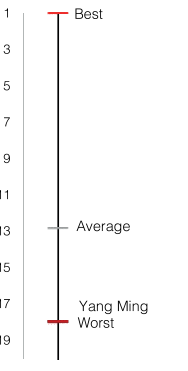
Fleet breakdown



Technical innovation scorecard



Emission reduction target



COSCO S.H

Stock exchange: SSE/HKEX

Average market cap Q4 2018: US$5.42 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
601919 CH/1919 HK	12	8	11	16

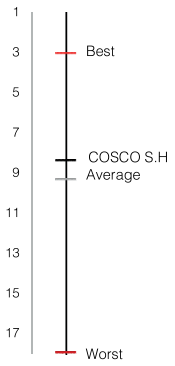
Company strengths

- COSCO S.H come eighth in transition risk with a relatively young fleet of container vessels.
- COSCO also benefit in terms of capital flexibility chartering more than 79% of their fleet (prior to the OOIL acquisition) and with a large percentage of their revenue from container transport they are expected to be resilient to long term decarbonisation trends.
- They are among the six container liners that report their emissions using the EEOI methodology and rank fifth overall for emission intensities from the container division (though this is a very recent change in their reporting with limited back-dating of historical emissions).

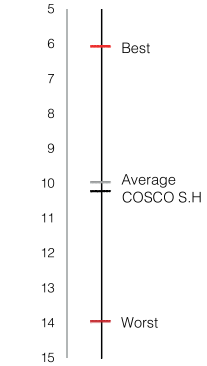
Company Weaknesses

- COSCO S.H rank sixteenth for Climate Governance & Strategy. They have shown no evidence of a long-term commitment to reducing emissions through target setting.
- COSCO S.H lack the presence of a climate committee at the board or executive levels. With their Sustainable Development Committee existing at the sub-executive level.
- The acquisition of OOIL in 2018 was secured through external financing affecting COSCO's leverage ratio which sat at 180% as of Q4 FY2018; the second highest in the universe.

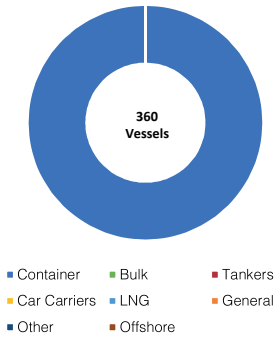
Emissions intensity weighted rank



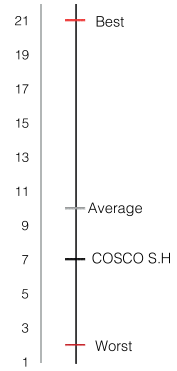
Capital flexibility weighted rank



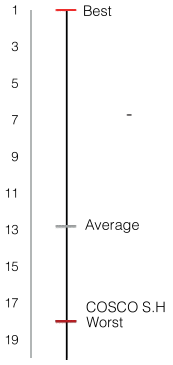
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Evergreen Marine

Stock exchange: TWSE

Average market cap Q4 2018: US$1.76 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
2603 TT	11	17	7	12

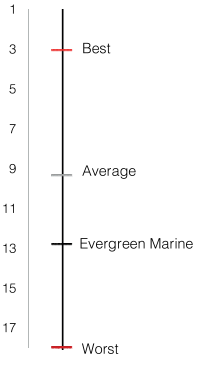
Company strengths

- Rank sixth for emission reduction targets having committed to the IMO's mid-term intensity target which aims for a 40% reduction by 2030.
- Rank tenth for fleet turnover and have purchased a number of Newbuild vessels over the 2012-2018 period. However, the company retains some of the oldest container vessels and show little evidence of retrofitting their fleet
- They have also adopted a wide range of voyage optimisation measures whilst also collaborating with OEMs to improve the technical efficiency of new vessels and rank seventh overall for Transition Opportunities.

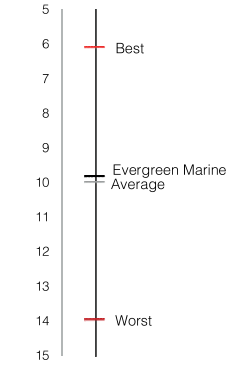
Company Weaknesses

- Evergreen Marine rank sixteenth overall for emission intensities. The methodology Evergreen Marine uses to report their emissions lacks clarity with no indication of whether reported figures are based on a real or nominal capacity basis.
- Evergreen Marine is highly leveraged with a debt-to equity ratio of 117% and rank tenth overall for capital flexibility.
- Despite articulating a detailed ship recycling policy Evergreen Marine have been identified for unethical recycling practices and rank last overall.

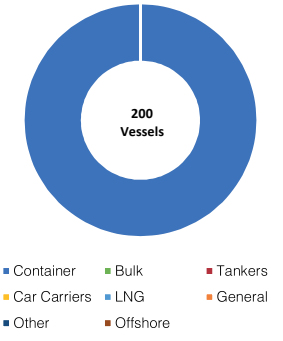
Emissions intensity weighted rank



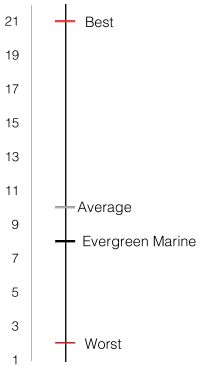
Capital flexibility weighted rank



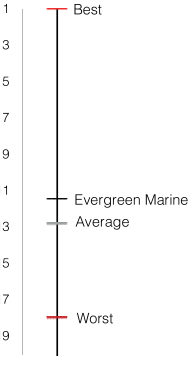
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Wan Hai

Stock exchange: TWSE

Average market cap Q4 2018: US$1.16 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
2615 TT	10	12	12	8

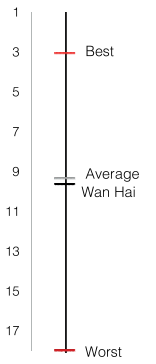
Company strengths

- Wan Hai have one of the oldest fleets of container vessels but have made steps to retrofit in recent years, ranking third overall for retrofitting activity.
- Wan Hai operate significantly smaller container vessels compared to their peers and therefore have a higher emissions intensity; however, they have made the most progress to reduce emissions over the 2012-17 period with an average annual reduction of 9% per year.
- Rank first for capital flexibility with the lowest default probability, and a very low debt-to-equity ratio at 31%.
- Rank eighth for Climate Governance & Strategy and are among only a few companies to have a board level CSR committee.

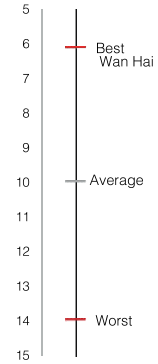
Company Weaknesses

- Ranks tenth for emission reduction targets. Wan Hai have committed to reducing their absolute emissions 2% every year but could provide greater clarity by making a longer-term commitment to reduce their emissions.
- Ranks seventeenth for fleet turnover with Wan Hai purchasing a number of mature second-hand vessels over the 2012-17 period.

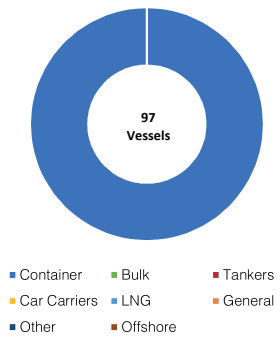
Emissions intensity weighted rank



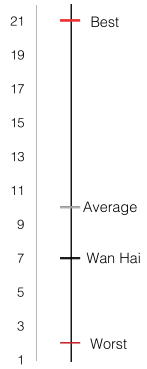
Capital flexibility weighted rank



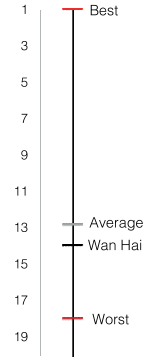
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Hapag-Lloyd

Stock exchange: FWB

Average market cap Q4 2018: US$4.5 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
HLAG GR	9	4	6	14

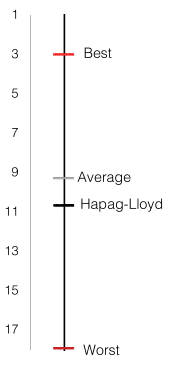
Company strengths

- Hapag-Lloyd rank first overall for their dry cargo emission intensities and have made more progress than their peers to reduce their emissions, averaging a CAGR of -7.2%.
- Hapag-Lloyd rank sixth overall for Transition Opportunities. They have started to integrate LNG-ready container vessels into their fleet and are also working with their partners Kuehne + Nagel to improve emissions performance through the adoption of operational and technical measures.
- The company performs well in ship recycling governance being members of the Sustainable Recycling Transparency Initiative.

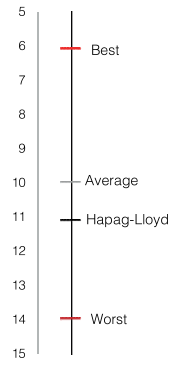
Company Weaknesses

- While Hapag-Lloyd rank first overall for their dry cargo intensities, they fail to disclose their reefer cargo intensities and are among the few container liners not to disclose intensities using the IMO's EEOI measure.
- They perform poorly across the capital flexibility metrics with a higher default probability compared to their peers and rank fourteenth overall.
- Hapag Lloyd have set an aggressive short-term target to reduce their emission intensities 20% by 2020 (2016 base year) but could make a longer-term commitment consistent with the IMO's GHG Strategy.
- Rank sixteenth for Board Level Management & Expertise with a climate committee at the sub-executive level with the committee chaired by the Head of Corporate Development who reports to the executive.

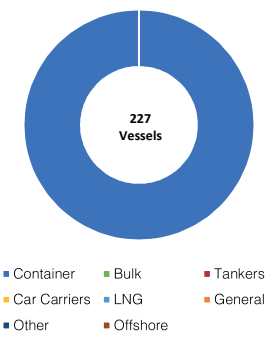
Emissions intensity weighted rank



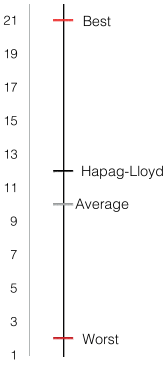
Capital flexibility weighted rank



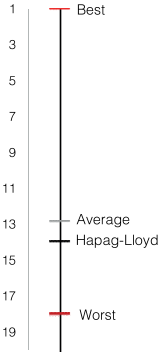
Fleet breakdown



Technical innovation scorecard



Emission reduction target



U-Ming

Stock exchange: TWSE

Average market cap Q4 2018: US$0.89 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
2606 TT	8	2	10	11

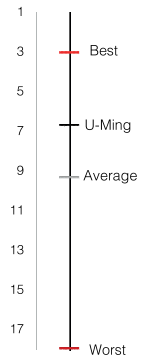
Company strengths

- Rank second in Transition Risk having one of the youngest fleets of bulk vessels, have made steps to replace older tonnage with newer vessels and have made good progress reducing emissions from their fleet
- Ranks seventh for technical innovation and has partnered with a number of companies to demonstrate the feasibility of LNG bulk vessels. U-Ming also have made 2 orders for LNG-ready Very Large Ore Carriers.
- U-Ming are one of only three companies to have a climate committee at the board level.
- U-Ming have a high level of capital flexibility and rank fourth overall. They have the third highest EBIT margins in the universe at 8.5% and the highest margins among the bulk transporters.

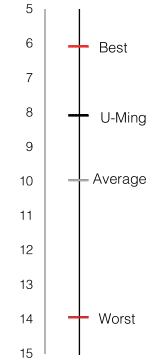
Company Weaknesses

- While U-Ming have identified a wide range of technical measures that they have adopted, evidence of the operational measures taken to improve efficiency are low with U-Ming ranked fourteenth in the operational scorecard.
- U-Ming rank seventeenth on the disclosure scorecard only reporting emissions from their self-owned vessels.
- More than 80% of U-Ming's shipped products are from coal and Iron ore transport, making them particularly exposed to long-term decarbonisation trends.

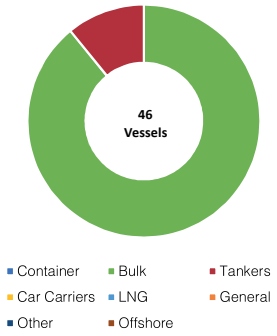
Emissions intensity weighted rank



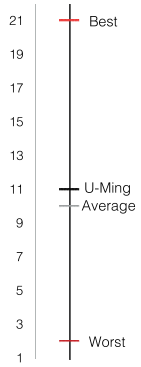
Capital flexibility weighted rank



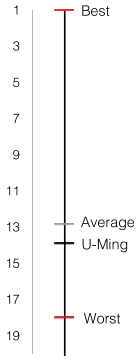
Fleet breakdown



Technical innovation scorecard



Emission reduction target



OOIL

Stock exchange: HKEX

Average market cap Q4 2018: US$6.04 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
316 HK	7	11	5	9

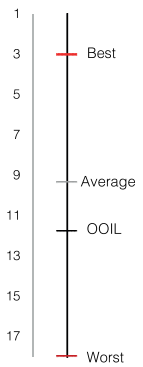
Company strengths

- OOIL rank fifth for transition opportunities having made a commitment for all new vessels to be LNG-ready. They are also actively adopting operational measures such as slow steaming and advanced weather routing to reduce emissions from their fleet.
- OOIL rank third for capital flexibility with a low leverage ratio at 49%; however, only 33% of their vessels are chartered.
- Though not official supporters of the TCFD OOIL have started to conduct scenario analyses to assess the impact of climate change on their operations and rank ninth overall for Climate Governance & Strategy.

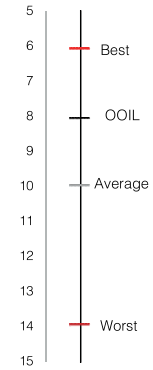
Company Weaknesses

- While OOIL's container emissions have reduced by a CAGR of -5.3% over the 2012-17 they have not provided clarity on the methodology used to calculate their reported emissions and rank ninth out of 11 container companies.
- Climate related risk is only managed at the sub-executive level of the company with OOIL's Safety, Security and Environment (SSE) steering committee chaired by a non-executive officer who reports to the executive on environmental matters.
- OOIL's recycling policy lacks detail with no explicit commitment to scrap vessels at facilities compliant with the Hong Kong Convention.

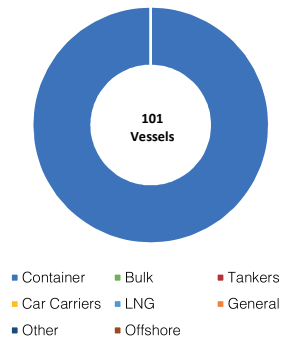
Emissions intensity weighted rank



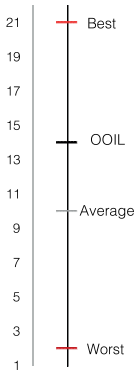
Capital flexibility weighted rank



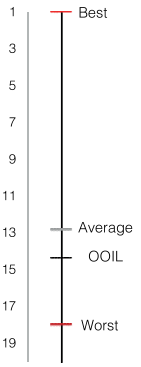
Fleet breakdown



Technical innovation scorecard



Emission reduction target



Norden

Stock exchange: CSE

Average market cap Q4 2018: US$0.6 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
DNORD DC	6	9	9	5

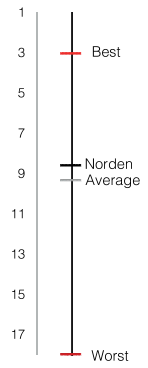
Company strengths

- Norden rank fifth for Climate Governance & Strategy having the third most ambitious emission reduction target aligned with the IMO GHG target with oversight from an executive level climate committee.
- They are one of only two companies actively pioneering the use of second-generation biofuels and rank eighth overall for transition opportunities
- Norden Have a high level of capital flexibility with the lowest leverage ratio at 17.3% at FY2018 Q4. Norden also charter more than 60% of their fleet which gives them greater agility in their response to changing market conditions.

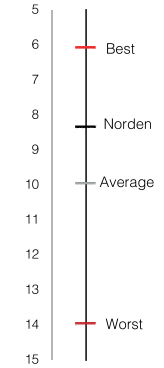
Company Weaknesses

- Norden's emission intensities are high relative to their peers and they have also seen intensities increase across their Bulk and Tanker fleets over the 2013-17 period.
- While Norden does have a CSR executive committee chaired by the CEO, there is limited evidence of climate related expertise at the board level.
- Norden transports commodities such as coal and refined oil products making them particularly exposed to long term decarbonisation trends impacting demand for these commodities.

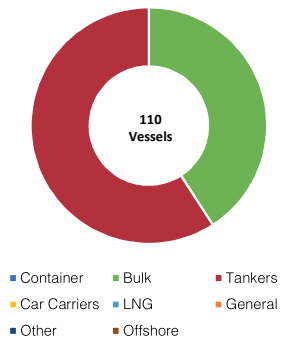
Emissions intensity weighted rank



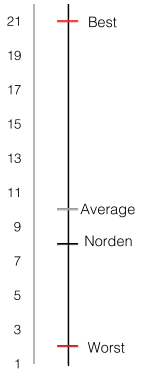
Capital flexibility weighted rank



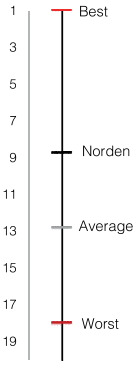
Fleet breakdown



Technical innovation scorecard



Emission reduction target



HMM

Stock exchange: KRX

Average market cap Q4 2018: US$1.03 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
011200 KS	5	7	8	4

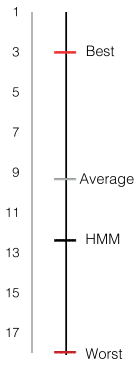
Company strengths

- Ranks third for the average age metric. HMM has the youngest fleet of container vessels with an average age of 7.4 years and have made steps to retrofit their fleet.
- Ranked fourth for Climate Governance & Strategy, largely driven by its target to achieve net-zero emissions by 2050. The company is exploring hydrogen fuel cell technology as part of its strategy to achieve this.
- HMM ranks second for operational innovation having introduced a number of voyage optimisation measures to drive decarbonisation, including real time monitoring of vessel performance to manage fuel consumption.

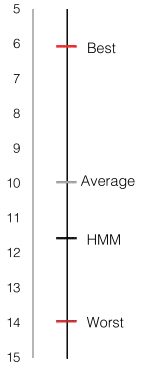
Company Weaknesses

- HMM rank fifteenth for emissions intensity and are among the only companies to report their bulk and tanker emissions on a nominal capacity basis.
- HMM only disclose emission intensities for their owned vessels which represent a very small percentage of the vessels HMM operates.
- Rank third from bottom for capital flexibility with the second highest default probability and a high leverage ratio. HMM have also struggled to operate profitably in recent years, averaging margins of -9.4% over FY17-18.

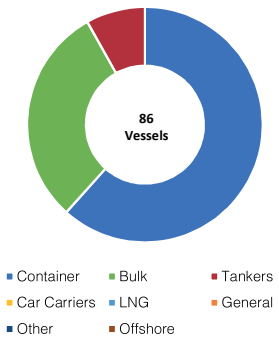
Emissions intensity weighted rank



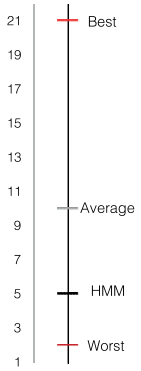
Capital flexibility weighted rank



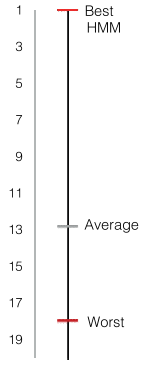
Fleet breakdown



Technical innovation scorecard



Emission reduction target



K Line

Stock exchange: TSE

Average market cap Q4 2018: US$2.21 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
9107 JP	4	5	4	3

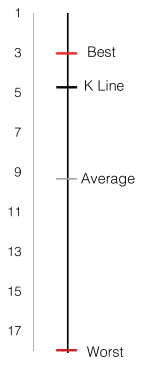
Company strengths

- Rank fourth for transition opportunities having led or participated initiatives such as their flagship project "Drive Green Highway" designed to find ways of improving the technical efficiency of their fleet.
- Ranked third position for emissions intensity. The company performs second, third, and fourth best in the bulk, tanker, and container divisions respectively.
- Ranked third in Climate Governance & Strategy with a science-based target aiming for a 50% reduction in emissions intensity by 2050 whilst also "A" grade in CDP's 2018 Climate Change questionnaire.

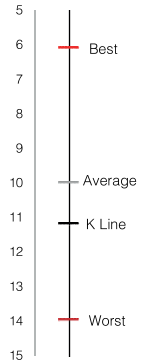
Company Weaknesses

- Ranks fifteenth for average age with the Bulk and Tanker vessels K Line's owns being relatively old compared to their peers. K Line also show limited evidence of retrofitting activities.
- Rank fifteenth for capital flexibility being highly leveraged with low EBIT margins and higher default probability relative to their peers.
- K Line aggregates the emissions intensities from their bulk and tanker divisions making it difficult to conduct an assessment of the emissions performance from each division.

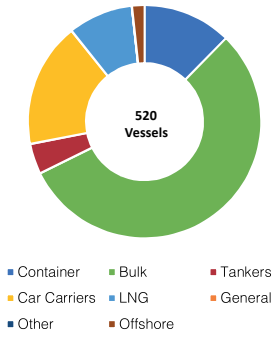
Emissions intensity weighted rank



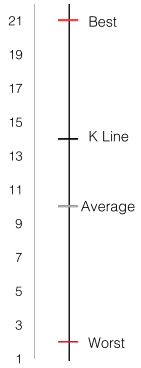
Capital flexibility weighted rank



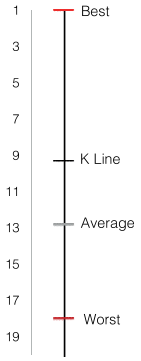
Fleet breakdown



Technical innovation scorecard



Emission reduction target



MOL

Stock exchange: TSE

Average market cap Q4 2018: US$3.48 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
9104 JP	3	1	3	6

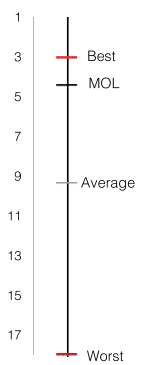
Company strengths

- Ranks first for transition risk and come second in the emissions intensity metric having made progress reducing the emissions profile, topping the container and tanker divisions and ranking third in the bulk division.
- Introduced a number of new vessels into their fleet over the 2012-18 period and have scrapped and sold some of their older tonnage ranking fourth overall for fleet turnover.
- Ranks third for transition opportunities, performing strongly across the technical and operational innovation scorecards. This is driven by activities such as MOL's participation the "Wind Challenger Project" as well as a number of voyage optimisation measures and initiatives.
- Ranks sixth for Climate Governance & Strategy with an executive level climate committee and have a target to reduce emission intensities 50% by 2050.

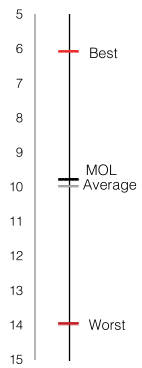
Company Weaknesses

- MOL rank eighth for capital flexibility and are highly leveraged relative to their peers.
- Rank second to last for ship recycling governance having been penalised for their association with unethical ship recycling practices, as highlighted in a report published by NGO Shipbreaking Platform in 2017.
- Compared to their immediate peers NYK and K Line, MOL haven't yet started to conduct scenario analysis but in 2018 stated their intention to do so in the next 2 years.

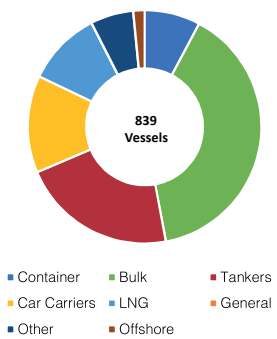
Emissions intensity weighted rank



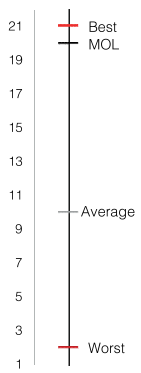
Capital flexibility weighted rank



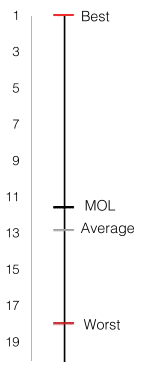
Fleet breakdown



Technical innovation scorecard



Emission reduction target



A.P. Moller-Maersk

Stock exchange: CSE

Average market cap Q4 2018: US$25.3 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
MAERSKA DC/MAERSKB DC	2	6	2	1

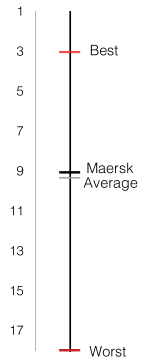
Company strengths

- Rank first for climate governance & strategy. Have set an ambitious emission reduction target aiming for net-zero emissions by 2050, have several board members with climate expertise and are official supporters of the TCFD.
- Second for transition opportunities. This is driven by their adoption of several technical and operational measures including the championing of second-generation biofuels as a carbon neutral alternative to Heavy Fuel Oil (HFO).
- First overall for retrofitting having invested $1 billion over the last four years retrofitting 150 vessels with measures that can deliver emission reductions up to 20% per transported TEU.
- Second for capital flexibility with a low debt to equity ratio and default probability.

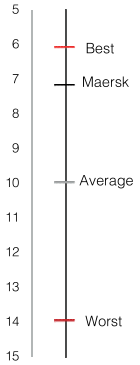
Company Weaknesses

- Rank sixth out of eleven container companies that have disclosed their container emissions and tenth overall. This is largely due to the company reporting their intensities on a nominal capacity basis rather than a methodology consistent with the IMOI EEOI.
- Maersk rank ninth on the fleet turnover metric with a net average age lower than their peers indicating that the inflows and outflows of their owned vessels haven't positively impacted the age profile of their fleet to the same extent as their peers

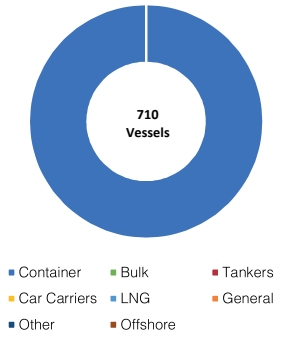
Emissions intensity weighted rank



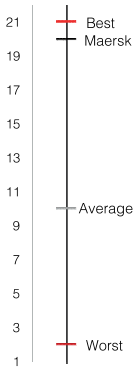
Capital flexibility weighted rank



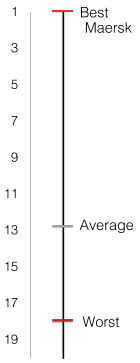
Fleet breakdown



Technical innovation scorecard



Emission reduction target



NYK Line

Stock exchange: TSE

Average market cap Q4 2018: US$3.44 bn

Ticker	League Table rank	Transition risks rank	Transition opportunities rank	Climate governance & strategy rank
9101 JP	1	3	1	2

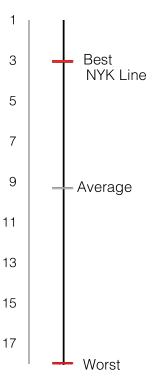
Company strengths

- First overall for emissions performance, having made particular progress reducing emission intensities from their container vessels with a CAGR of -6.0% per year since 2012.
- Second for Climate Governance & Strategy with an executive level climate committee and several board members with climate expertise.
- Set a science-based target to reduce their emissions intensity 50% by 2050 and have good all-round disclosure being official supporters of the TCFD and achieving an "A" grade in CDP's 2018 Climate Change Questionnaire.
- First for transition opportunities, coming top in the technical and operational innovation scorecards having adopted a number of measures which include the development of a zero-emission car carrier for 2050.

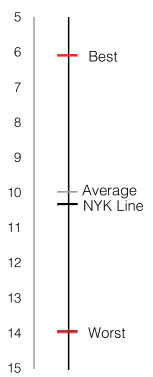
Company Weaknesses

- NYK ranks thirteenth for average age with NYK's owned vessels older than their peer group whilst also showing limited retrofitting activity.
- While NYK has made progress reducing emissions from their container and bulk vessels, NYK's tanker emissions have increased by a CAGR of 1.5% since 2012 but this has happened from a relatively low baseline.
- Eleventh for capital flexibility with one of the higher debt-to-equity ratios relative to their peers.

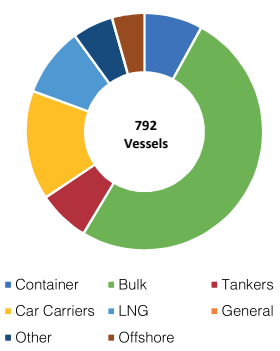
Emissions intensity weighted rank



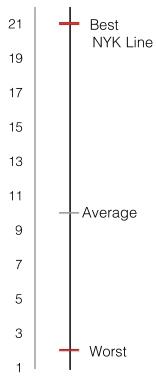
Capital flexibility weighted rank



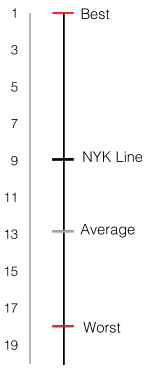
Fleet breakdown



Technical innovation scorecard



Emission reduction target



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