CLARKSONS RESEARCH

DRYBULKTERMINALS GROUP

Dry Bulk Shipping Ports and Terminals and their Green Transition

Dry Bulk Terminals Group
Operational & Technical Conference
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Ref: A4638b

Shipping's Green Transition

Vital transitions for shipping industry will impact the bulkcarrier fleet and dry bulk ports and terminals

As pressures build globally to find solutions to moderate climate change, the Green Transition will cause fundamental change to shipping, trade, offshore, energy and renewables. We are committed to providing data and intelligence to help frame the critical decisions that stakeholders across our industry will need to make to facilitate the Green Transition.

Energy Transition

Some ~40% of shipping capacity is involved in energy transportation. Our data, modelling and insights provide a framework for understanding how Energy Transition may impact the maritime "universe".

Our *Energy Transition Model* presents this framework to our clients, discussing the timing of "peak" fossil fuel usage and how trade flows may be impacted.

Offshore Transition

Today, offshore oil and gas fields produce 16% of the world's energy supply. While we continue to track this important segment, our coverage also extends to providing data and intelligence around the rapidly growing Offshore Renewables segment.

With offshore wind capacity having grown at a rate of ~26% per annum over the past decade, providing for example electricity for millions more homes across Europe, the Offshore Transition is gathering pace.

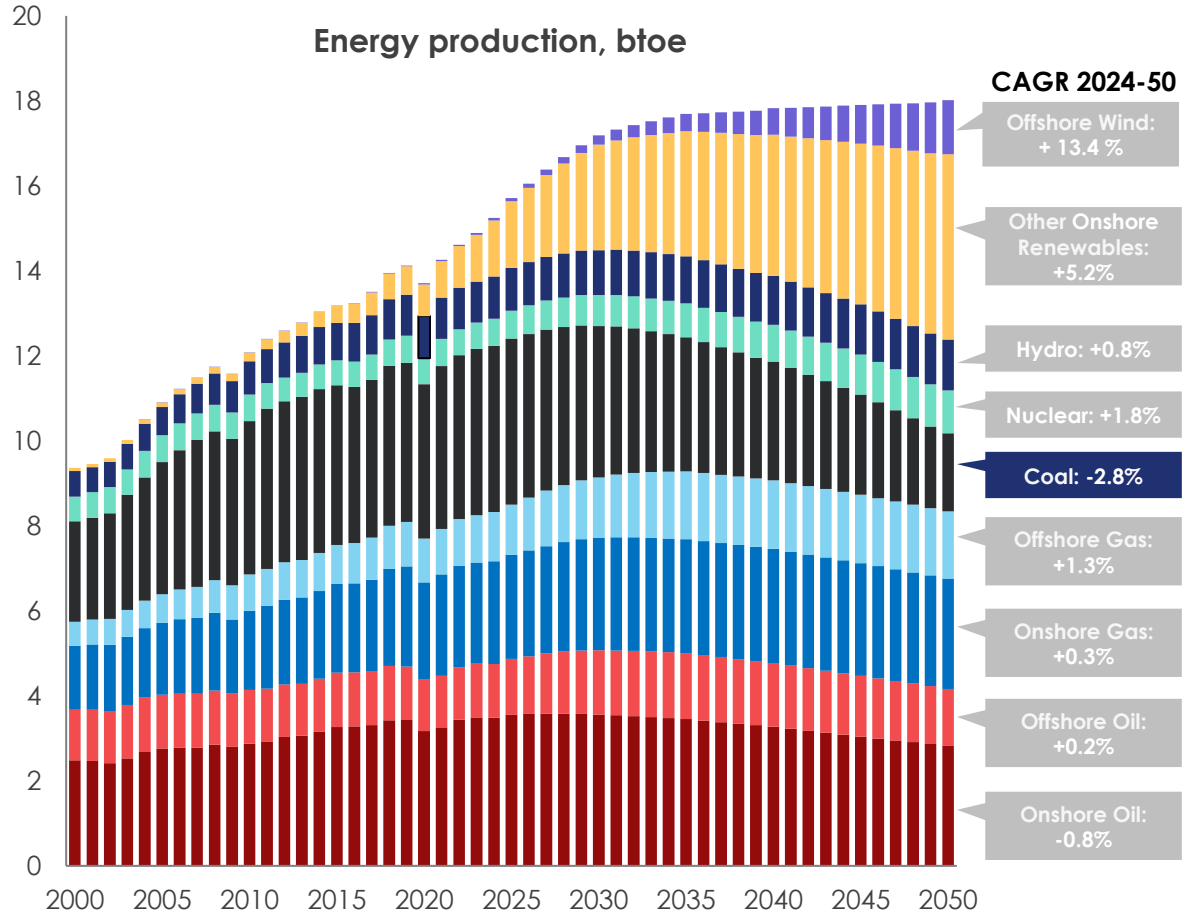
Fuelling Transition

Emissions from the shipping industry are projected to total ~1,050m tonnes on a CO_{2eq} basis in 2024 (~2% of global GHG emissions). Though progress has been made in reducing emissions and shipping remains the most carbon efficient mode of transport, further decarbonisation strategies are needed, with a Fuelling Transition central. Through our *World Fleet Register*, we help understanding of new and complex environmental regulation, we track the uptake of alternative fuels and energy saving technologies (ESTs) across the world fleet, we assess the impact of technology and regulation on vessel earnings, value and market supply / demand and we project transition scenarios that would meet emission reduction targets.

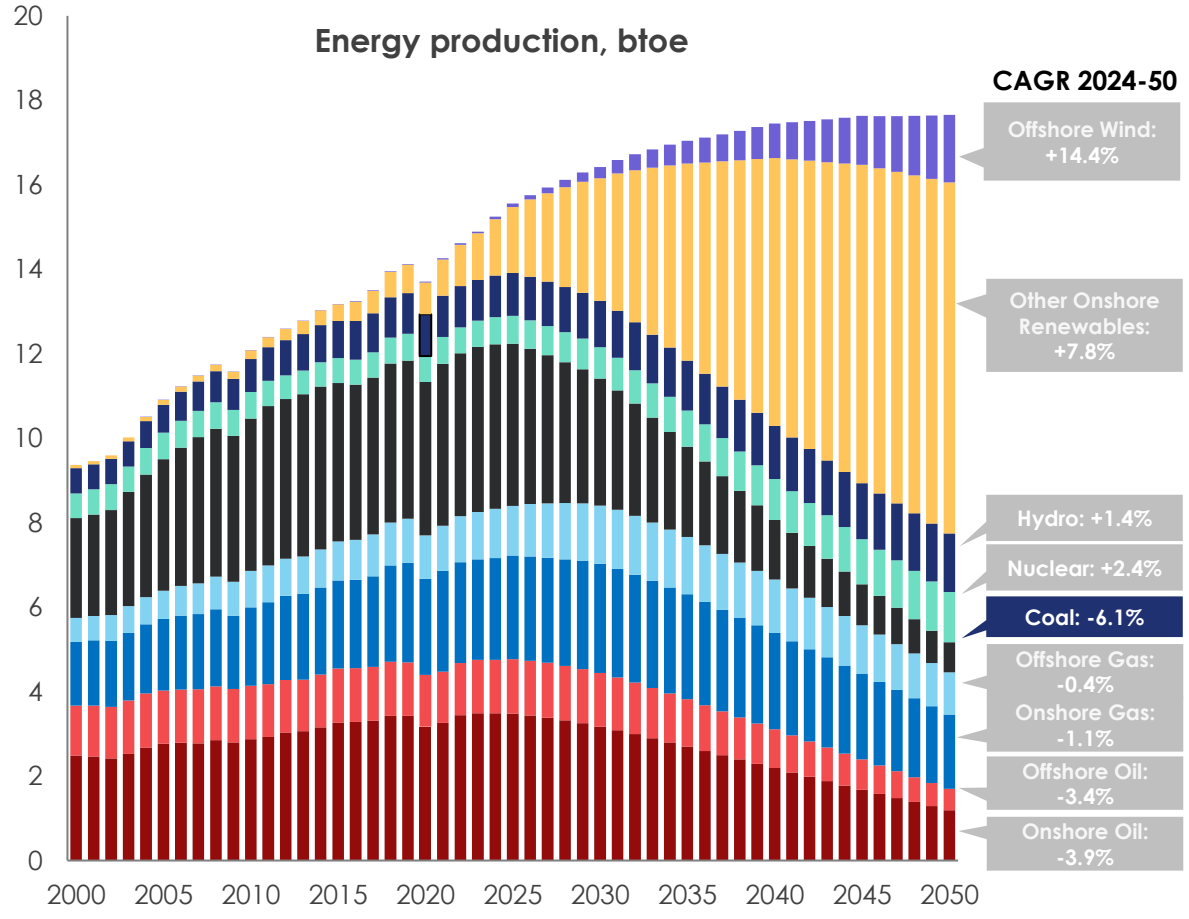
Clarksons Research Energy Transition Model

Scenarios vary but transition will impact shipping's cargo base

Gradual Transition



Rapid Decarbonisation

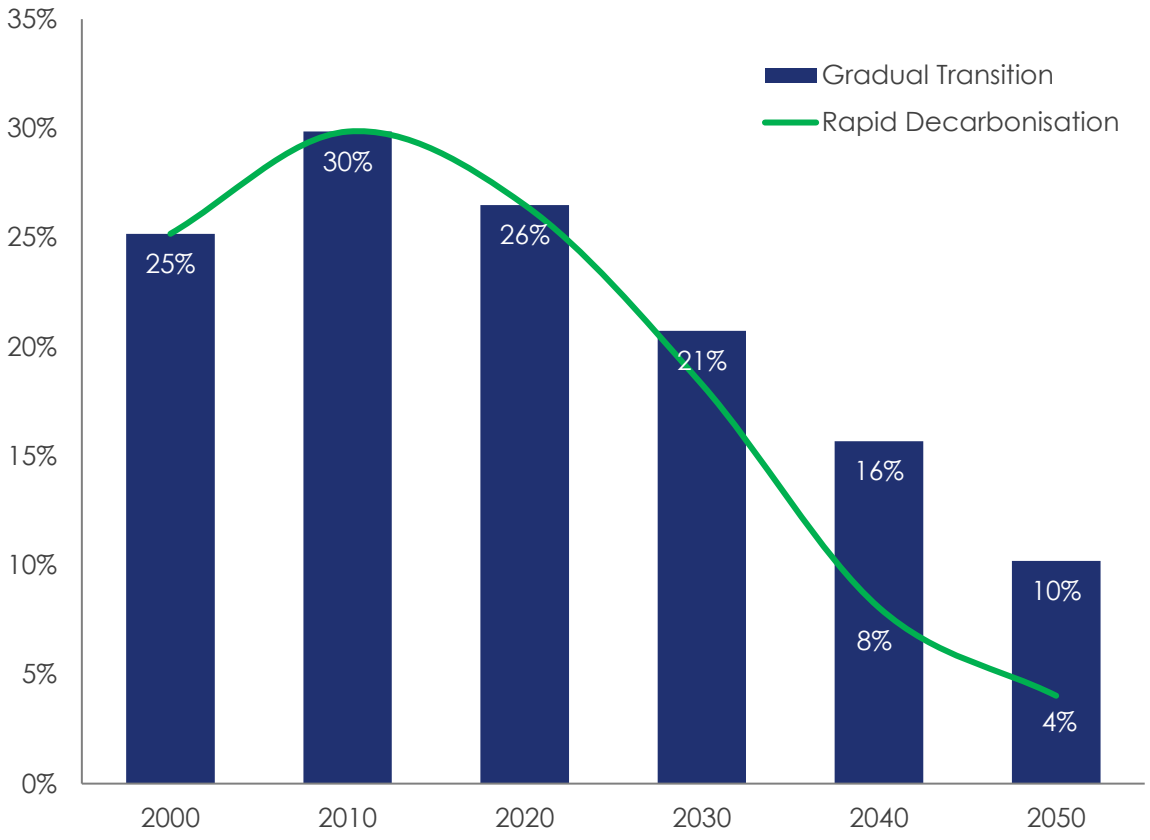


Source: Clarksons Research. Assumes consumption = production.

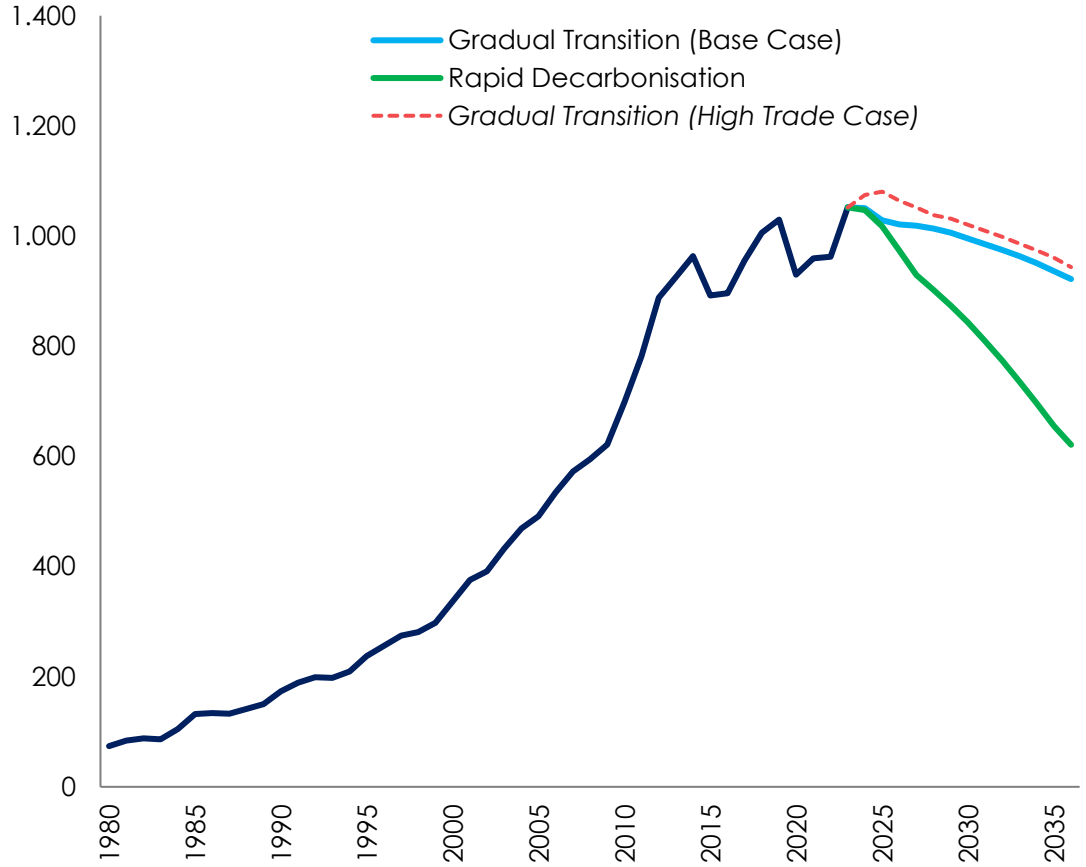
Dry Bulk Sector Cargo Base Impacted By Transition In Energy Mix

Range of scenarios for pace of transition

Energy Transition Scenarios: Coal's Share of Global Energy Production (mtoe)



Energy Transition Scenarios: Seaborne Coal Trade (million tonnes)

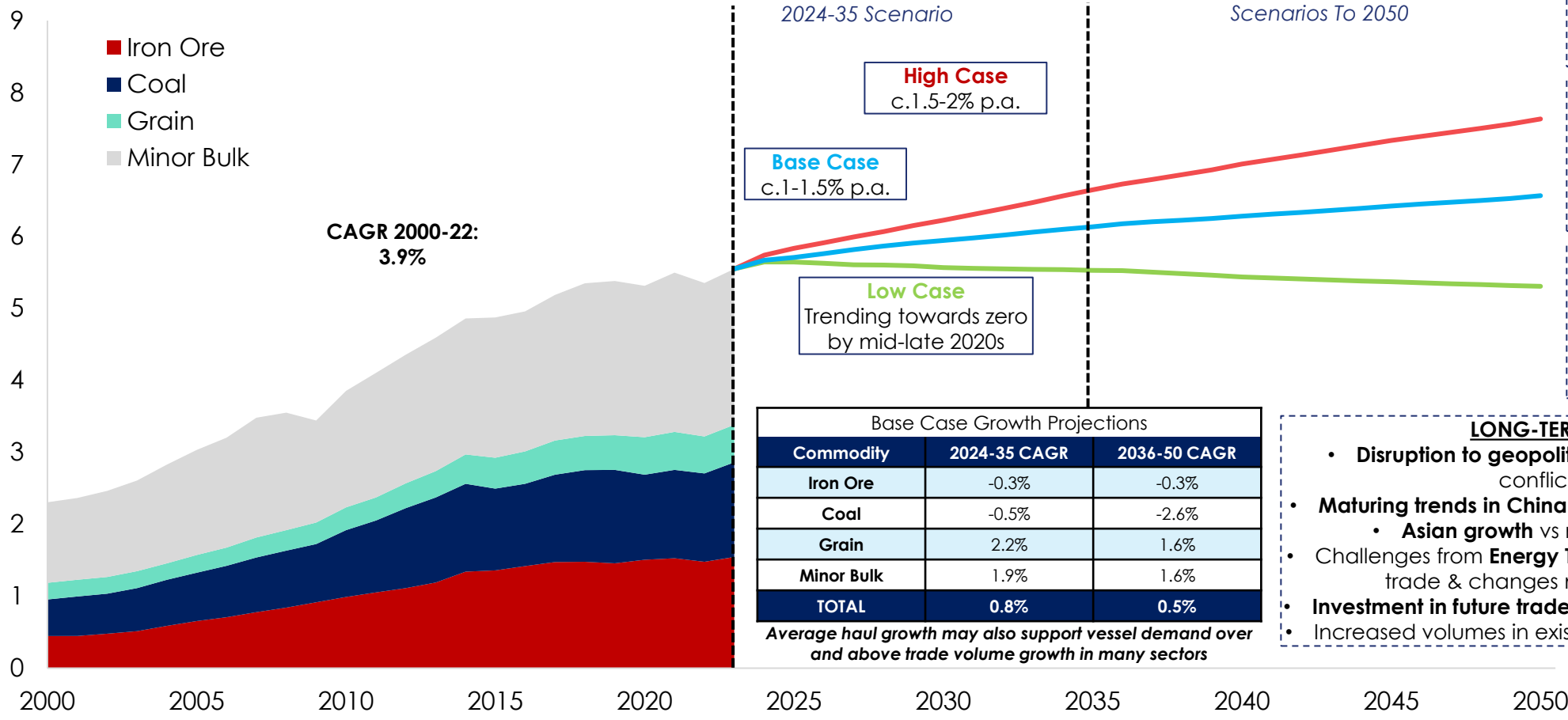


Source: Clarksons Research. Assumes consumption = production.

Long-Term Global Seaborne Dry Bulk Trade Scenarios

Debate over long-term growth; coal's role in the changing energy mix to impact on moderating growth rates

Global Seaborne Dry Bulk Trade, bn tonnes



High Case
Moderating towards 1% p.a. in longer-term, **pressure on coal** but firmer trends in grain, minor bulk; iron ore fairly steady

Base Case
Slowing to 0.5-1% p.a. in longer-term as **energy transition has an increasing impact on coal trade**, Chinese steel output gradually softens

Low Case
Declining gradually in longer-term as **coal comes under significant pressure**, limited new markets for iron ore as China's heavy industry focus wanes

Base Case Growth Projections

Commodity	2024-35 CAGR	2036-50 CAGR
Iron Ore	-0.3%	-0.3%
Coal	-0.5%	-2.6%
Grain	2.2%	1.6%
Minor Bulk	1.9%	1.6%
TOTAL	**0.8%**	**0.5%**

Average haul growth may also support vessel demand over and above trade volume growth in many sectors

LONG-TERM TRADE DEBATE

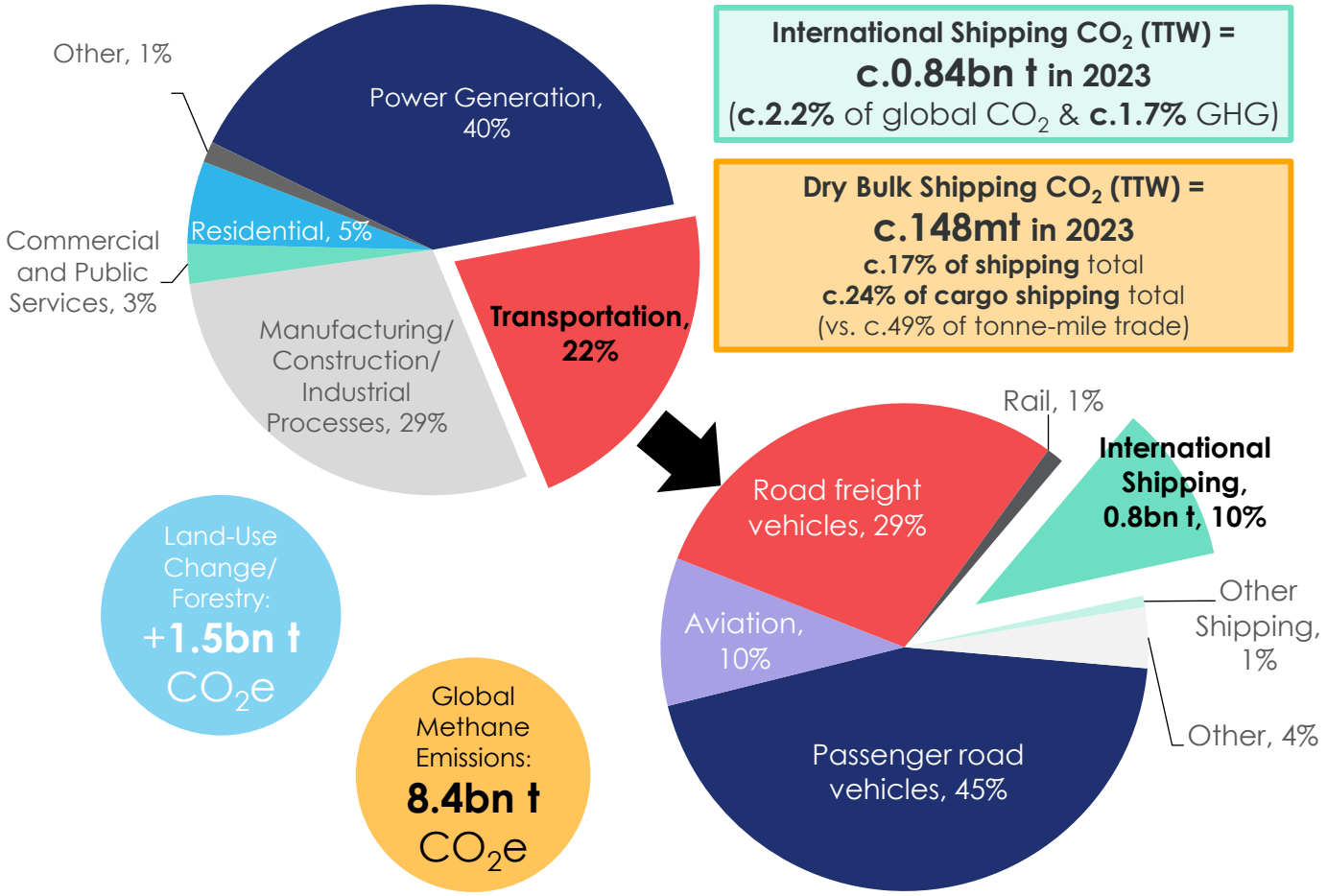
- **Disruption to geopolitical norms** (e.g. Russia-Ukraine conflict); trade tensions
- **Maturing trends in China** vs support in some areas from 5YP
- **Asian growth** vs mature Europe/N.America
- Challenges from **Energy Transition**, notably impacts on **coal** trade & changes needed in e.g. steel industry
- **Investment in future trade infrastructure**, China's Belt & Road
- Increased volumes in existing and **evolving cargo segments**

Source: Clarksons Research, September 2024.

Decarbonisation Scenarios - Shipping's Emissions In Context

International shipping emissions increasing marginally in 2024, c.2.0% of global GHG emissions 'Well-to-Wake'

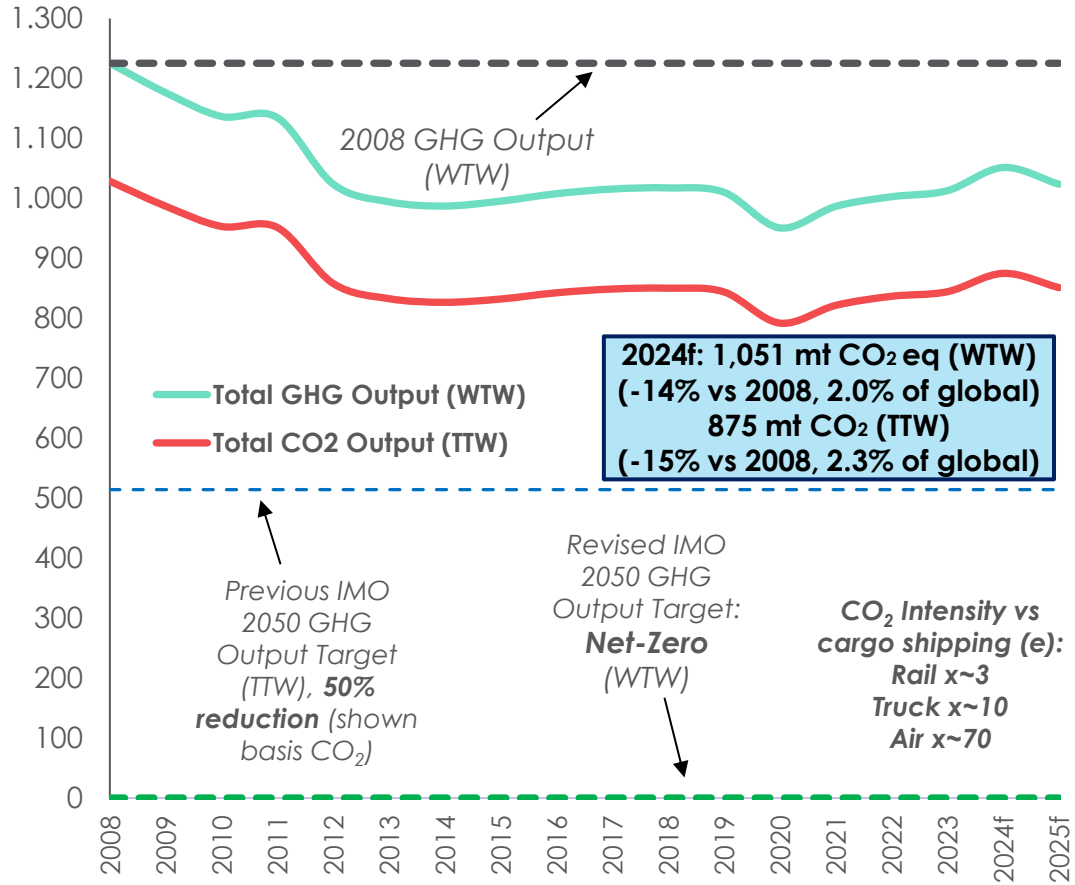
Global CO_2 Emissions By Sector (2022), tonnes CO_2



International Shipping CO_2 (TTW) =
c.0.84bn t in 2023
(**c.2.2%** of global CO_2 & **c.1.7%** GHG)

Dry Bulk Shipping CO_2 (TTW) =
c.148mt in 2023
c.17% of shipping total
c.24% of cargo shipping total
(vs. c.49% of tonne-mile trade)

International Shipping Emissions, tonnes CO_2 eq



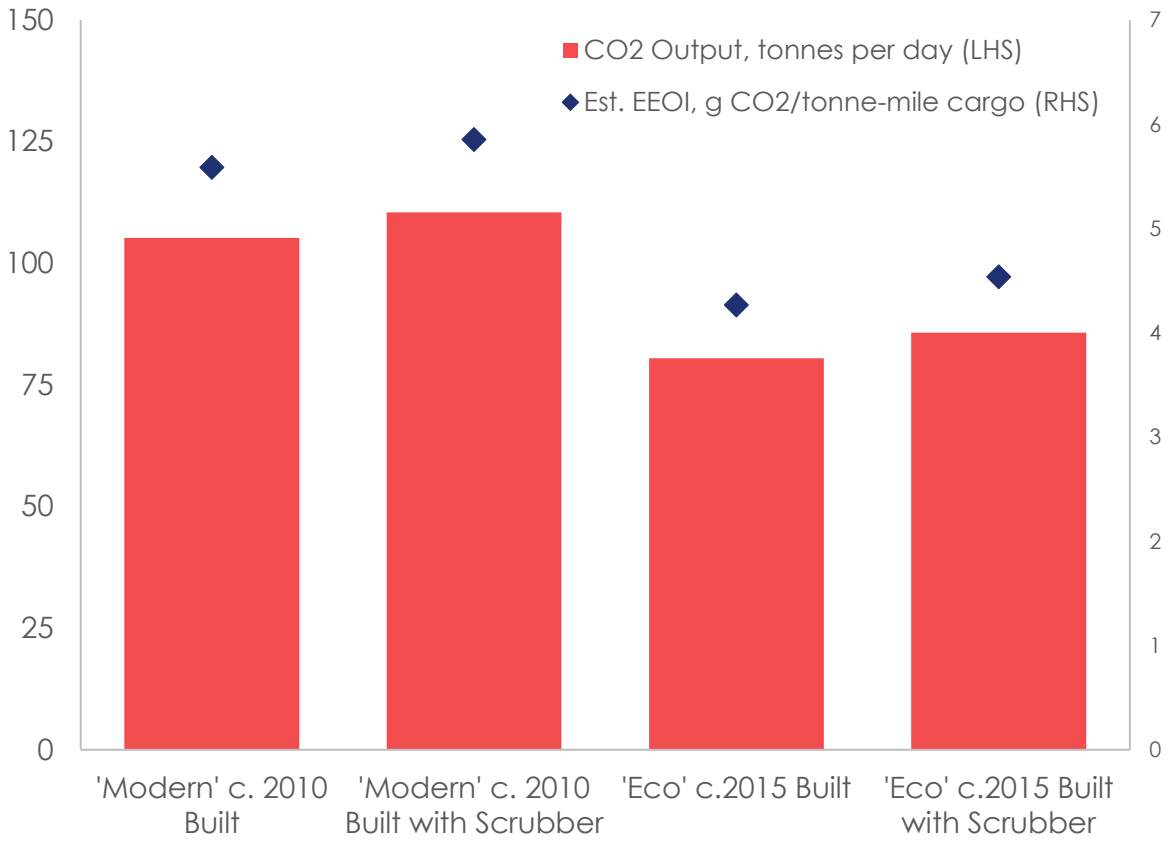
Comparable data for car, rail and aviation available on request. From 2008 to 2018, aviation CO_2 emissions increased by 20%, car and truck increased by 15-20% and rail declined by 10%.

Source: Clarksons Research. World Resources Institute/Climate Watch. Global Carbon Project. IEA. Global CO_2 excluding LUCF.

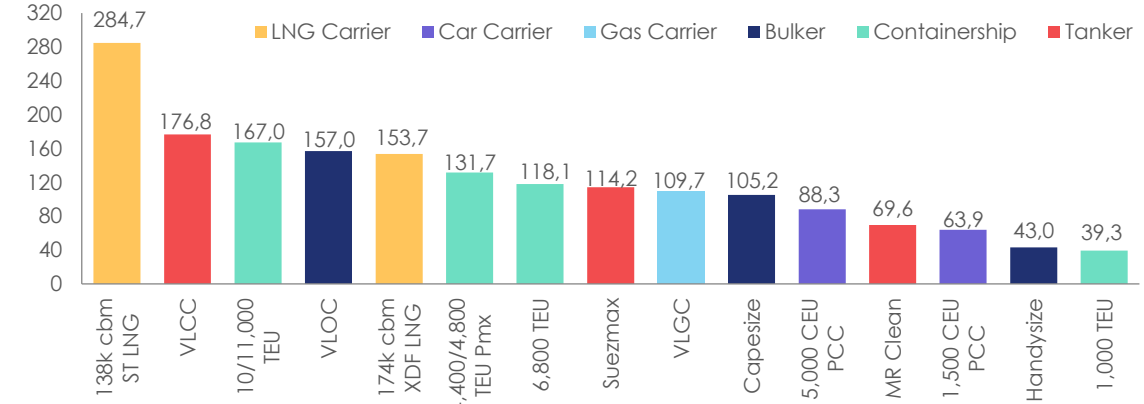
Clarksons Research CO_2 Emissions Benchmarks

Tracking GHG emission output & intensity becoming increasingly important

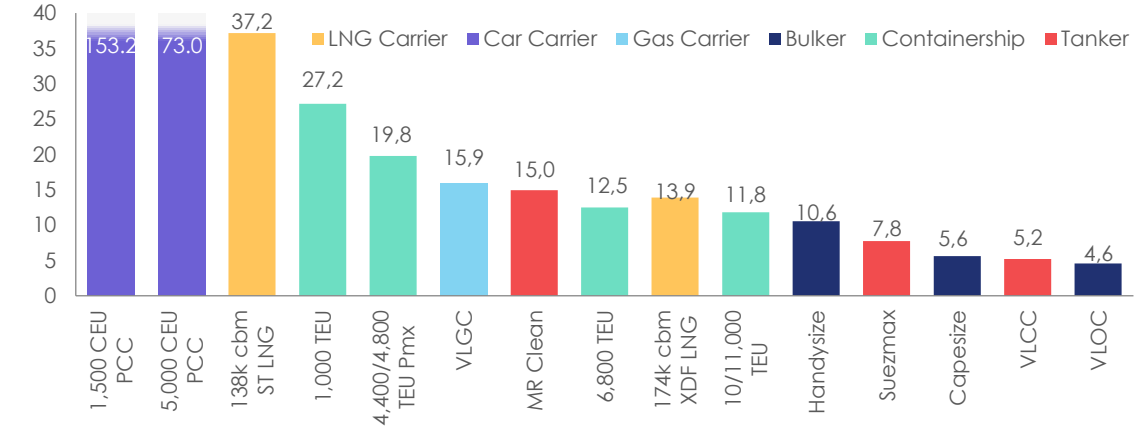
Average Capesize CO_2 Output (TTW) & Est. EEOI



Average CO_2 Output (TTW) By Vessel Sector, tonnes CO_2 per day



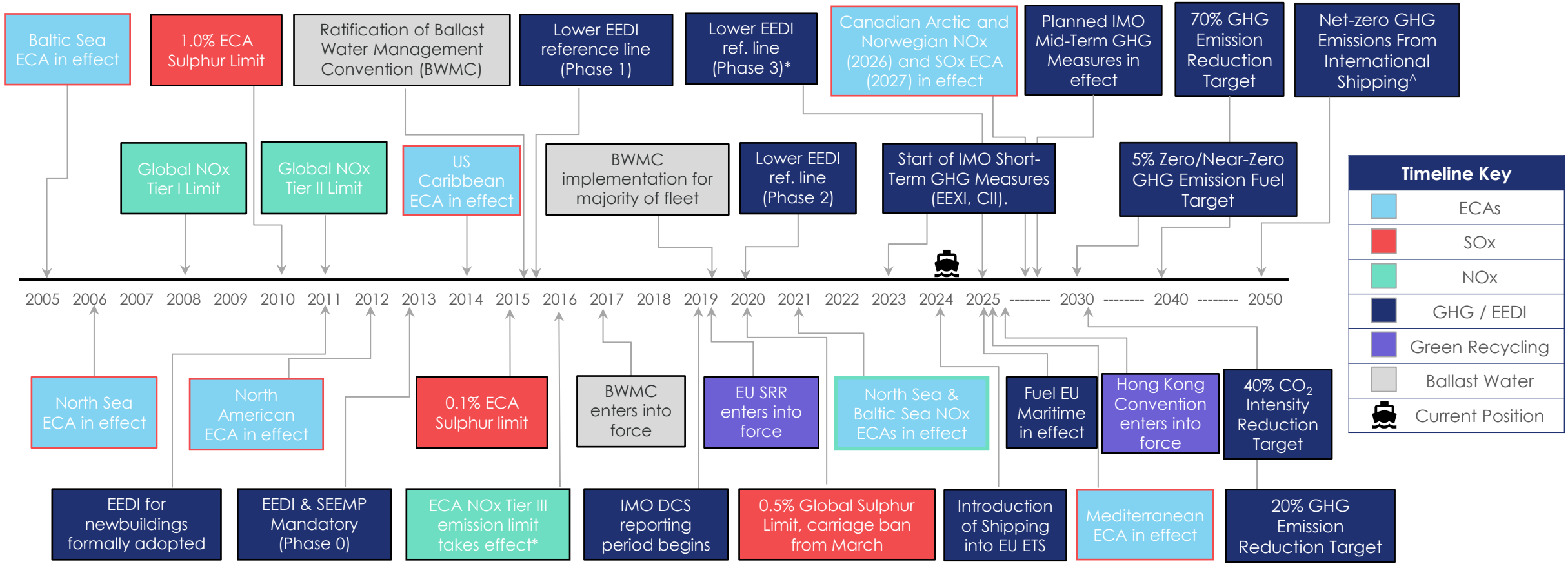
Average Estimated EEOI By Vessel Sector, gCO_2 /tonne-mile cargo



Source: Clarksons Research, October 2024. Average vessel CO_2 output and est. EEOI basis averages calculated on a selection of standard voyages on the basis of standard ship types. Assumptions include: cargo loaded per voyage, voyage distances, sea time, port time, working days per year, trade lane service structure, capacity utilisation, cargo weight, peak-leg/backhaul imbalance and reefer cargo/consumption. EEOI metrics published here are theoretical estimates based on Clarksons Research calculations and assumptions and may differ from other published operational energy efficiency indicators. All tanker, bulker and PCC CO_2 output and EEOI values based on a 'Modern' c.2010 built ship, VLGC values basis 'eco' c.2015 built vessel, containerships basis 'eco' vessels except for 'Old Panamax'.

Shipping's Regulation Timetable Continuing To Accelerate

Regulatory timeline accelerating, net zero target by IMO, Well-to-Wake.

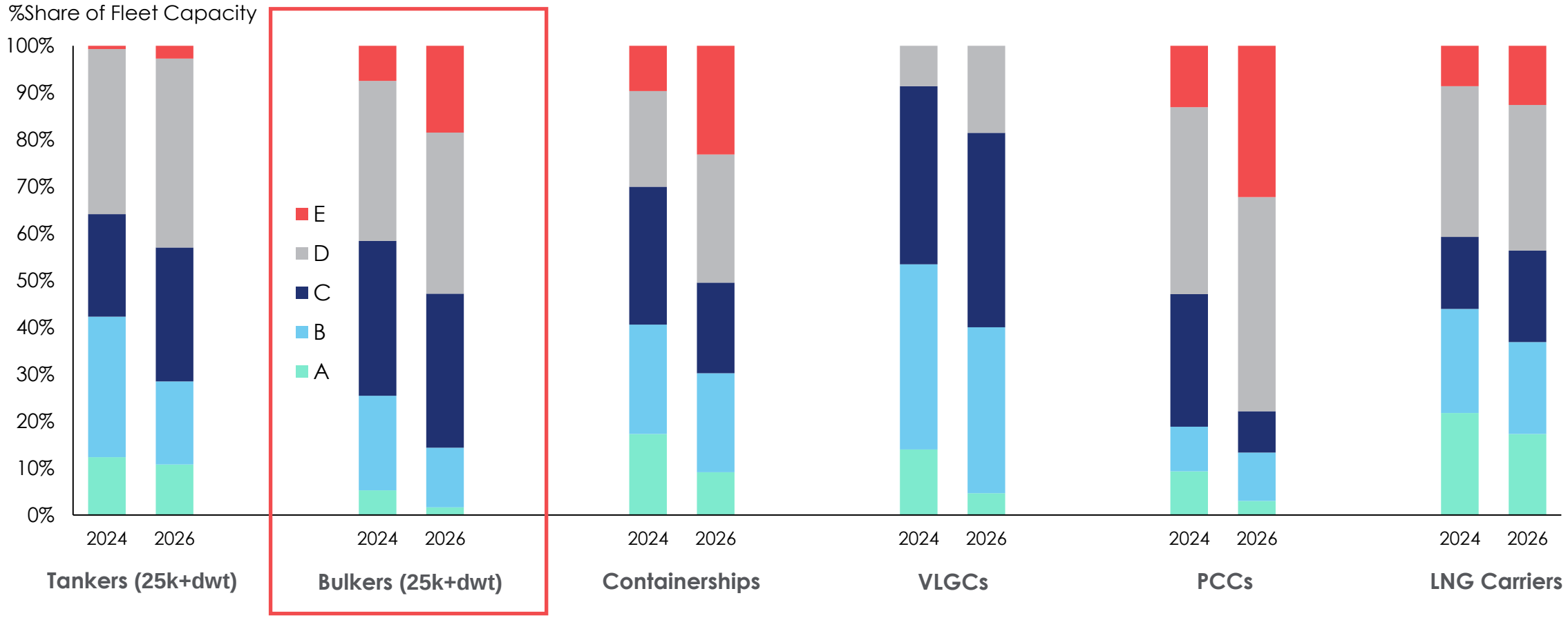


Source: Clarksons Research, September 2024. *EEDI phase 3 requirements brought forward to 2022 for gas carriers, general cargo ships and containerships. ^ Net-zero target has been defined as 'by or around, i.e. close to 2050', basis well-to-wake GHG emissions and taking into account different national circumstances.

Tracking Impacts Of Regulations (And Tiered Markets Ahead?)

Case study: CII (Carbon Intensity Indicator) – benchmark estimates against 2024 and 2026 targets

Current Tanker (25k+ dwt), Bulker (25k+ dwt), Containership, VLGC, PCC & LNG Carrier Fleets Split By CII Rating In 2024



Source: Clarksons Research. Provisional CII analysis uses CRS emissions benchmarks (estimated AERs), based on mapping current fleet to Clarksons Research standard ships. CRS benchmark AERs calculated as averages across a 'basket' of standard voyages. 2024 ytd CII ratings are basis 2024 ytd operational data, where AER metrics are estimated based on Clarksons Research calculations and assumptions combined with operational AIS data for the relevant period. AER estimates are subject to variations in movements data coverage. Rating assessments based on the current fleet only, and do not take into account improvements in vessel efficiency/fuelling/speed etc. going forwards. Basis 2024 ytd/Data as of October 2024.

IMO 'Mid-Term' Measures: Summary & Timeline

Development under way of a technical and an economic measure to drive shipping's long-term decarbonisation

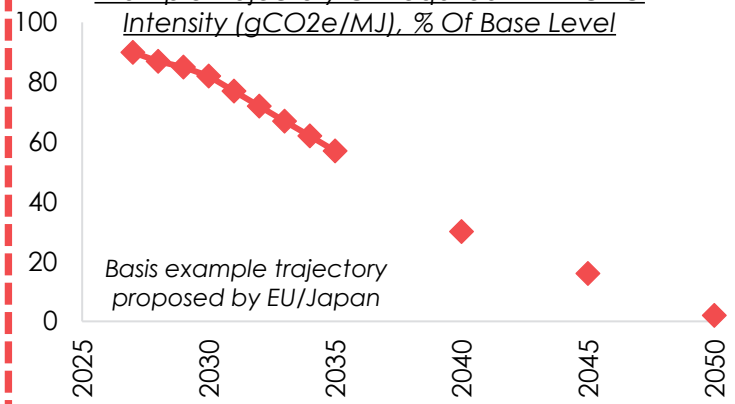
'Mid-Term' Measures Development Timeline:

- **2021-23** — Discussions & proposals around possible measures
- **Jul-23** — IMO adopts new long-term targets
- **Mar-24 (MEPC 81)** — Interim report on potential impacts of different proposed measures
- **Sep-24 (MEPC 82** — Final report on potential impacts of different proposed measures
- **Spring 25 (MEPC 83)** — Planned approval of mid-term measures
- **2H 25 (MEPC 84)** — Formal adoption of mid-term measures
- **2027** — Mid-term measures come into force

1. Technical Measure

- A **marine fuel standard**, **limiting the GHG intensity of fuels**
- Likely that limits will be gradually **tightened over time**, driving the uptake of fuels with low well-to-wake emissions
- Exact standards and reduction trajectory **still to be agreed**
- Under discussion whether a 'pooling' approach will be taken to compliance

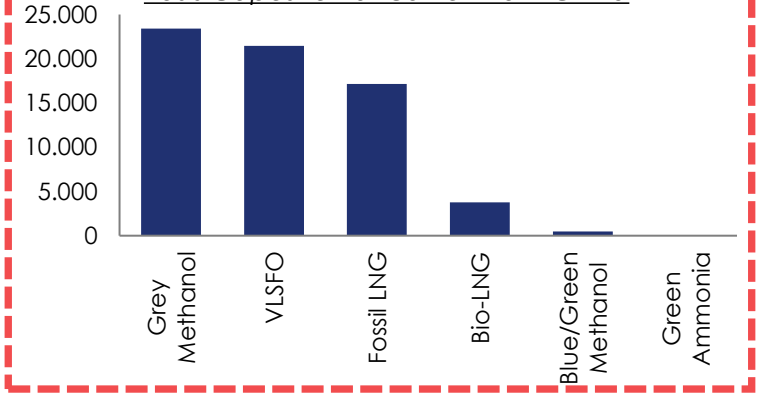
Example Trajectory Of Required WTW GHG Intensity (gCO2e/MJ), % Of Base Level



2. Economic Measure

- A **GHG pricing mechanism**
- **Major debate** ongoing
- Some countries proposing a **levy on all GHG emissions**, e.g. \$100 or \$150/t CO_2e
- Others proposing a **trading scheme** based around compliance level with technical measure
- May help narrow gap between prices of alternative and conventional marine fuels

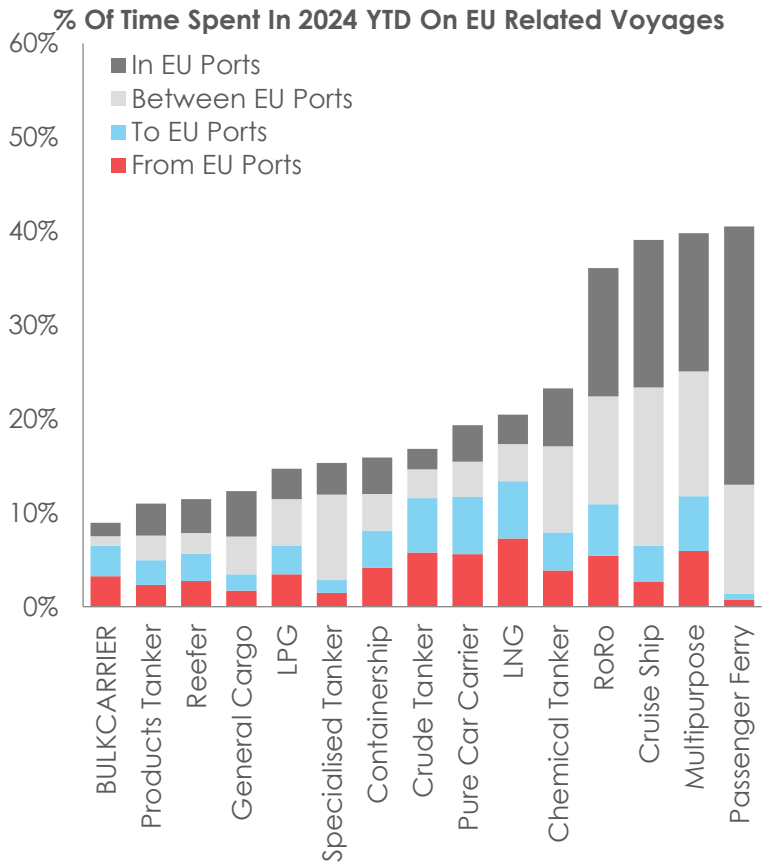
Example Emissions Levy Cost In \$/day At \$150/t CO2e Basis Capesize Bulkcarrier Brazil-China



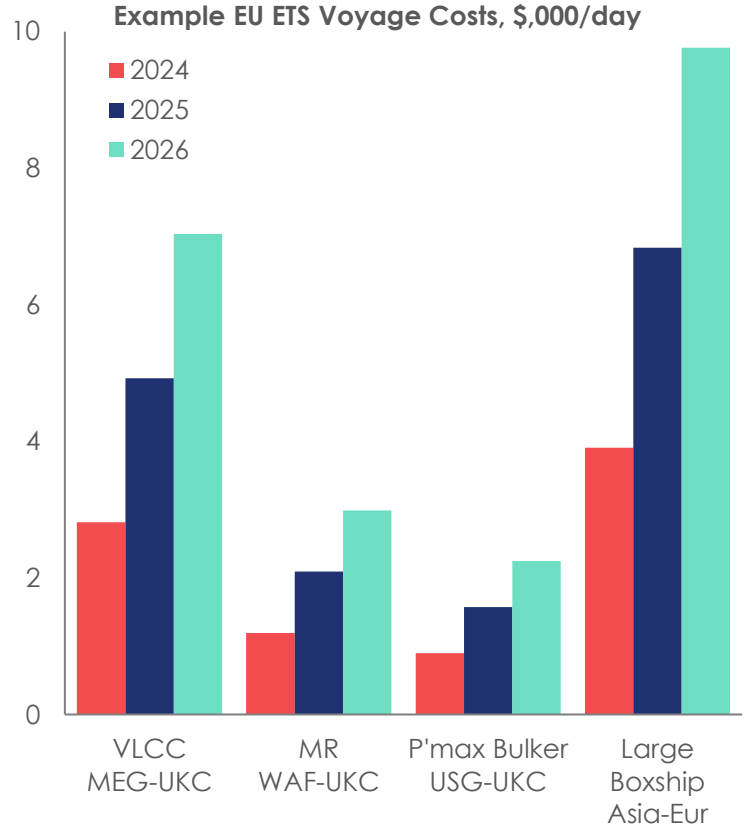
EU Shipping Emissions Regulation: Emissions Trading Scheme & FuelEU Maritime

Emissions allowances must now be purchased for EU seaborne voyages; GHG intensity regulations begin in 2025

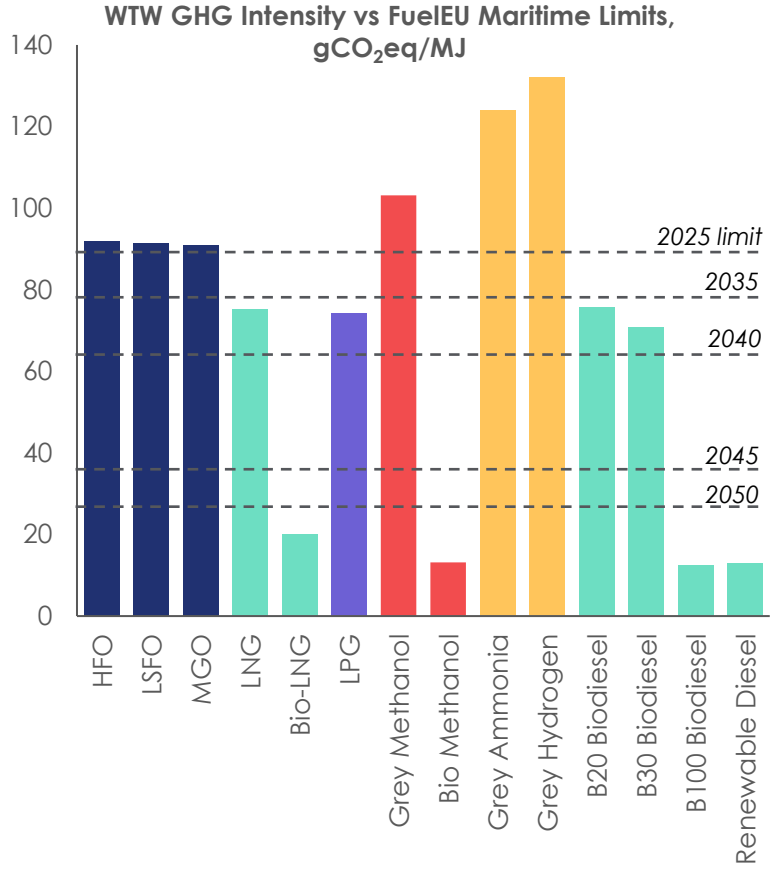
Varying exposure to EU voyages by sector: across the fleet 17% of time spent on EU trips



EU ETS is being phased in across 3 years, leading to higher costs on EU voyages



Conventional marine fuels exceed the 2025 limit; 'green' fuels needed long-term

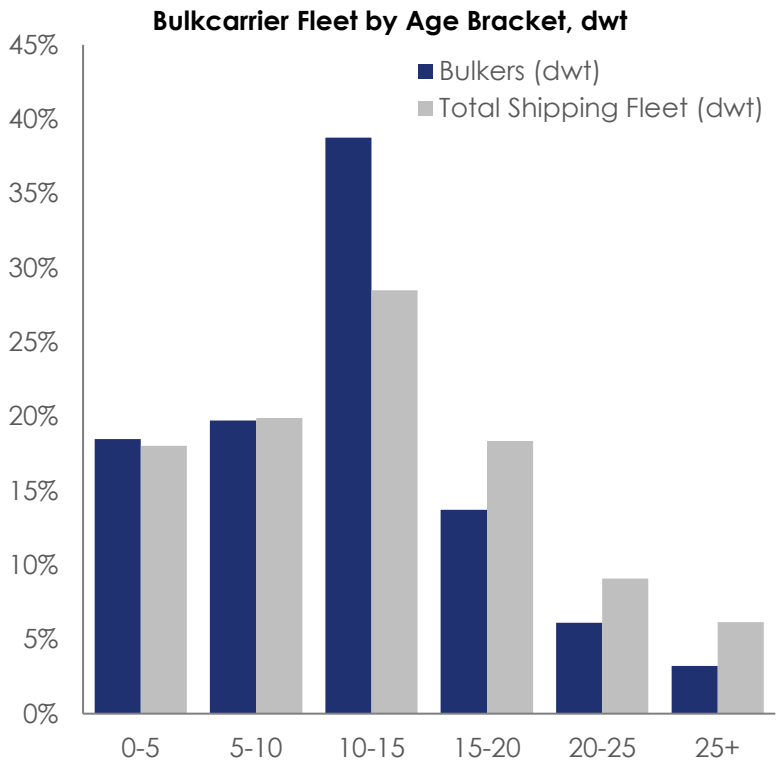


Source: Clarksons Research

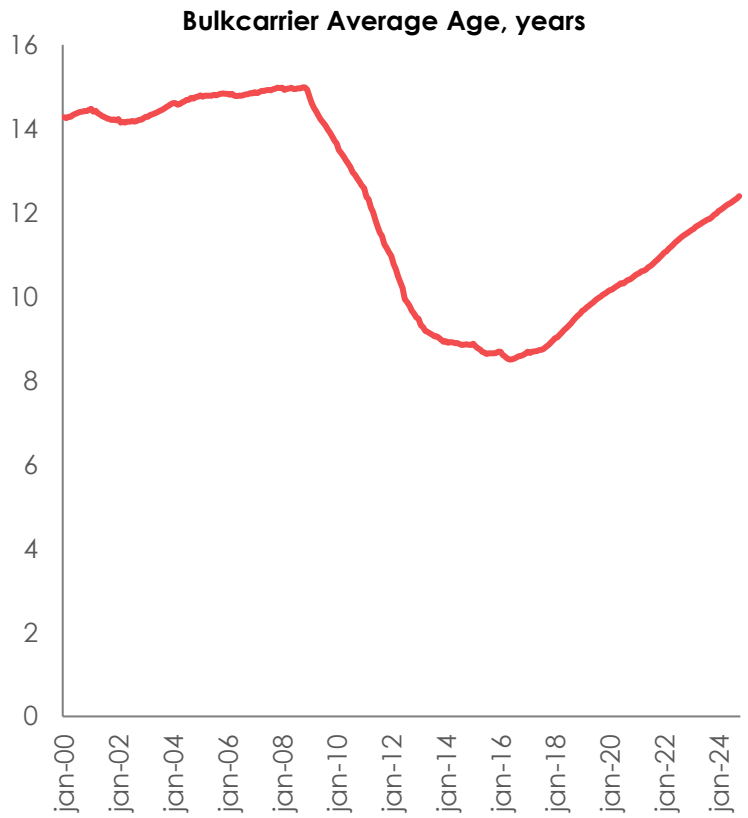
Increasing Bulkcarrier Fleet Renewal Requirements Ahead

Fleet mostly 'middle aged' for now but significant renewal needed eventually…

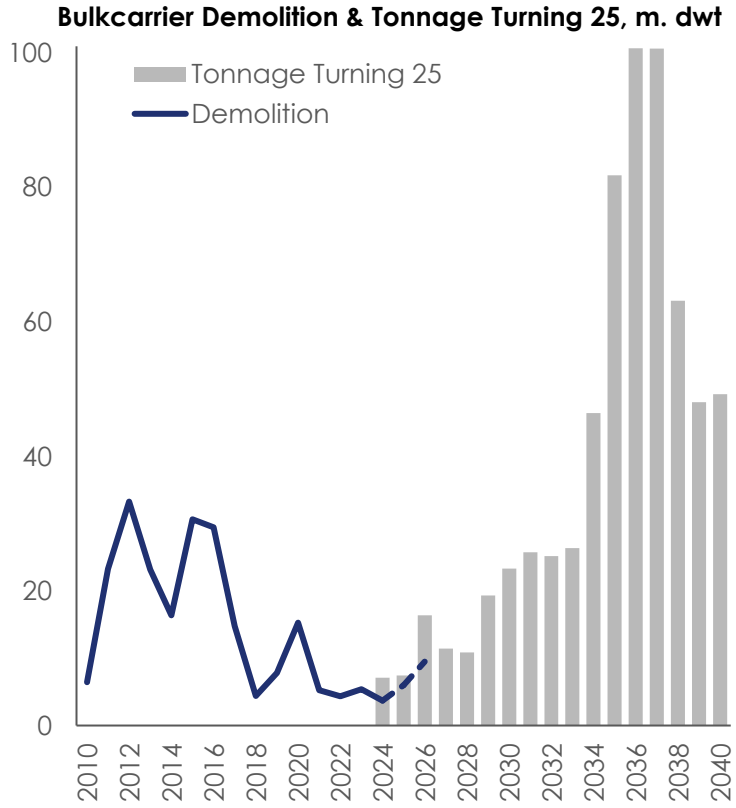
The bulkcarrier fleet is relatively young compared to the broader shipping industry…



But the bulker fleet is ageing gradually amid limited demolition of older ships & only 'moderate' deliveries…



And there is a significant need for fleet renewal eventually as 'boom ships' reach end of life age…

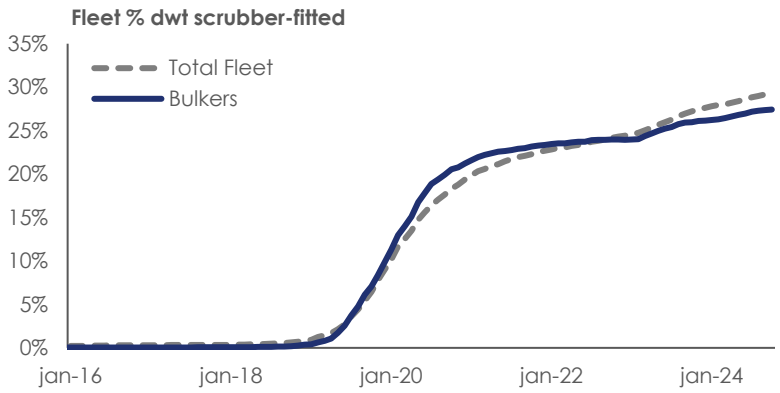


Source: Clarksons Research

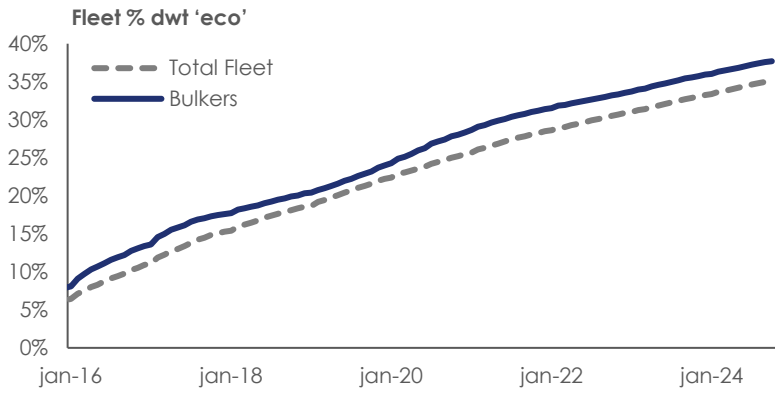
Tracking Bulkcarrier "Green" Vessel Technology Uptake

Bulker uptake of scrubbers, ESTs and 'eco' ships considerable, but lagging behind on alternative fuels…

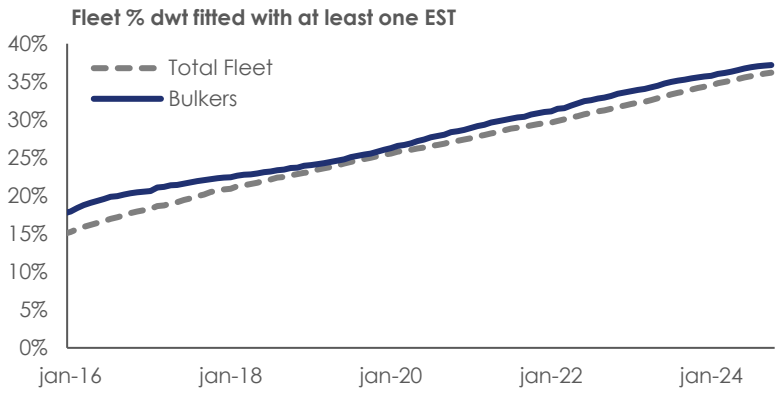
>27% of bulker fleet scrubber-fitted



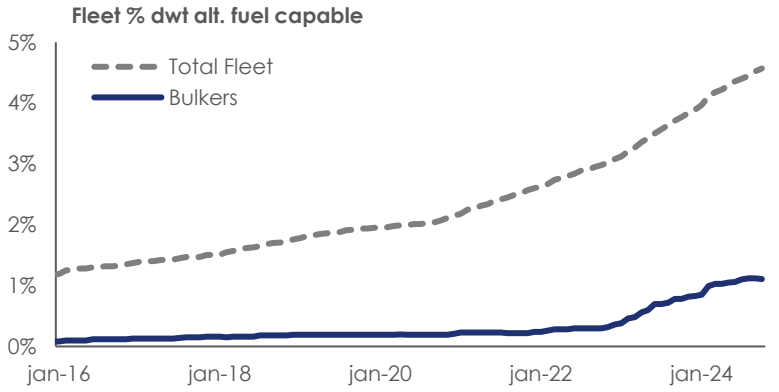
A significant >37% is now 'eco'



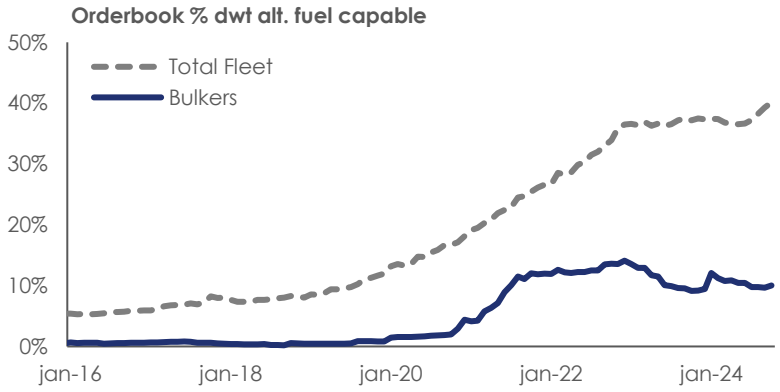
>37% is fitted with Energy Saving Tech.



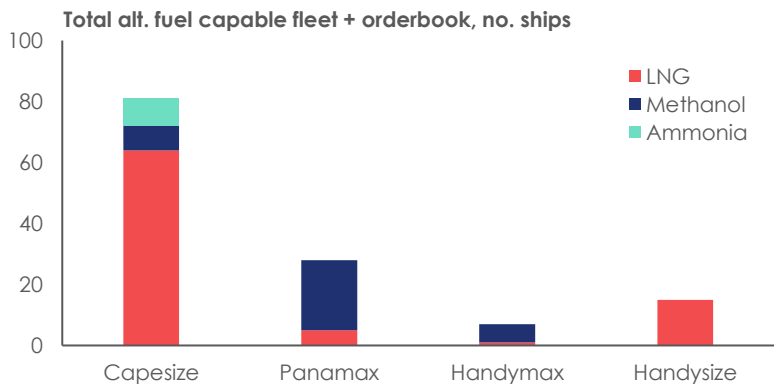
But <1% of bulker fleet is alt. fuel capable



Alt. fuel ordering has been limited…



…mostly LNG Capes ordered back in 2021



Source: Clarksons Research

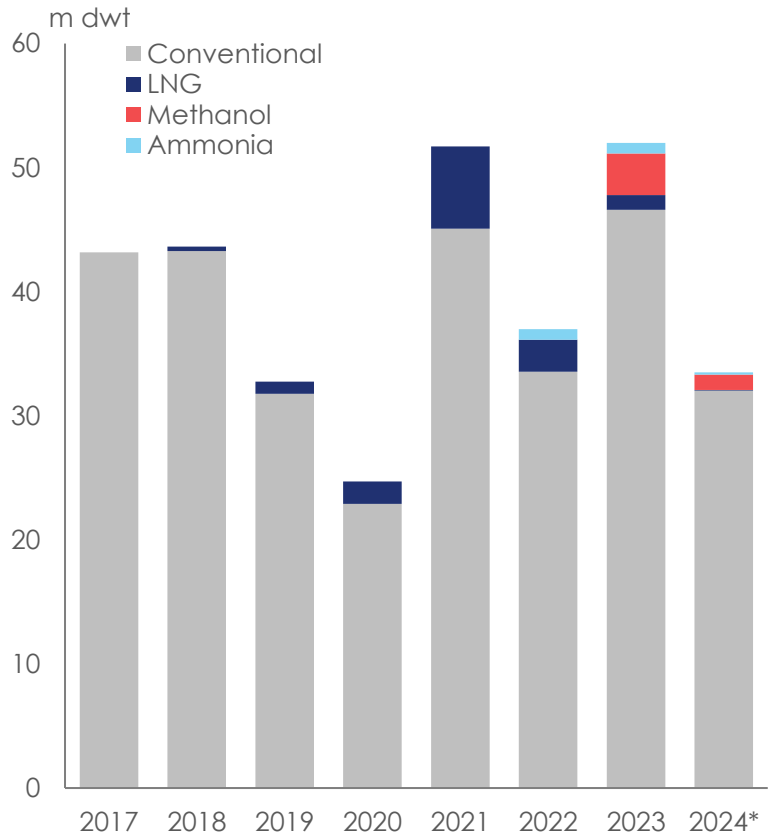
Environmental Uptake – Bulkcarrier Sector Comparison

Shippers want "greener" supply chain but bulkcarrier adoption lagging behind other volume shipping sectors

	Environmental Uptake	Containerships		Crude Tankers		Bulkcarriers	
		% Fleet (TEU)	% Ordbk (TEU)	% Fleet (DWT)	% Ordbk (DWT)	% Fleet (DWT)	% Ordbk (DWT)
Technical	SOx Scrubber (Fitted/Pending)	**46%**	23%	**46%**	65%	**28%**	32%
	'Eco Modern'	**45%**	~100%	**37%**	~100%	**38%**	~100%
	Alt Fuels Capable (LNG, Biofuel, Methanol)	6%	**80%**	3%	**21%**	1%	**10%**
	Alt Fuels 'Ready'	12%	**20%**	4%	**30%**	3%	**16%**
	Energy Saving Technologies (No. Ships Fitted)	**>1,890 (>28%)**		**>970 (>42%)**		**>3,860 (>28%)**	
Operational	Avg Operating Speed* (Knots, 2023 YTD)	**14.1**		**11.4**		**10.9**	
	% Avg Speed Change Since 2008	***-27%***		***-20%***		***-20%***	
Infrastructure	Ports With Onshore Power	**162**		**126**		**166**	
	Ports With Active LNG Bunkering (Terminal, STS, TTS)	***125***		***115***		***138***	

For more details on our offering contact the Clarksons Green Transition Team and visit https://content.clarksons.com/green-transition. Note: Data basis start October 2024. *Basis average daily operating speeds within selected speed ranges. 'Eco Modern' – vessels with electronic injection main engine contracted after 1st January 2012. Source: Clarksons Research, World Fleet Register.

Bulkcarrier ordering remains mostly conventionally fuelled; early interest in LNG and methanol, some ammonia…

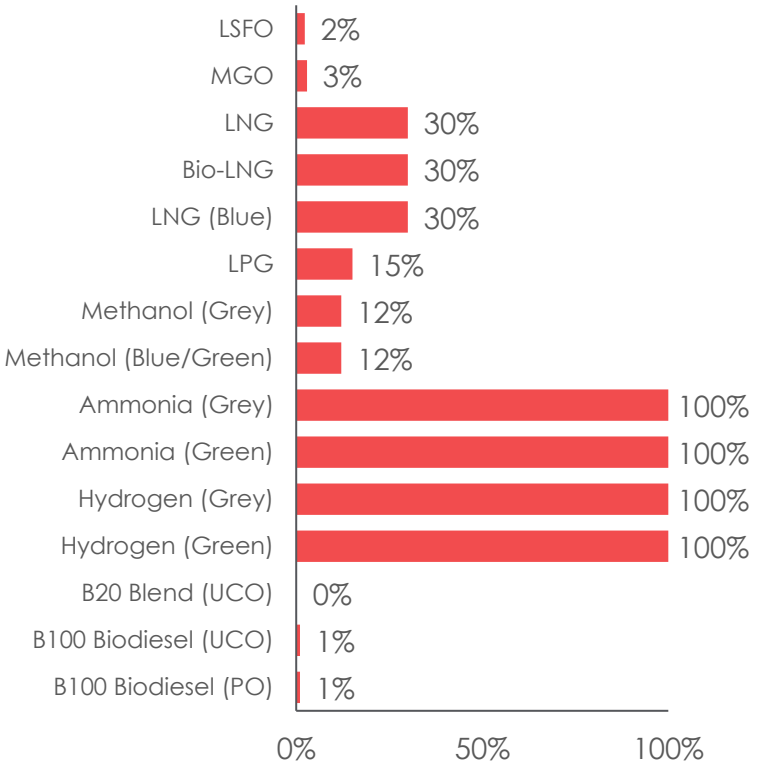


Lifecycle Greenhouse Gas Emissions: From Tank-To-Wake (TTW) To Well-To-Wake (WTW)

Combining tank-to-wake with well-to-tank GHG emissions has an impact on fuel type emissions and choice

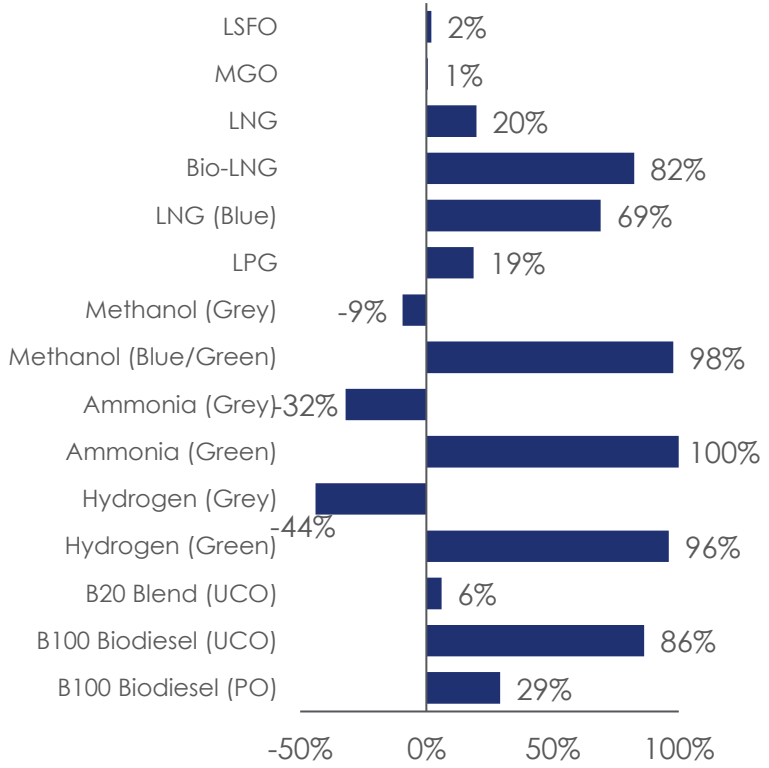
Alternative fuels can provide material GHG TTW reductions vs HFO on an energy-equivalent basis…

TTW GHG reduction vs HFO, tonnes of CO2eq (basis HFO energy equivalent)



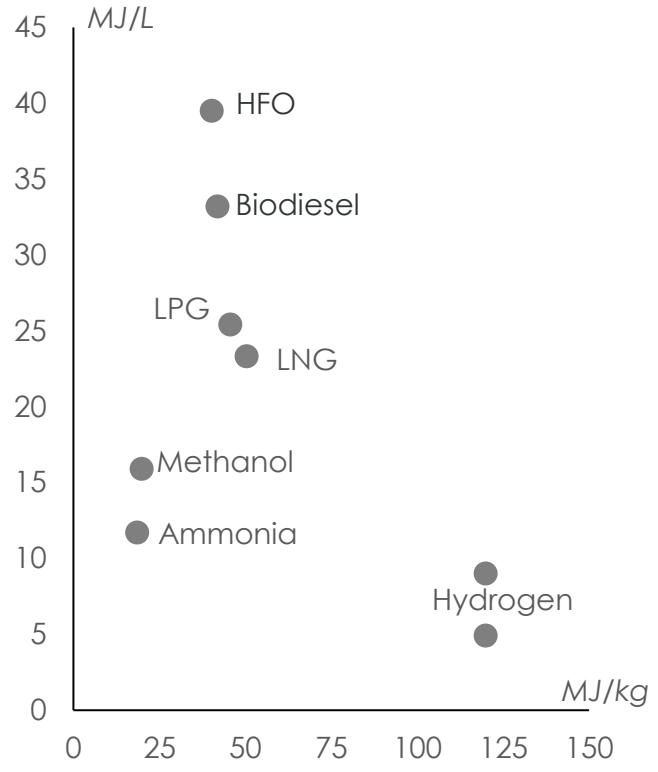
….though picture more mixed on a WTW basis, with 'grey' alternative fuels generating greater emissions on a WTW basis than HFO

WTW GHG reduction vs HFO, tonnes of CO2eq (basis HFO energy equivalent)



Varying energy densities of marine fuels also have implications for vessel design and operations

Fuel Type Volumetric & Energy Density

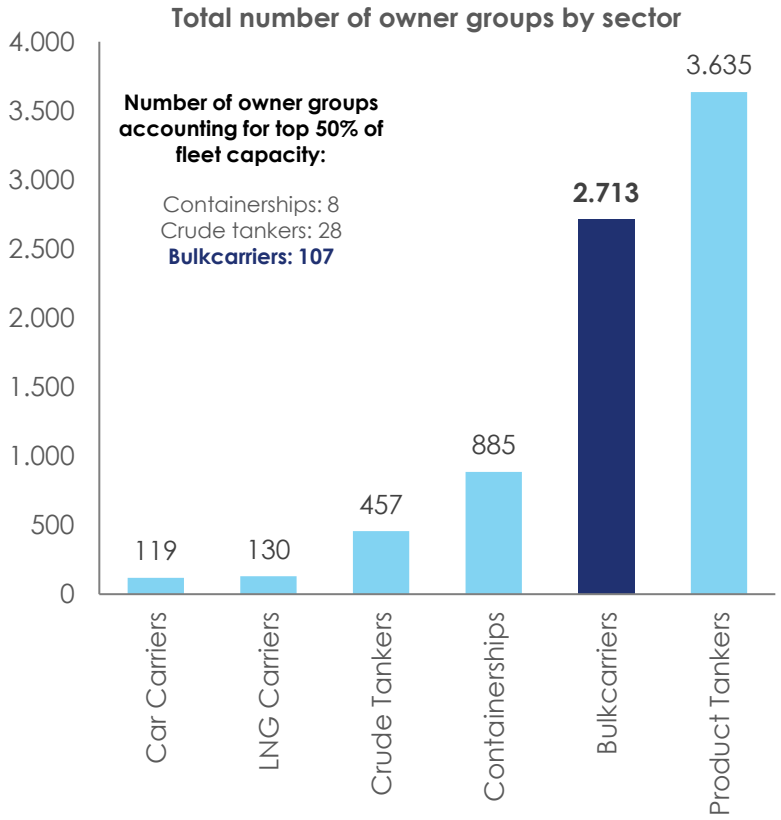


Source: Clarksons Research, September 2024. UCO=Used Cooking Oil. PO=Palm Oil. B20 blended 20% UCO biodiesel with 80% HFO. Note WTW reduction excludes any emissions for which factors remain "to be measured".

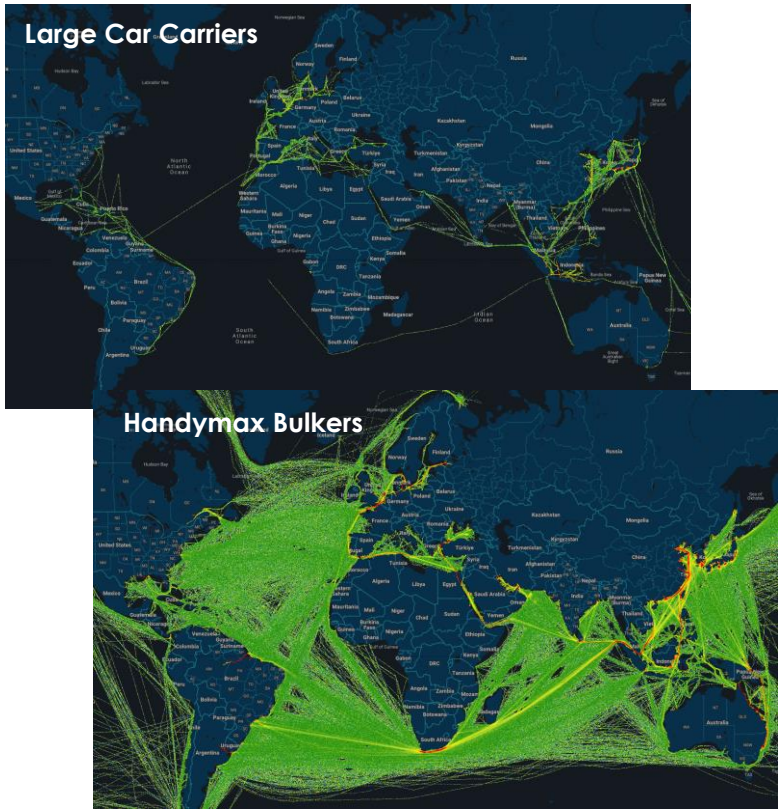
Potential Barriers to Alternative Fuels Adoption in the Bulkcarrier Sector

Fragmented sector, diverse trade patterns and strong cashflows in other sectors are all barriers…

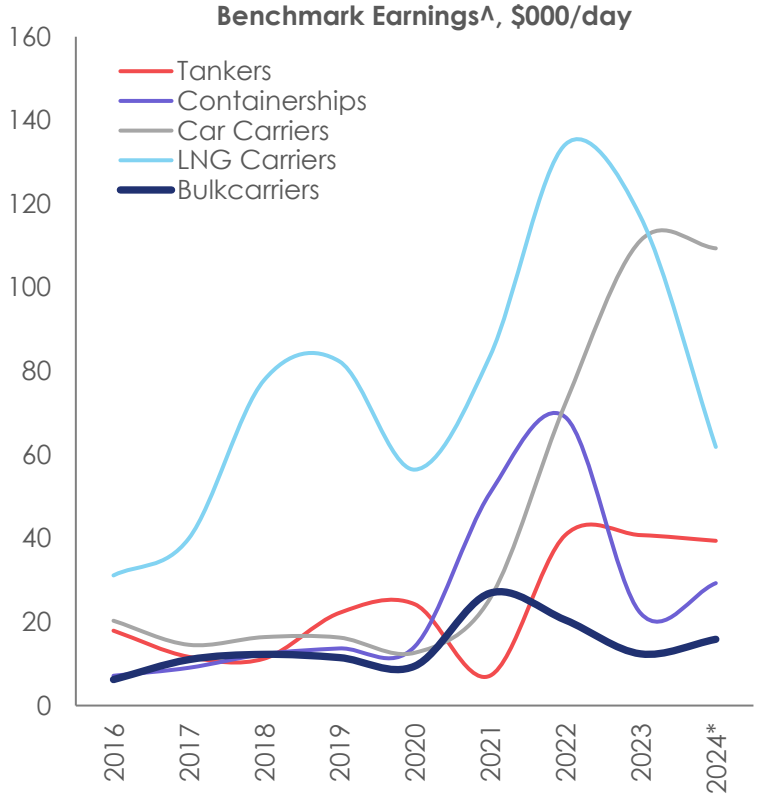
Fragmented bulker sector (compared to e.g. liner shipping) makes it harder for 'early adopters' to drive sector progress



Bulkcarrier trading patterns are very diverse; 'tramp' shipping less predictable routings vs. 'liner' shipping…



Bulkcarrier markets have been generally 'solid' in recent years, but cashflow not as 'exceptional' as in some other sectors…

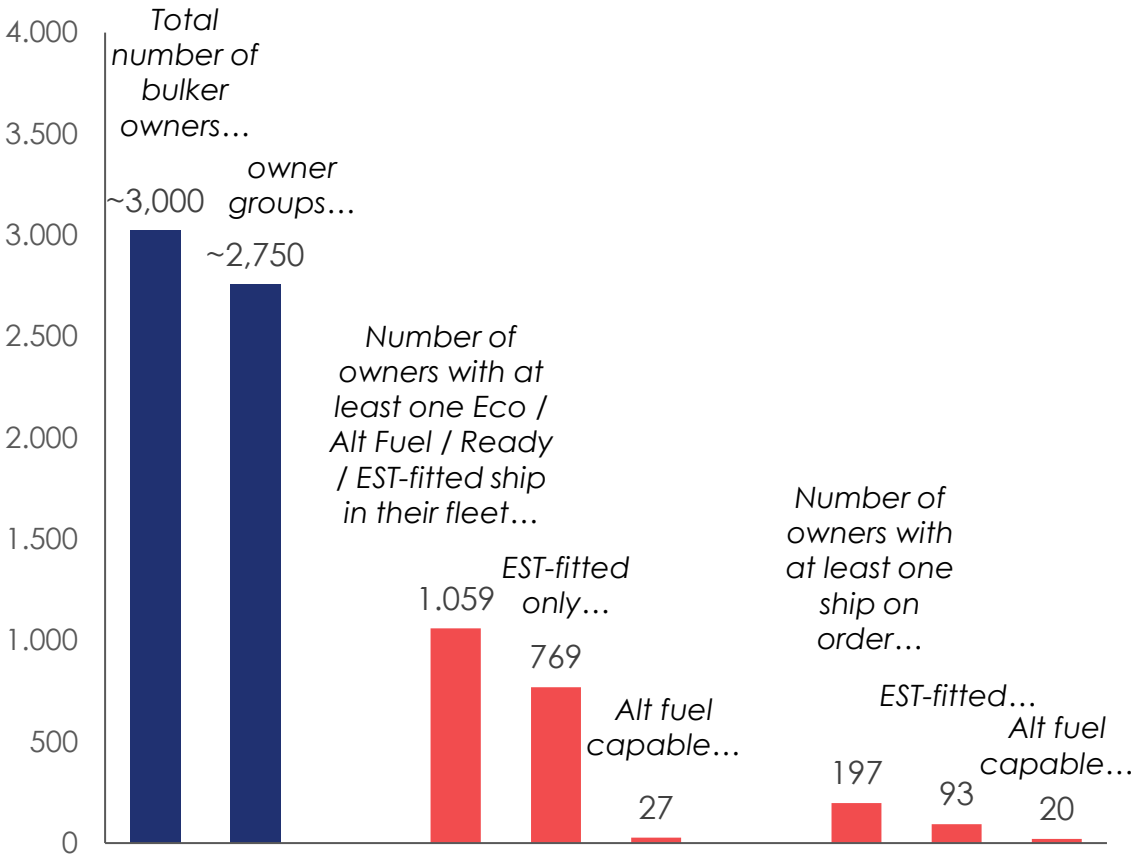


Source: Clarksons Research. *2024 YTD. ^Tankers, bulkers, containerships basis Clarksons Weighted Average Earnings, car carriers basis 6,500 ceu PCTC 1yr TC rate, LNG basis 160k cbm 1yr TC rate.

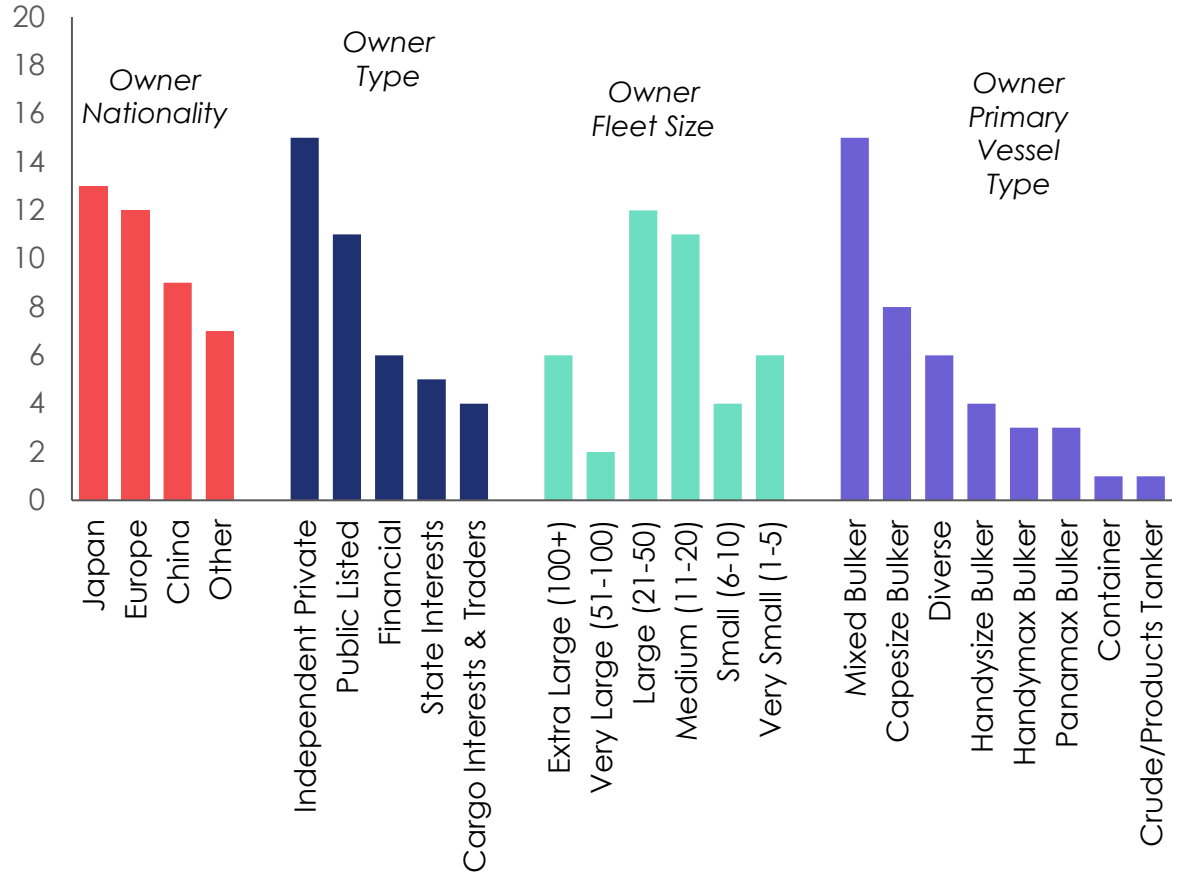
Progress To Be Made In The Bulkcarrier Fuelling Transition…

A fragmented sector, but only a small number of companies have so far taken major action…

Number of Bulkcarrier Owner Companies…



No. Of Owners With Alt. Fuel Capable Bulkers In The Fleet/Obk By…

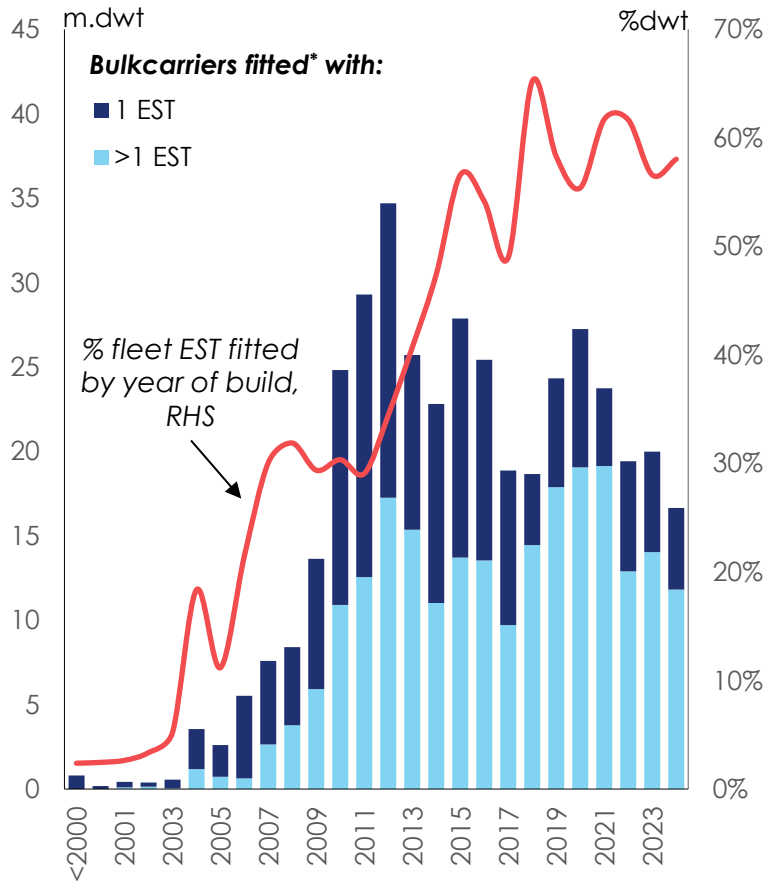


Source: Clarksons Research

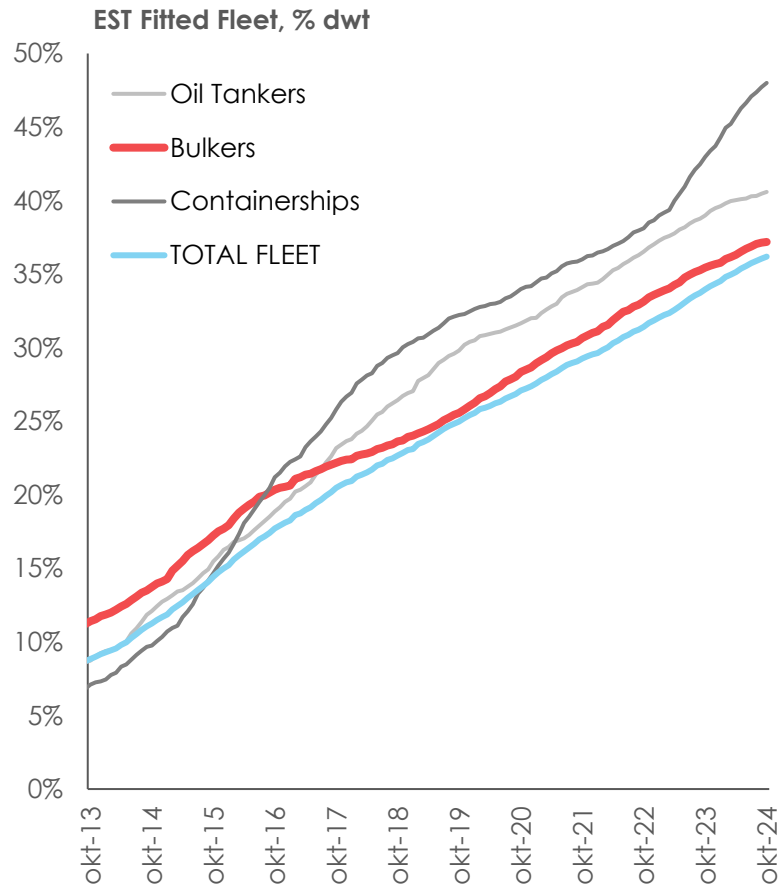
Energy Saving Technologies Uptake Rising

More than a third of bulkcarrier tonnage fitted with an EST, with larger ships seeing larger uptake

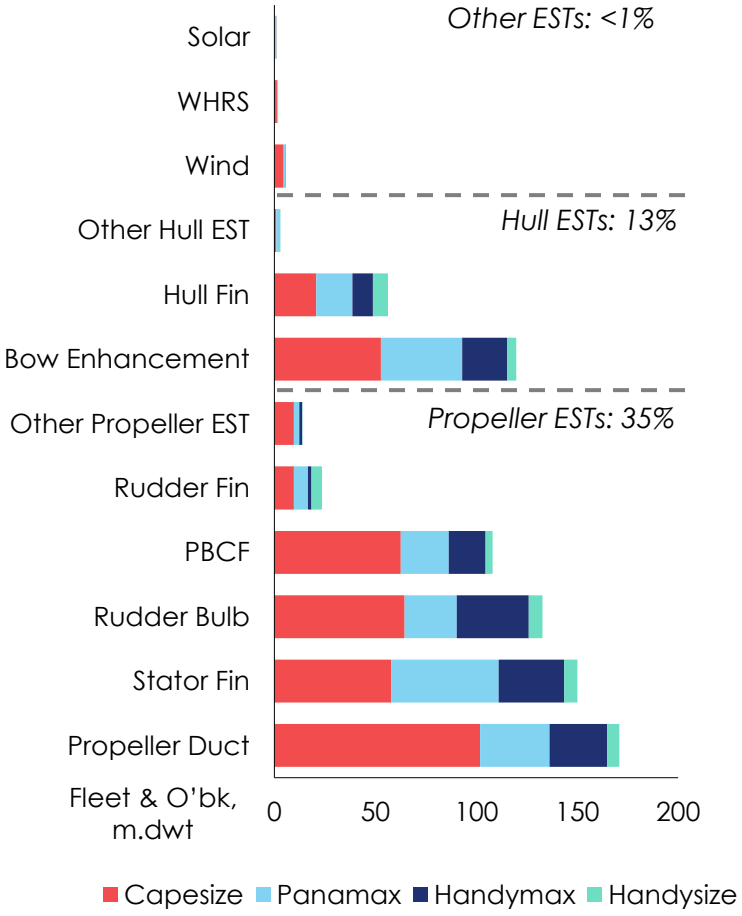
ESTs becoming standard on younger vessels: >57% of capacity built since start-17 EST fitted, >41% of ships built in '24ytd have >1 EST…



37% bulker fleet EST fitted, with rising uptake across other major cargo sectors too…



Propeller ESTs proving most popular so far in bulkcarrier sector, though a range of technologies being adopted…

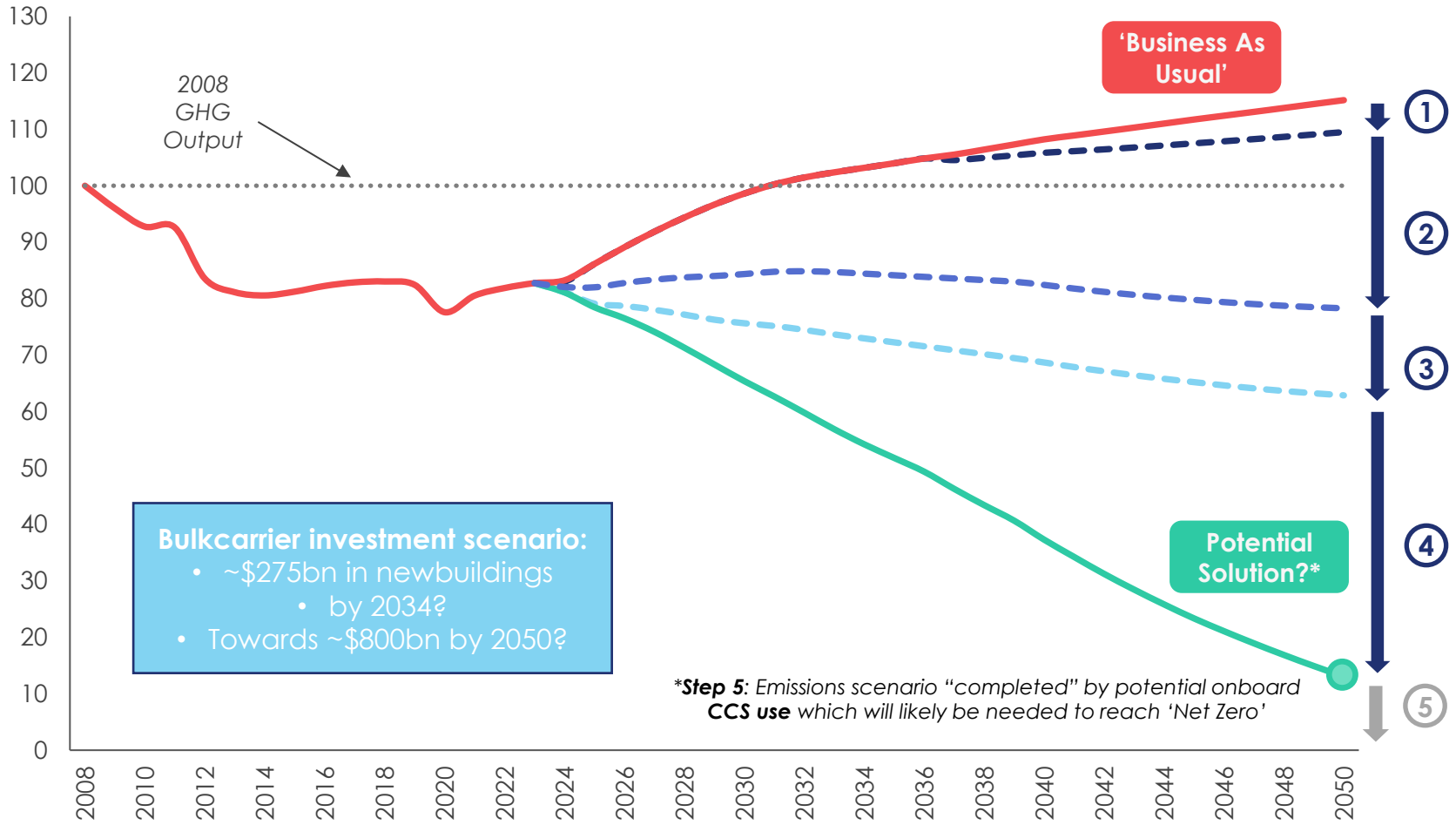


Source: Clarksons Research. October 2024. *Includes vessels pending retrofit. Data coverage is not comprehensive and may underestimate total uptake.

IMO 2050: Four Steps To A Potential Solution?

How does changing the key variables impact shipping's Greenhouse Gas (GHG) output?

Total Estimated World Fleet Greenhouse Gas Output (WTW), Index



Source: Clarksons Research. Business as usual assumes no changes to speeds and efficiency, no further alt. fuel ordering and 'base case' trade/vessel demand trends. See World Fleet Register or contact Clarksons Research for more details.

Steps To A Solution?

- **"Business As Usual" leads to clear overshoot of IMO targets (and 2008 level)**
- **Range of scenarios remain; our modelling outlines 4 key steps to one potential solution:**

Step 1 - Reduced Seaborne Trade Avg. Haul:

- *Average haul contracts by **0.5% p.a. from the mid 2030s***
- *Tonne-mile trade growth slows to "flat" by 2040s*

Step 2 - Slower Vessel Speeds:

- *Vessel **speeds fall by ~15-20%** or ~2 knots vs. 2023 by 2050*

Step 3 - Vessel Efficiency Gains with ESTs etc:

- *Oil-fuelled fleet **>90% 'eco' by 2050***
- ***Accelerating uptake of ESTs** (partly supported by IMO mid-term measures)*
- *Overall **fuel efficiency gains** of ~20-25% for oil-fuelled fleet and ~10% for LNG-fuelled fleet*
- *Continued upsizing & other efficiency gains*

Step 4 - Fleet Fuel Mix Evolution:

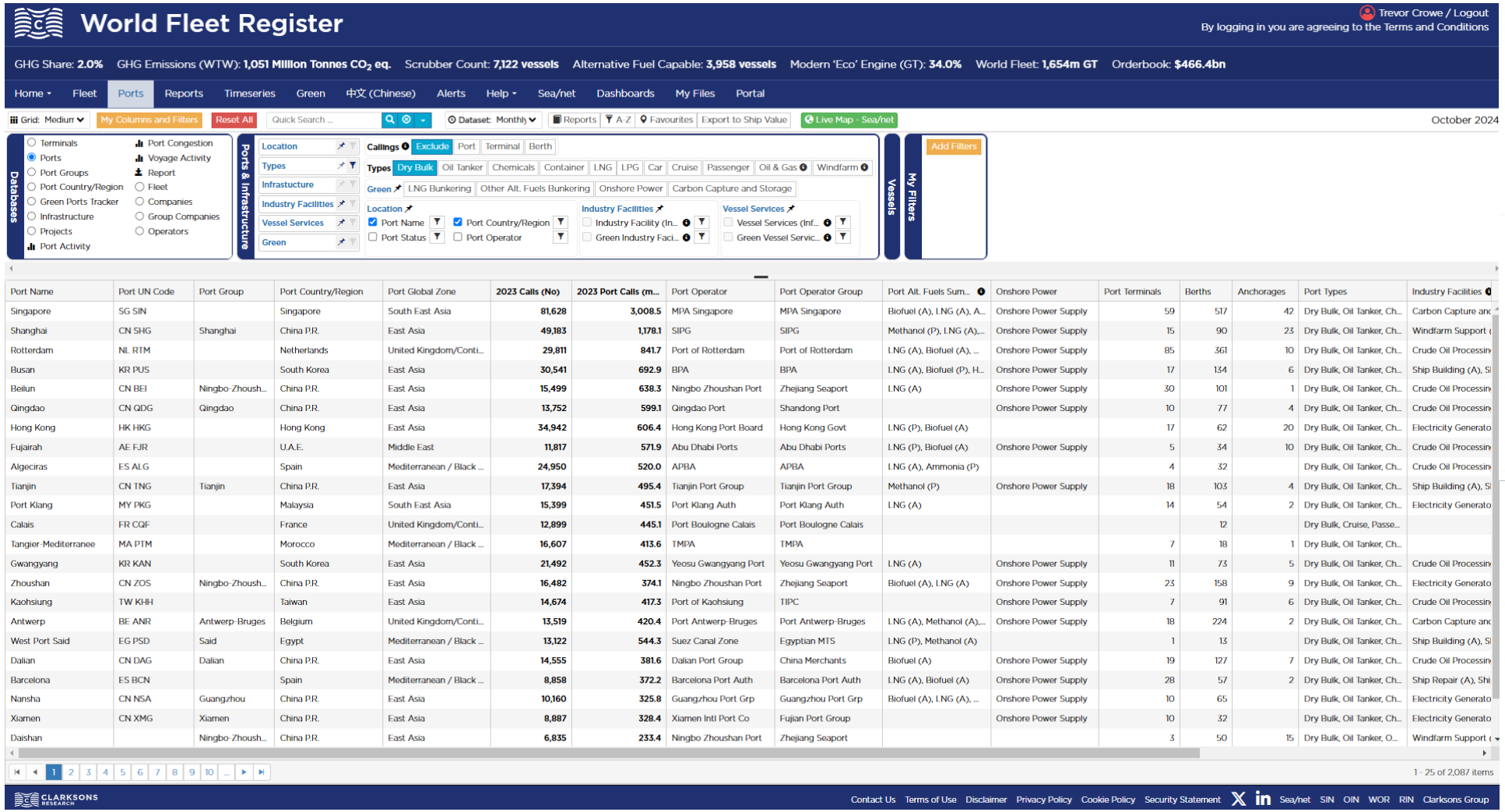
- *2050 fuel mix scenario:*
  - ***9% oil** / conventional*
  - ***24% LNG***
  - ***24% other 'Phase One'** fuels (methanol, LPG)*
  - ***43% 'Phase Two'** fuels (ammonia, hydrogen, others)*

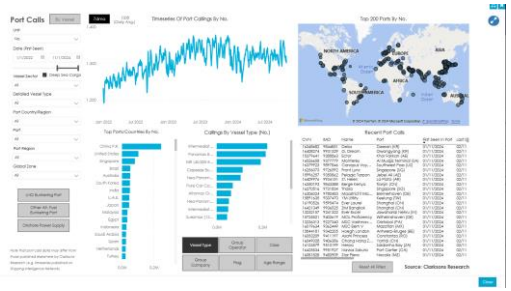
Takeaways:

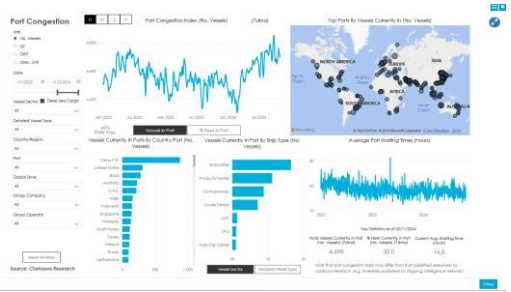
- **No one factor alone is sufficient to hit target**
- **Changes to fuel mix are essential**
- **Move to 'Well-To-Wake' targets unlocks greater potential contribution from 'green fuels'**
- **Carbon Capture & Storage (CCS) may also help to achieve Net Zero**

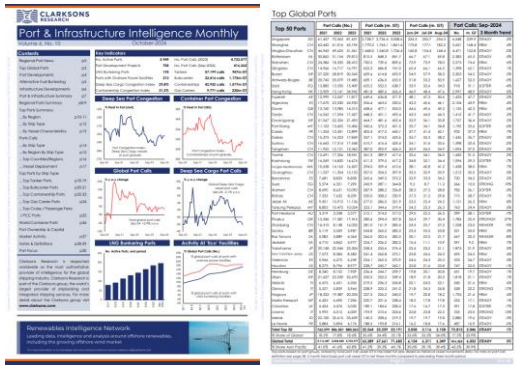
Clarksons Research Ports & Terminals Data on *World Fleet Register*

Online database of >6,000 ports, >9,000 terminals, >35,000 berths & associated infrastructure, including green facilities, callings, congestion data. Contact research.crs@clarksons.com for a demo or trial.









Dry Bulk Port Facilities – Vital To Green Transition Across Seaborne Transportation

23% of dry bulk ports have a significant 'green' facility, ports in NW Europe leading, larger ports leading investment

	Ports By Region	Bulkcarrier Port Calls 2023	Port Development Projects			LNG Bunkering		Ammonia Bunkering		Methanol Bunkering		Hydrogen Bunkering		Onshore Power"		Other 'Eco'*		% Ports With A Current Or Proposed 'Eco' Facility
	Active		U/C	Proposed	Expansion	Current	Under Devt.^	Current	Under Devt.^	Current	Under Devt.^	Current	Under Devt.^	Current	Under Devt.^	Current	Under Devt.^	
North America	**256**	26,668			60	10	6		6	3		1	3	3	1	5	8	**16%**
S&C America	**216**	30,191			22	4	1			1						2		**5%**
North West Europe	**354**	23,190			78	57	9		10	3	4	1	14	1	1	41	16	**34%**
Mediterranean	**240**	41,033		2	51	15	4		2		2			2		15	1	**14%**
Africa	**56**	8,720	1	2	19		2		1		2		3			18		**13%**
Middle East/ISC	**156**	32,186	3	2	60	2	3		3					3		32		**26%**
Asia Pacific	**803**	218,037	2	2	173	45	25	2	5	4	5		9	64	4	111	6	**28%**
DRY BULK PORTS	**2,081**	**380,025**	**6**	**8**	**463**	**133**	**50**	**2**	**27**	**11**	**13**	**2**	**29**	**73**	**6**	**224**	**31**	**23%**
Top 100	***100***	***162,926***			***60***	***15***	***9***	***1***	***6***	***4***	***2***		***7***			***46***	***2***	***85%***
Top 500	***500***	***207,563***			***210***	***59***	***20***	***2***	***18***	***6***	***11***	***1***	***18***			***109***	***13***	***52%***
Top 1,000	***1,000***	***367,252***			***344***	***104***	***33***	***2***	***23***	***11***	***13***	***2***	***21***			***151***	***21***	***36%***
ALL PORTS	***6,029***		**27**	**49**	**629**	**195**	**81**	**2**	**29**	**14**	**16**	**4**	**42**	**213**	**43**	**260**	**99**	**11%**

*Other 'Eco' includes Exhaust Gas Cleaning Systems, Ballast Water Discharge, Carbon Capture and Windfarm Support facilities.

^Under Devt. includes potential projects. Expansion specify the number of ports subject to terminal, berth and environmental facility construction or redevelopment. "Basis ports with an onshore power facility at a dry bulk terminal.

Source: Clarksons Research

Data available on World Fleet Register including "Green Port Tracker"

Tracking "Green" Dry Bulk Port & Terminal Projects

Selected and recently announced "Green" port and shoreside infrastructure projects & progress

Status	Country	Port / Location	Project Name	Project Type	FID Date	Start Date (Est.)	Project Cost (m)	Currency	Lead Company
Completed	**Australia**	**Dampier**	Dampier Ammonia Bunkering STS Trial	Ammonia Bunkering	2024	2024			Yara Clean Ammonia
Completed	**Oman**	**Sohar**	Sohar (Hormuz Marine) Biofuel TTS	Biofuel Bunkering	2024	2024			Hormuz Marine
Completed	**Netherlands**	**Rotterdam**	Rotterdam (Titan - Alice Cosulich) STS	LNG Bunkering	2023	2024			Titan
Pre-FEED	**Singapore**	**Singapore**	Singapore (TFG Marine) Methanol Bunkering STS	Methanol Bunkering	2024	2024/2025			TFG Marine
Pre-FEED	**China**	**Jinzhou**	Jinzhou Coal Terminal Onshore Power	Onshore Power	2024	2025			Jinzhou Port
Appraisal	**South Africa**	**Saldanha Bay**	Saldanha Bay Hydrogen Bunkering	Hydrogen Bunkering	2025	2025			Sasol Limited
Appraisal	**China**	**Shanghai**	SPIC Green Methanol	Methanol Production	2025	2027			COSCO, SPIC & SIPG JV
Appraisal	**China**	**Tianjin**	Tianjin Methanol Bunkering	Methanol Bunkering	2025	2027			Royal Vopak
Appraisal	**Australia**	**Newcastle**	Clean Energy Precinct	Hydrogen Production	2025	2028	100	AUD	Newcastle Port Corp
Appraisal	**Spain**	**Algeciras**	Algeciras Ammonia Plant Development	Ammonia Production	2025	2027	1,000	EUR	CEPSA
Pre-FEED	**Australia**	**Gladstone**	H2-Hub Gladstone	Hydrogen & Ammonia Production	2026	2029	4,700	AUD	Hydrogen Utility (H2U)
Appraisal	**Netherlands**	**Amsterdam-IJmuiden**	Amsterdam-IJmuiden CO2 Transport Hub & Offshore Storage (Athos) – Onshore Capture	Carbon Capture	2028	2030			Athos JV

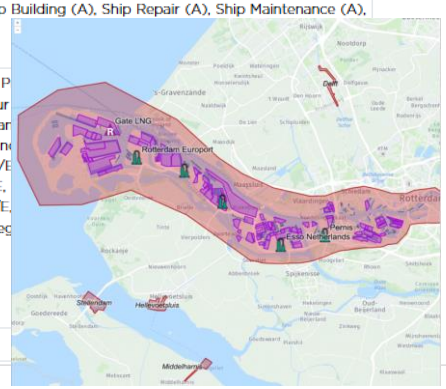
Source: Clarksons Research, October 2024

Clarksons Research Port Database – Port Profiles on *World Fleet Register*

Detailed information on port, infrastructure, commercial details, callings, green facilities…

Port Profile > Rotterdam, Netherlands Port Calls (Last 12 Months) 815.0m GT

Port Summary	
Port CVN	32403378
Port Name	Rotterdam
Port UN Code	NL RTM
Country/Region	Netherlands
Global Zone	United Kingdom/Continent
Group Operator	Port of Rotterdam
Operator	Port of Rotterdam
Website	https://www.portofrotterdam.com
Email	info@portofrotterdam.com
Phone	+31 10 252 1010
Address	World Port Center (WPC), Wilhelminakade 909, 3072 AP, Rotterdam, Netherlands
Alternative Fuels	LNG (A), Biofuel (A), Methanol (A), Ammonia (P), Hydrogen (P) *A = Active, UC = Under Construction, P = Potential*
Vessel Services	**Green:** Methanol Bunkering STS (A), LNG Bunkering TTS (A), LNG Bunkering STS (A), LNG Bunkering Terminal (A), LNG Bunkering (P), Ammonia Bunkering STS (P), Ammonia Bunkering (P), Hydrogen Bunkering (P), Biofuel Bunkering STS (A), Biofuel Bunkering (A), Onshore Power Supply (A), Ballast Water Discharge (A), Exhaust Gas Cleaning Systems (A) **Other:** Container (A), Passenger (A), RoRo (A), Stacking (A), General Cargo (A), Cruise (A), Ship Recycling (A), Towage Services (UC) *A = Active, UC = Under Construction, P = Potential*
Industry Facilities	Crude Oil Processing (A), Electricity Generator (A), Ship Building (A), Ship Repair (A), Ship Maintenance (A), Ship to Ship Transfer (A) *A = Active, UC = Under Construction, P = Potential*
Commodities	**Crude Oil and Oil Products I/E** (Crude Oil I/E, Oil P Fuel/Kerosene I/E, Gas Oil (Diesel) I/E, Ultra Low Sulphur **Dry Bulk I/E** (Iron Ore I, Coal I, Grain I, Agribulks I, Raw ar Bauxite I, Minerals I/E, Petroleum Coke I, Steelmaking Min **Gas I/E** (LPG + Petrochemical Gases I/E, LPG I/E, LNG I/E **Chemicals I/E** (Organic I/E, Asphalt and Bitumen I/E, Toluene I/E, Cyclic Hydrocarbons E, Other Aromatics I/E, and Other Fats I/E, Soybean Oil E, Palm Oil I/E, Other Veg **Vehicles I/E** (Cars I/E) **Reefer Cargoes** **Other Liquid Cargoes I** (Fruit Juice I) *I = Import, E = Export*
Berths (No.)	361



Associated Infrastructure

Anchorages, Berths and Terminals | Green Linked Infrastructure | Other

Infrastructure Name	Status	Startup Year	Infrastructure Type	Operator	Group Operator	Linked Port
ADM Europoort	Active	2016	Port Terminal	A.D.M.	A.D.M.	Rotterdam
AKZO Nobel Rotterdam	Active	2016	Port Terminal	AKZO Nobel Rotter	AkzoNobel	Rotterdam
Alco Energy Rotterdam B.V.	Active	2017	Port Terminal	Alco Energy	Alco Energy	Rotterdam
Almatis	Active	2017	Port Terminal	Almatis	Almatis	Rotterdam
Aluchemie	Active	2016	Port Terminal	Aluchemie	Rio Tinto Group	Rotterdam
APM Terminals Maasvlakte II	Active	2016	Port Terminal	APM Maasvlakte II	A.P. Moller	Rotterdam
Boskalis	Active	2005	Port Terminal	Baggermaat Boskalis	Boskalis	Rotterdam
Barge Center Waalhaven	Active	2016	Port Terminal	Barge Center	Waalhaven Group	Rotterdam
Borax Rotterdam	Active	2016	Port Terminal	Borax Rotterdam	Rio Tinto Group	Rotterdam
Broekman Distriport BV	Active	2016	Port Terminal	Broekman Distriport	CLdN Group	Rotterdam
BSR Van Uden Stevedoring	Active	2017	Port Terminal	BSR VUS	BSR VUS	Rotterdam
Steinweg Hartel Terminal	Active	2017	Port Terminal	C. Steinweg Group	C. Steinweg Group	Rotterdam
Cargill Botlek	Active	2016	Port Terminal	Cargill	Cargill	Rotterdam
Chemtrade Terminal	Active	2017	Port Terminal	ChemTrade	ChemTrade	Rotterdam
C. RO Ports Automotive Rotterdam	Active	2017	Port Terminal	CLdN Ports	CLdN Group	Rotterdam
DFDS Seaways Rotterdam	Active	2017	Port Terminal	DFDS Seaways	DFDS	Rotterdam
Dutch Trading Consortium	Active	2017	Port Terminal	DTR	DTR	Rotterdam
EMO	Active	2016	Port Terminal	E.M.O.	HES International	Rotterdam
EP Stevedoring	Active		Port Terminal	E.P. Stevedoring	E.P. Stevedoring	Rotterdam
EBS Botlek	Active	2016	Port Terminal	EBS	HES International	Rotterdam

1 2 3 4 5 6 7 8 9 10 …

Port Calls by Year

Year	Callings (No.)	Callings (m GT)
2016	30,008	725.03
2017	31,435	799.46
2018	31,347	817.37
2019	31,567	834.07
2020	30,084	801.44
2021	30,862	815.50
2022	31,154	848.31
2023	29,812	841.75
2024*	22,037	609.51

Recent Port Calls

Vessel Name	Vessel Type	GT	DWT	Spec. Value	Spec. Unit	First Received	Last Received	Duration (Hours)
Rich Azure	Bulkcarrier	36,128	64,452	64,452	DWT	2024-11-02	2024-11-03	3
ESL America	Multipurpose	12,936	17,349	17,349	DWT	2024-11-02	2024-11-03	3.9
Hendrika Margaretha	Multipurpose	2,058	3,200	3,200	DWT	2024-11-02	2024-11-03	3.8
DHT Amazon	Crude Tanker	160,928	318,130	318,130	DWT	2024-11-02	2024-11-03	4
Sigrid Theresa	Chemical Tanker	5,744	8,140	8,140	DWT	2024-11-02	2024-11-03	5
Seraphine	RoRo	50,455	20,092	5,400	Lane m.	2024-11-02	2024-11-03	5
Panda 002	Containership	7,852	9,322	803	TEU	2024-11-02	2024-11-03	6
Nordic Sola	Chemical Tanker	2,613	4,054	4,054	DWT	2024-11-02	2024-11-03	5.7
Eleonora	Multipurpose	4,842	6,250	6,250	DWT	2024-11-02	2024-11-03	6.7
Ever Living	Containership	99,946	104,652	8,508	TEU	2024-11-02	2024-11-03	6.8
Weco Madeleine	Chemical Tanker	28,326	49,708	49,708	DWT	2024-11-02	2024-11-03	6.9
Pan Regina	Bulkcarrier	36,025	63,243	63,243	DWT	2024-11-02	2024-11-03	8
Multratug 36	Tug	447	225	6,862	HP	2024-11-02	2024-11-03	7.9
Bartok	Chemical Tanker	2,974	4,114	4,114	DWT	2024-11-02	2024-11-03	8
Stellata	Products Tanker	57,997	109,990	109,990	DWT	2024-11-02	2024-11-03	8.9

Clarksons Research Port Database – Port Profiles on *World Fleet Register*

Green facilities, green port activity, also "Green Port Tracker"

Green Linked Facilities

Vessel Services

Infrastructure Name	Facility Type	Facility Sub Type	Status	Infrastructure Type	Startup Year	Operator	Group Operator	Linked Port
Rotterdam	Ammonia Bunkering	STS	Potential	Port	2027	North Ammonia (Facility)	North Ammonia (Facility)	Rotterdam
VTTI Euro Tank Terminal...	Ammonia Bunkering		Potential	Port Terminal	2025	ETT (Port Terminal)	ETT (Port Terminal)	Rotterdam
Holland Amerikakade	Biofuel Bunkering		Active	Berth	2022			Rotterdam
EECV West	Biofuel Bunkering		Active	Berth	2021	Goodfuels (Facility)	Goodfuels (Facility)	Rotterdam
2784-2790	Biofuel Bunkering	STS	Active	Berth	2021	Shell PLC (Facility)	Shell PLC (Facility)	Rotterdam
Rotterdam	Biofuel Bunkering		Active	Port	2021	BP (Facility)	BP (Facility)	Rotterdam
Rotterdam	Biofuel Bunkering		Active	Port	2022	TFG Marine (Facility)	TFG Marine (Facility)	Rotterdam
Rotterdam	Biofuel Bunkering		Potential	Port	2025	TFG Marine (Facility)	TFG Marine (Facility)	Rotterdam
Rotterdam	Hydrogen Bunkering		Potential	Port	2025	Port of Rotterdam (Faci...	Port of Rotterdam (Faci...	Rotterdam
Palen 83	LNG Bunkering	STS	Active	Berth	2019	Anthony Veder (Facility)	Anthony Veder (Facility)	Rotterdam

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Vessel Services

Infrastructure Name	Facility Type	Facility Sub Type	Status	Infrastructure Type	Startup Year	Operator	Group Operator	Linked Port
Rotterdam	LNG Bunkering	STS	Potential	Port	2026	Titan (Facility)	Titan (Facility)	Rotterdam
Rotterdam	LNG Bunkering	TTS	Active	Port	2011	Vopak (Facility)	Vopak (Facility)	Rotterdam
Rotterdam	LNG Bunkering	Terminal	Active	Port	2013	Vopak (Facility)	Vopak (Facility)	Rotterdam
Vopak Terminal Europo...	LNG Bunkering	STS	Active	Port Terminal	2020	Vopak Europoort (Facili...	Vopak (Facility)	Rotterdam
8400-8410	Methanol Bunkering	STS	Active	Berth	2023	Equinor (Facility)	Equinor (Facility)	Rotterdam
8168-8176	Methanol Bunkering	STS	Active	Berth	2024	OCI Global (Facility)	OCI Global (Facility)	Rotterdam
8400-8410	Methanol Bunkering	STS	Active	Berth	2023	OCI Global (Facility)	OCI Global (Facility)	Rotterdam
No. 355	Onshore Power Supply		Potential	Berth	2026			Rotterdam
Holland Amerikakade	Onshore Power Supply		Construction	Berth	2024	CPSP (Facility)	CPSP (Facility)	Rotterdam
2200-2202	Onshore Power Supply		Active	Berth	2023	Rotterdam Shore JV (F...	Rotterdam Shore JV (F...	Rotterdam

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Green Vessel Callings Trends

SOx Scrubbers | LNG Capable | HVSC | Eco Main Engine | Alternativ

Year	Count (No.)	Total GT (m GT)	% of calls (% GT)
2016	1,389	40.2	5.5
2017	2,274	86.0	10.8
2018	2,732	99.8	12.2
2019	3,088	126.0	15.1
2020	4,123	225.7	28.2
2021	4,802	276.7	34
2022	5,265	316.6	37.3
2023	5,729	337.2	40.1
2024*	4,956	269.4	44.2

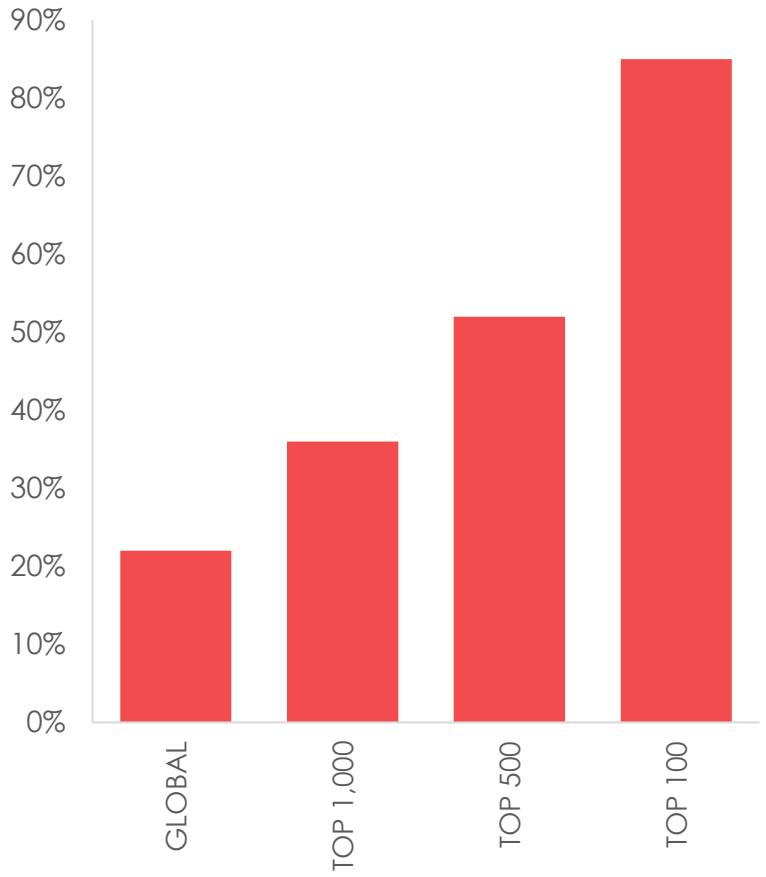
SOx Scrubbers | LNG Capable | HVSC | Eco Main Engine | Alternati

Year	Count (No.)	Total GT (m GT)	% of calls (% GT)
2016	147	7.7	1.1
2017	189	8.9	1.1
2018	346	15.0	1.8
2019	489	22.1	2.6
2020	579	24.8	3.1
2021	769	39.9	4.9
2022	871	53.2	6.3
2023	948	58.4	6.9
2024*	845	49.3	8.1

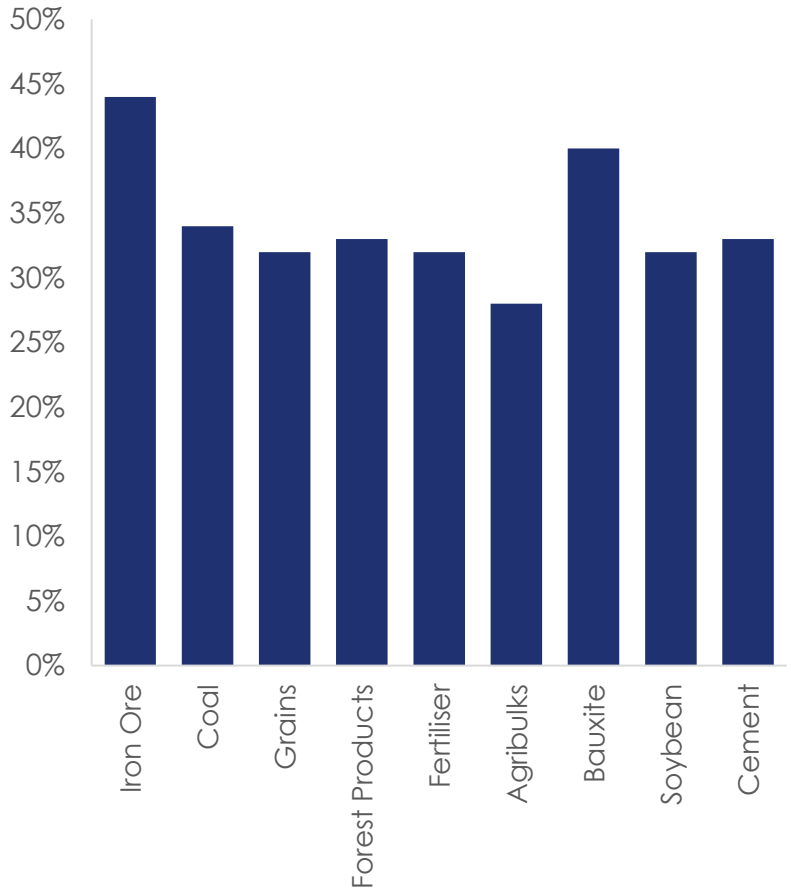
Tracking Green Investment At The World's Dry Bulk Ports

Tracking the progress of "green facilities" – for more details see our "Green Port Tracker"

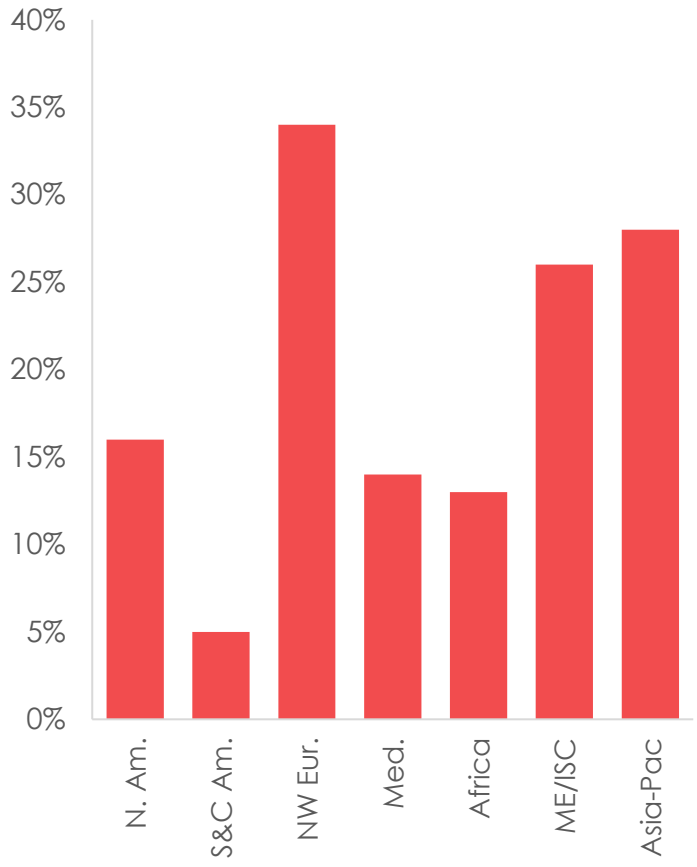
~20% of total Dry Bulk ports have a significant active or proposed "green facility"…



… with greater progress at ports serving some of the major sectors…



…most significant progress at ports in Asia-Pacific, NW Europe and ME/ISC

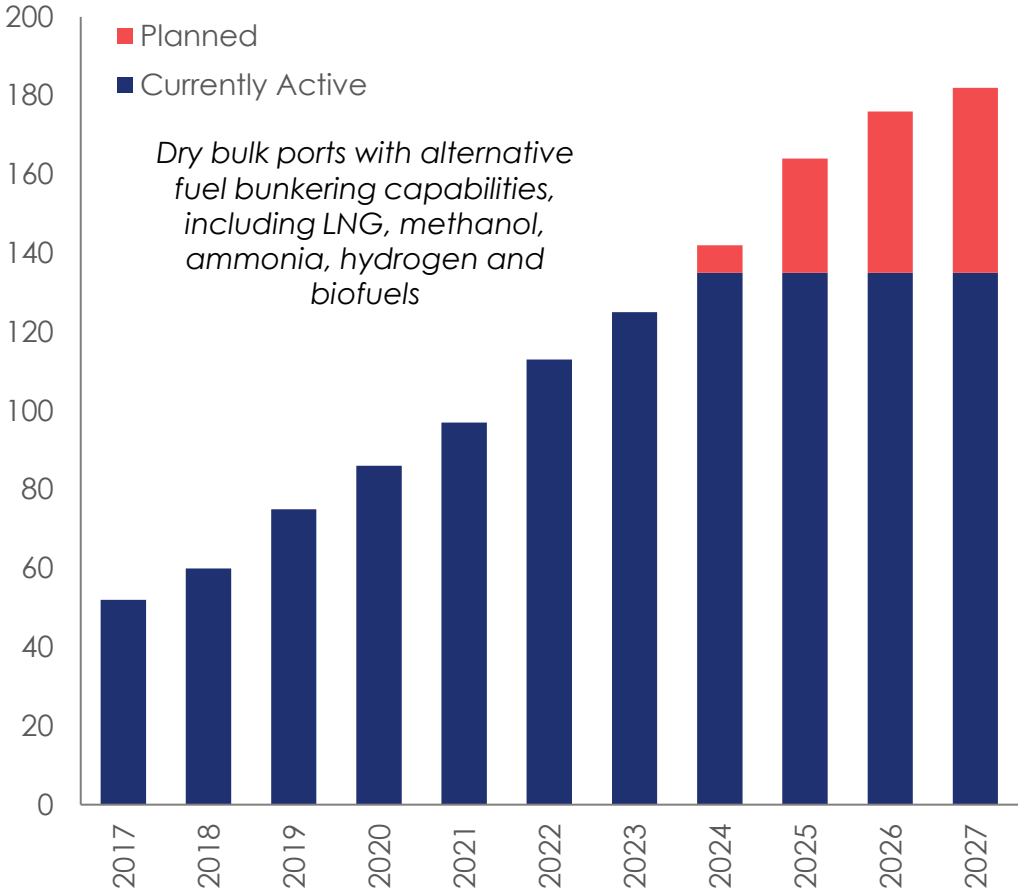


Source: Clarksons Research. Data as of October 2024. *Green facilities have been defined here as alternative fuel bunkering, onshore power, exhaust gas cleaning systems, ballast water discharge, carbon capture or windfarm support.

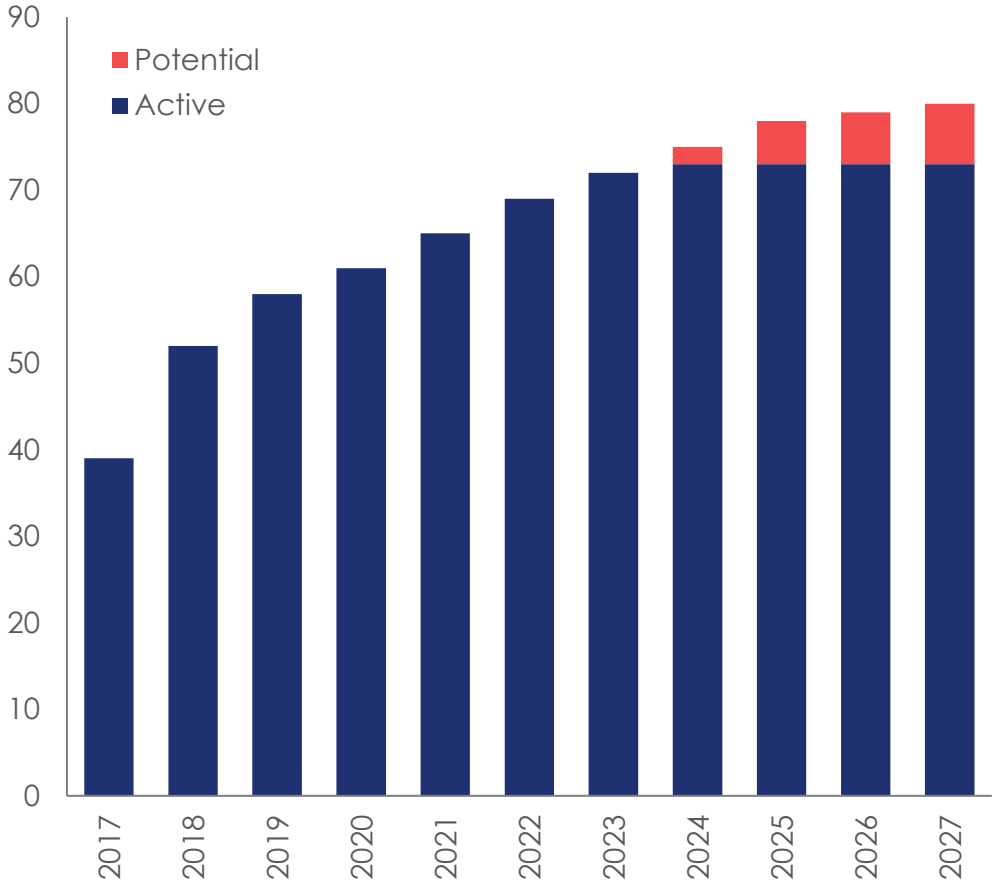
Dry Bulk Ports – Development Of Alternative Fuel Bunkering & Onshore Power Facilities

By 2026, number of dry bulk ports with alternative fuel bunkering facilities will have doubled compared to 2021…

Number of Dry Bulk Ports Globally with Alternative Fuel Bunkering Capabilities



Number of Ports Globally with Onshore Power Capabilities at Dry Bulk Terminals

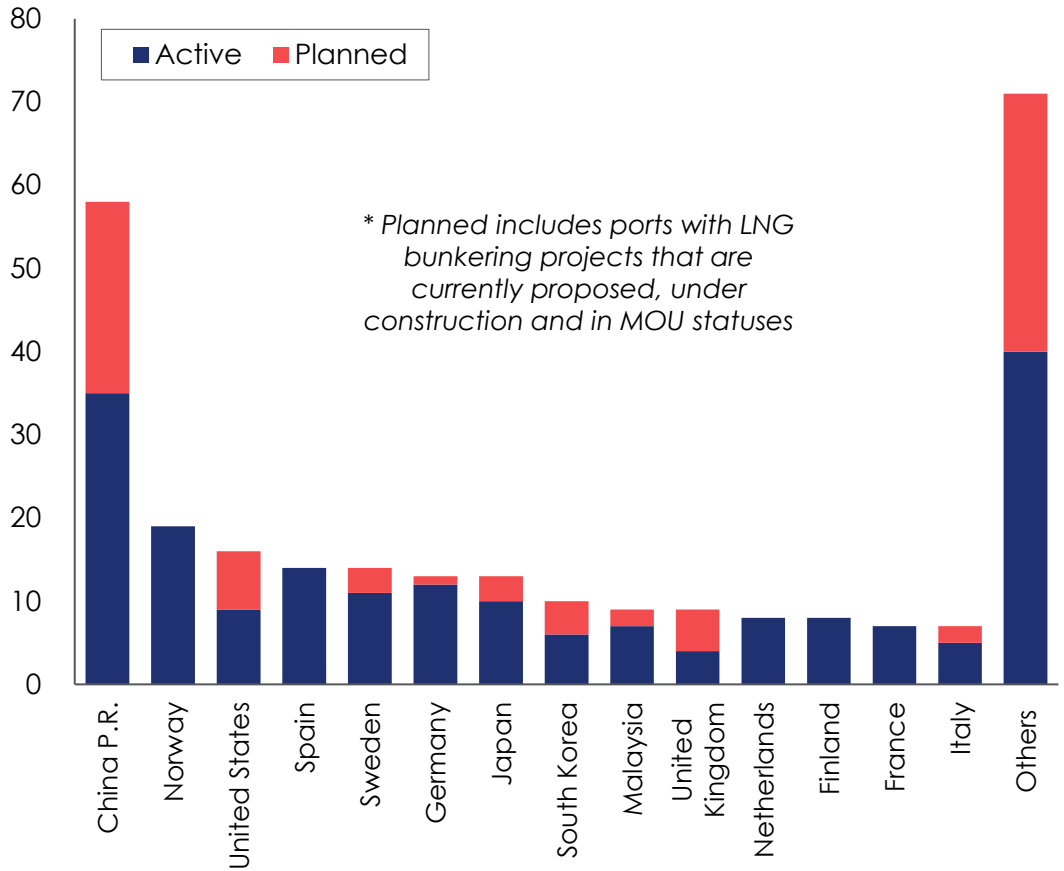


Source: Clarksons Research. October 2024.

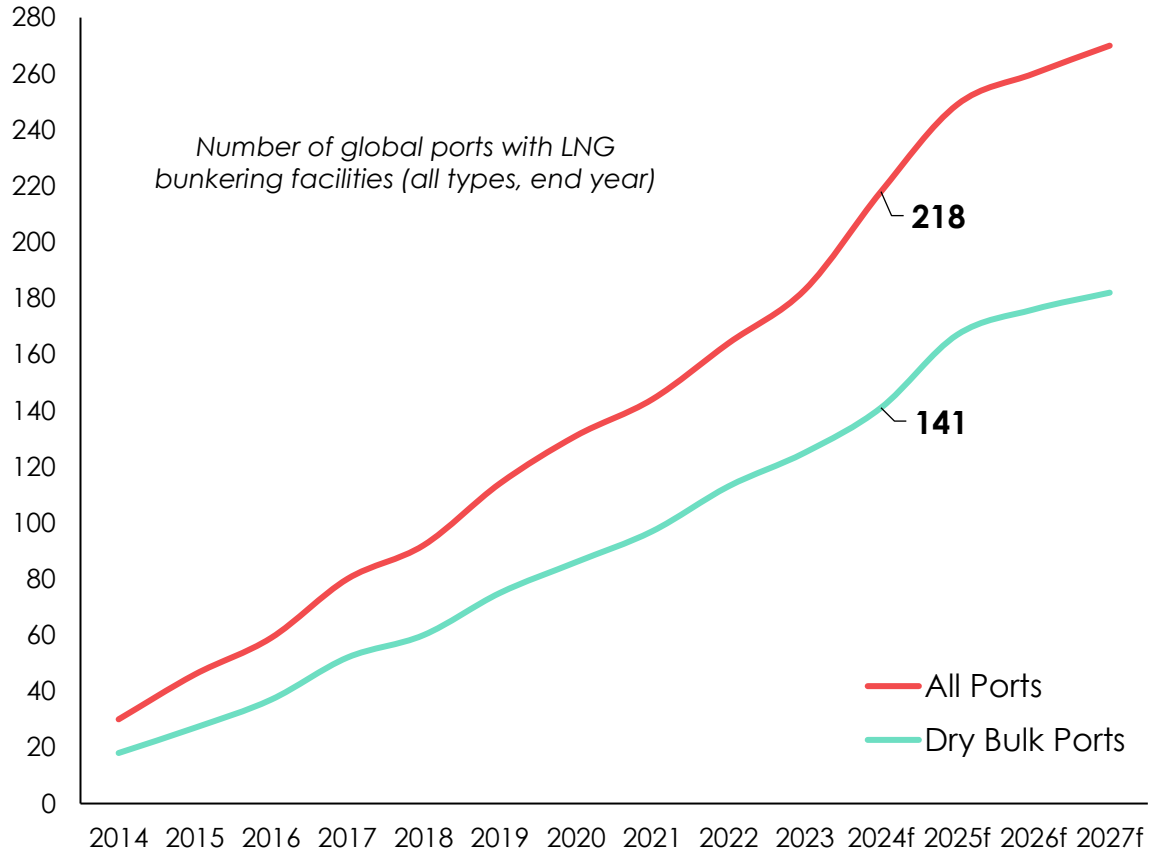
LNG: Bunkering Port Development

Over 200 active and planned LNG bunkering locations across all ship types

Number Of LNG Bunkering Ports By Country



Global Active LNG Bunkering Ports



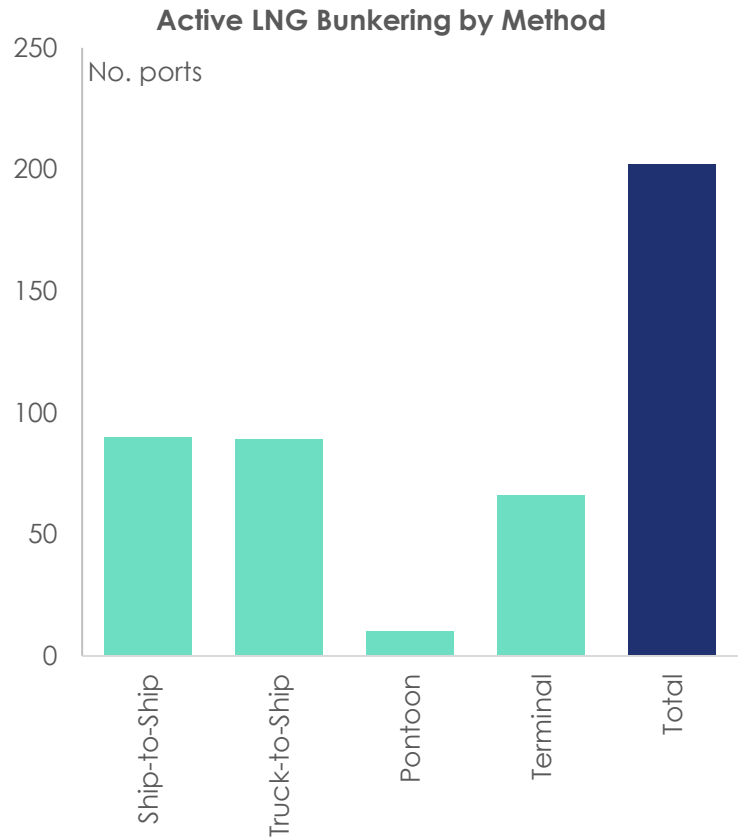
Source: Clarksons Research. Data as of September 2024.

Estimated number of active ports from 2024 onwards basis current data on scheduled start-up dates of planned LNG bunkering facilities.

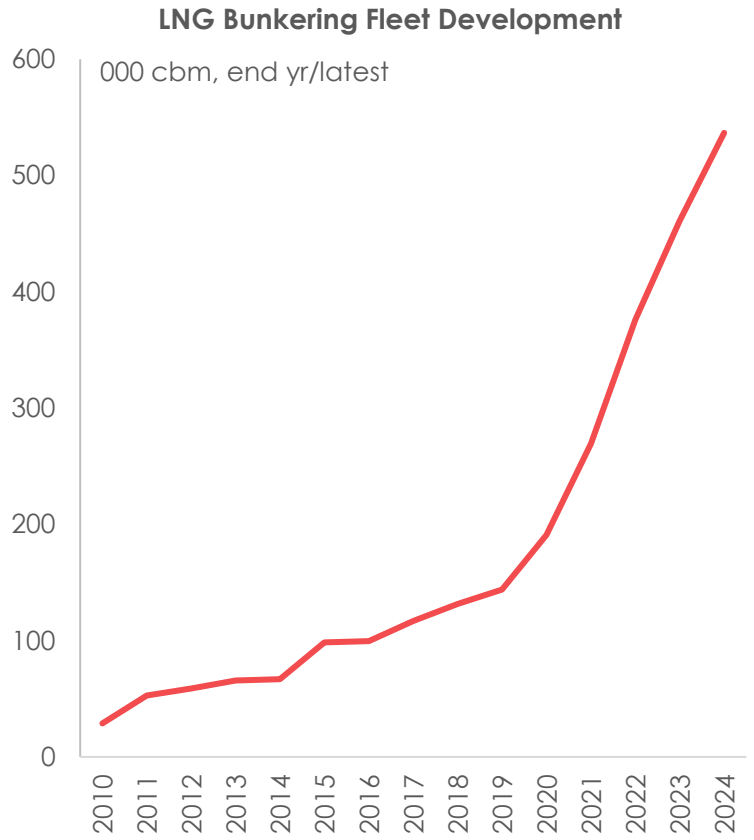
LNG: Bunkering Unit Deployment

LNG bunkering activity concentrated in Europe but increasing in Asia and North America

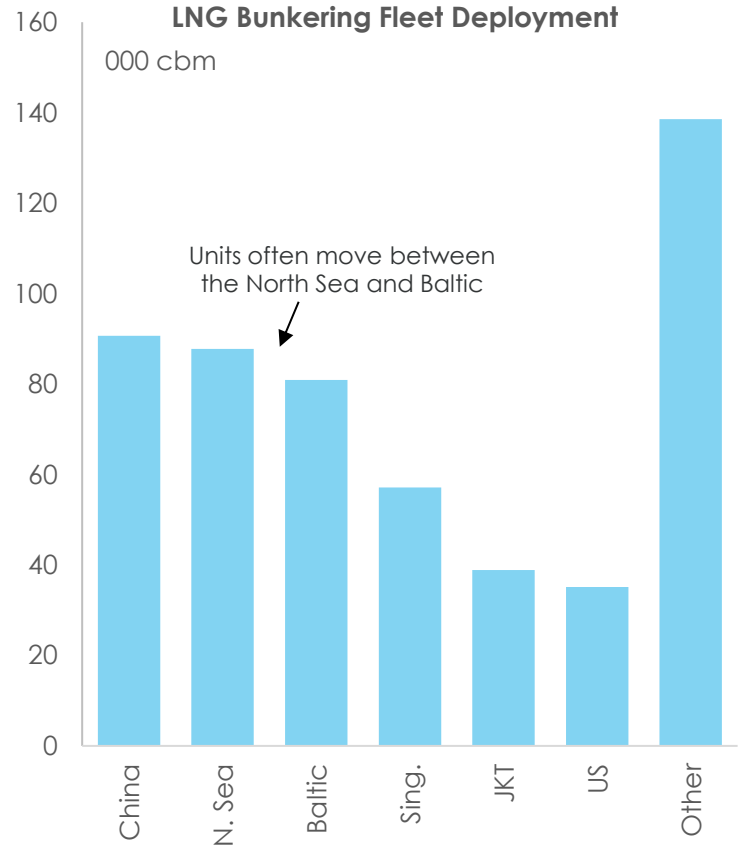
Ship-to-Ship and Truck-to-Ship the most popular method for LNG bunkerings



LNG bunkering capable fleet hit 73 units of 537k cbm worldwide by Sep-24, with some ports sharing units



Bunkering tankers currently concentrated in Europe and Asia, with barges more common in China



Source: Clarksons Research. Multiple LNG bunkering methods in operation at some ports. Fleet deployment basis unit main port of call during Aug-Sep 2024.

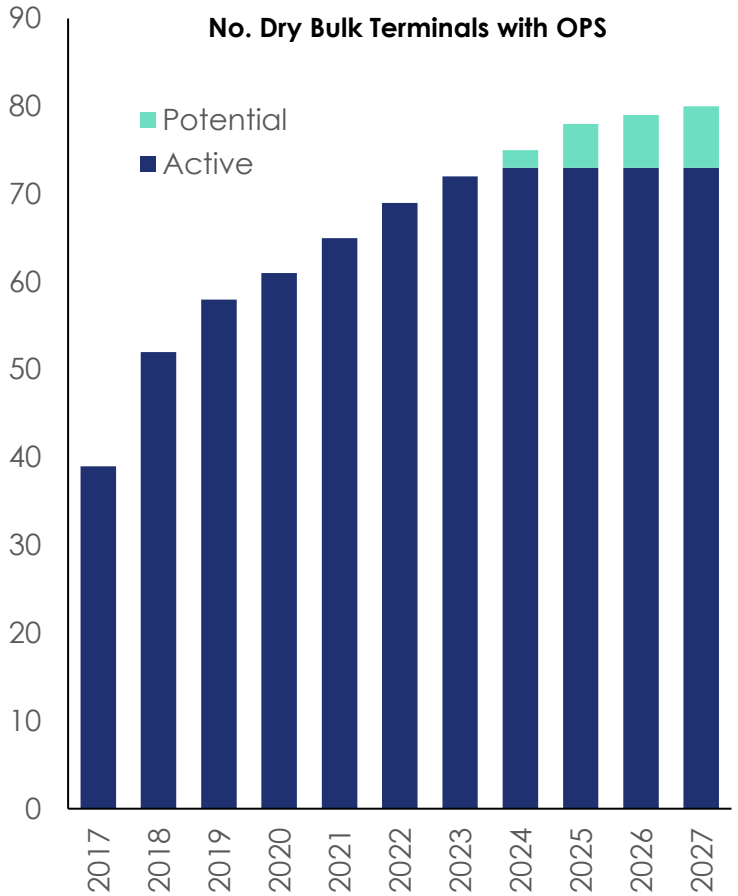
Onshore Power Connections (OPS)

Uptake of technology at ship and port level progressing but less notable focus than in other sectors

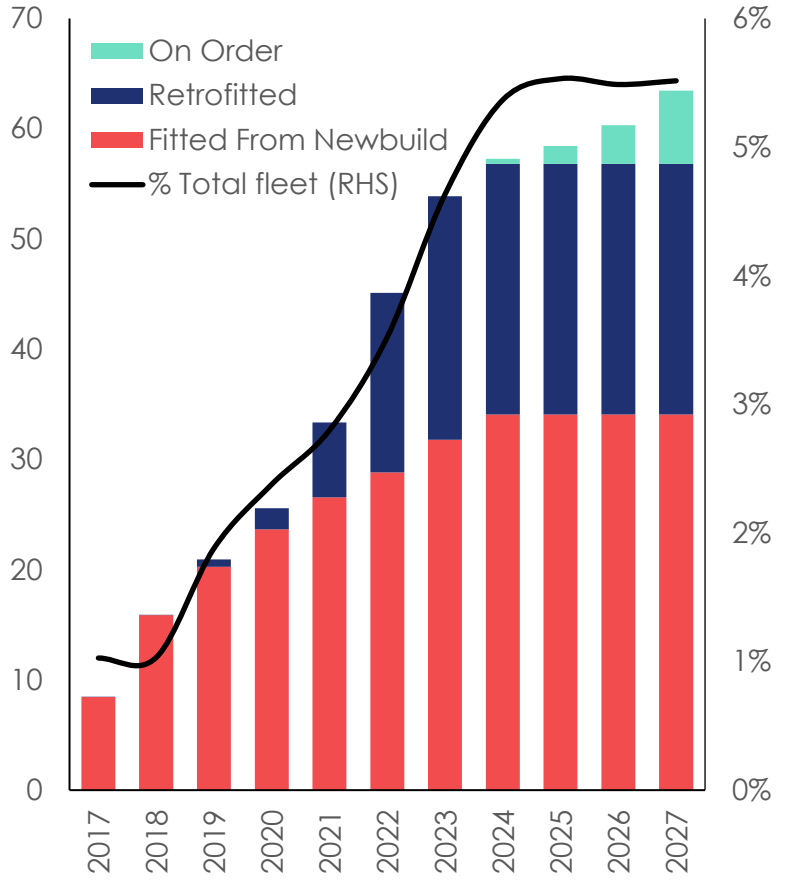
Over 70 ports now have dry bulk terminals with Onshore Power Connections, mostly in China…

Port Country/ Region	No. Dry Bulk Terminals With OPS	
	Active	*Proposed*
China	60	4
Europe	4	1
ISC	3	
US	2	1
Australia	2	1
Singapore	1	
Canada	1	
Indonesia	1	
Total Dry Bulk	**73**	**9**

A notable increase in recent years, but much less activity so far than liner/pass. shipping…



OPS-Fitted Bulkcarrier Fleet Development, m. dwt end year* (now 5% of fleet GT)…

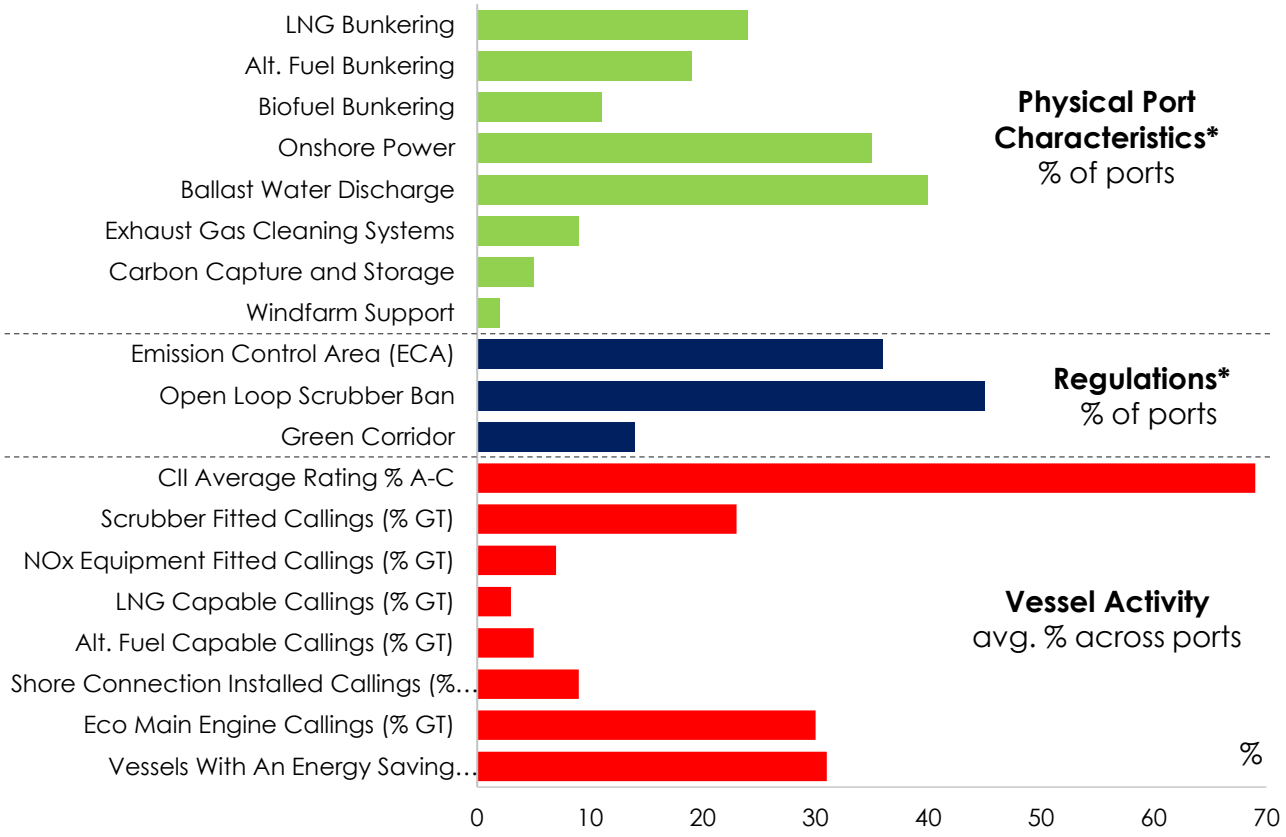


Source Clarksons Research.

Green Port Tracker – Dry Bulk Ports

Tracking investment in green facilities and measuring green vessel activity at ports

Green Port Tracking – Top 100 Dry Bulk Ports (By GT Callings 2023)



World Fleet Register 'Green Port Tracker'…

Gr...	Green Port Name	Green Port C...	Port Group Alt. Fu...	LNG Bunkering...	Alt. Fuels (Excl. LNG)...	Biofuel Bunkering ...	Onshore Power ...	Ballas
1	Shanghai	China P.R.	LNG (A), Methanol (A...	Active	Active		Active	Active
2	Shenzhen	China P.R.	LNG (A), Biofuel (A)	Active	Active	Active	Active	Active
3	Ningbo-Zhoush...	China P.R.	LNG (A), Biofuel (A)	Active	Active	Active	Active	Active
4	Dalian	China P.R.	Biofuel (A)		Active	Active	Active	Active
5	Antwerp-Bruges	Belgium	LNG (A), Biofuel (A), ...	Active	Active	Active	Active	Active
6	Guangzhou	China P.R.	Biofuel (A), LNG (A), ...	Active	Active	Active	Active	Active
7	Rotterdam	Netherlands	LNG (A), Biofuel (A), ...	Active	Active	Active	Active	Active
8	Amsterdam	Netherlands	LNG (A), Biofuel (A), ...	Active	Active	Active	Active	Active
9	Singapore	Singapore	Biofuel (A), LNG (A), ...	Active	Active	Active	Active	Active
10	Tallinn	Estonia	LNG (A), Hydrogen (P)	Active	Potential		Active	
11	Xiamen	China P.R.	Biofuel (A)		Active	Active	Active	Active
12	Barcelona	Spain	LNG (A), Biofuel (A)	Active	Active	Active	Active	Active
13	Hamburg	Germany	LNG (A), Ammonia (P)	Active	Potential		Active	Active
14	Yantai	China P.R.	LNG (A)	Active			Active	Active
15	Zhenjiang	China P.R.	LNG (A)	Active			Active	Active
16	Wilhelmshaven	Germany	LNG (A)	Active				Active
17	Gothenburg	Sweden	LNG (A), Methanol (A...	Active	Active	Active	Active	
18	Tianjin	China P.R.	Methanol (P)		Potential		Active	Active
19	Nantong	China P.R.					Active	Active
20	Helsinki	Finland	LNG (A)	Active			Active	
21	Le Havre	France	LNG (A), Biofuel (A)	Active	Active	Active	Construction	
22	Eemshaven	Netherlands	LNG (A)	Active				Active
23	Jiangmen	China P.R.	LNG (A)	Active				Active
24	Southampton	United Kingd...	LNG (A)	Active			Active	Active
25	Kokkola	Finland	LNG (A)	Active				Active
26	Ghent	Belgium	LNG (A), Biofuel (P)	Active	Potential	Potential	Active	
27	Hong Kong	Hong Kong	LNG (P), Biofuel (A)	Potential	Active	Active		Active
28	Busan	South Korea	LNG (A), Biofuel (P), ...	Active	Potential	Potential	Active	Active
29	Hirtshals	Denmark	LNG (A)	Active	Potential			
30	Wenzhou	China P.R.					Active	

*Includes active and planned facilities and active or planned regulatory areas/green corridors.

Selected Top Dry Bulk Ports – "Green Port Tracking" Profiles

Selected leading dry bulk ports and selected green criteria; search, sort, and rank…

Selected Ports	Country	Total Bulker Port Calls 2023 (m. GT)	Alternative Fuel Bunkering	Onshore Power Supply	CII 2023 Target Year A-C Rated (% GT)	Alt. Fuel Capable Callings (% GT)	Onshore Power Installed Callings (% GT)	Scrubber Fitted Callings (% GT)	NOx Equipment Fitted Callings (% GT)	Eco Main Engine Callings (% GT)	Vessels with an Energy Saving Technology (% GT)
Singapore	**Singapore**	928.4	Active	Active	70%	12%	9%	39%	13%	42%	44%
Shanghai	**China**	592.9	Active	Active	63%	3%	17%	15%	6%	27%	24%
Ningbo-Zhoushan	**China**	468.5	Active	Active	54%	12%	22%	36%	11%	37%	41%
Tangshan	**China**	379.7		Active	60%	5%	19%	20%	7%	29%	27%
Suzhou	**China**	317.4		Active	63%	3%	16%	16%	8%	31%	26%
Port Hedland	**Australia**	314.1	Potential		79%	5%	2%	47%	15%	49%	51%
Newcastle	**Australia**	105.9	Potential		85%	1%	3%	29%	11%	43%	39%
Port Walcott	**Australia**	105.2			78%	8%	0%	36%	15%	44%	50%
Ponta Da Madeira	**Brazil**	88.5			74%	39%	25%	88%	11%	57%	68%
Santos	**Brazil**	77.2			72%	3%	16%	32%	9%	37%	35%
Hay Point	**Australia**	67.5			85%	2%	3%	36%	11%	45%	45%
Vancouver	**Canada**	60.9	Active	Active	79%	2%	22%	44%	8%	36%	45%
Saldanha Bay	**South Africa**	55.9	Potential		80%	7%	0%	33%	14%	42%	49%
Richards Bay	**South Africa**	54.6			80%	2%	2%	23%	6%	32%	39%
Rotterdam	**Netherlands**	54.4	Active	Active	54%	17%	18%	44%	17%	38%	42%
Busan	**South Korea**	44.4	Active	Active	52%	17%	25%	42%	13%	41%	41%
Visakhapatnam	**India**	38.4			66%	3%	3%	14%	6%	22%	30%
Antwerp-Bruges	**Belgium**	18.8	Active	Active	49%	23%	16%	34%	9%	40%	40%
Amsterdam	**Netherlands**	16.7	Active	Active	83%	5%	10%	31%	18%	34%	32%
Hamburg	**Germany**	16.3	Active	Active	40%	19%	28%	44%	8%	38%	50%

Source: Clarksons Research. Alternative fuel bunkering includes LNG.

"Green Port Tracking"

Tracking progress on "green" criteria vital to assess progress in role of ports in Green Transition

"Green Port Tracking" Criteria	Category	All Dry Bulk Ports	Top 100 Dry Bulk Ports	Top 50 Eur. Dry Bulk Ports
LNG Bunkering	Port Facilities (% of ports with)	9%	**48%**	68%
Other Alternative Fuel Bunkering		4%	**33%**	30%
Biofuel Bunkering		1%	**18%**	20%
Onshore Power		10%	**59%**	54%
Ballast Water Discharge		7%	**42%**	20%
Exhaust Gas Reception		1%	**14%**	14%
Carbon Capture / Storage		2%	**6%**	20%
Windfarm Support		2%	**6%**	10%
Emission Control Area (ECA)	Regulations & Policies (% of ports in/with)	35%	**64%**	80%
Open Loop Scrubber Ban		26%	**51%**	52%
Green Corridor		2%	**23%**	32%
CII Average Rating % A-C	Vessel Port Call Activity (% of calls in GT in last 12 months, avg. age of vessel calls)	64%	**60%**	54%
Average Age		18.5	**15**	18
Scrubber Fitted Callings (% GT)		20%	**32%**	36%
NOx Equipment Fitted Callings (% GT)		9%	**10%**	12%
LNG Capable Callings (% GT)		7%	**5%**	9%
Alt. Fuel Capable Callings (% GT)		8%	**11%**	19%
Shore Connection Installed Callings (% GT)		10%	**17%**	22%
'Eco' Main Engine Callings (% GT)		24%	**28%**	20%
Vessels With An Energy Saving Technology (% GT)		23%	**34%**	33%

Also other criteria: green energy projects, decarbonising handling and other terminal services, streamlining activity…

Source: Clarksons Research.

Funding The Transition

Lenders are coming under increasing pressure to decarbonise their shipping portfolios

Poseidon Principles

"The Poseidon Principles offer a framework for integrating climate considerations into lending decisions to promote international shipping's decarbonisation."

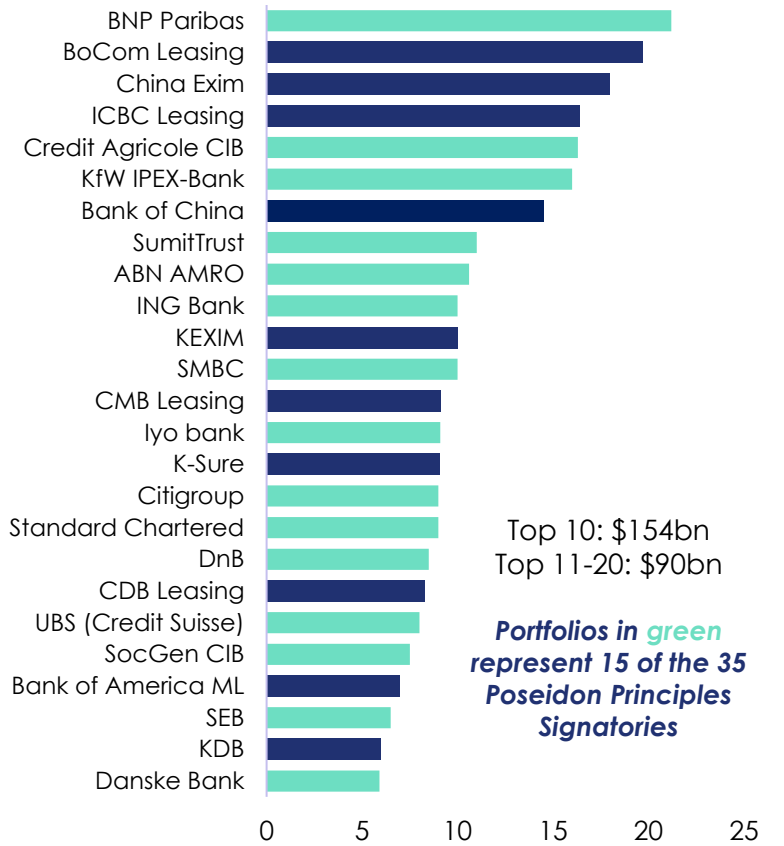
Principle One ASSESSMENT:
PP Signatories will measure the carbon intensity and assess climate alignment of their shipping portfolios. PP uses carbon intensity relative to decarbonisation trajectories to measure climate alignment.

Principle Two ACCOUNTABILITY:
Signatories of the Poseidon Principles commit to using data types, sources, standards and service providers established by the IMO to calculate their shipping portfolio's climate alignment.

Principle Three ENFORCEMENT:
Signatories will agree to work with clients & partners to covenant the provision of necessary information to calculate carbon intensity and climate alignment. The standardised covenant clause is recommended, but not compulsory.

Principle Four TRANSPARENCY:
PP Signatories must publicly acknowledge they have signed the PP, report the climate alignment on of their shipping portfolios to the PP Secretariat & to institute reports on an annual basis.

Leading Maritime Portfolios



Signatories not shown:, Bpifrance, CaixaBank, CDP, CIC, Danish Ship Finance, DekaBank, DBJ, Eksfin, Finnerva, Hiroshima Bank, OCBC, MUFG Bank, Nordea, OCBC Bank, SACE, Shinsei Bank, SpareBank1, Sparebanken Vest, Sumitomo Mitsui Finance & Leasing, Swedbank, The Chugoku Bank. Portfolios as of start 2024 & 1H 2024, includes some 2023 data and estimates.

"Green" Financing				
Date	**Company**	**Amount ($m)***	**Coupon Rate**	**Issuance Type**
Jun-24	KCC AS	28	NIBOR3M+3.65%	Sustainability-linked Loan
Apr-24	MPCC	55	Not disclosed	Sustainability-linked Loan
Apr-24	SFL Corp	150	8.25	Sustainability-linked Bond
Apr-24	Odfjell	70	Not disclosed	Transition Loan
Jan-24	NYK	300	Not disclosed	Green Loan
Jan-24	MOL	135	0.639%	Blue Bond
Dec-23	Pacific Basin	150	Not disclosed	Sustainability-linked Loan
Nov-23	International Seaways	160	SOFR+1.90%	Sustainability-linked Loan
Sep-23	A.P. Moller Maersk	750	0.75%	Green Bond

Source: Clarksons Research, Clarksons Platou Structured, Asset Finance, Marine Money, Petrofin, Industry Sources. September 2024.

Dry Bulk Shipping, Ports & Terminals – The Green Transition

Dry bulk shipping has made some progress in its vital transition but it's only a start…

Shipping, including the dry bulk sector, is at the beginning of a vital transition which is now central to future developments

The Energy Transition is of particular importance to dry bulk shipping, and impacts on the cargo base (coal, green steelmaking) will need management

Fuelling Transition: global shipping is ~2% of global GHG emissions (though more "efficient" per tonne/mile vs other modes of transport) but there is a lot to be done; regulations and policies need tracking and choices around fuel technology and timing are "tricky"

Bulkcarrier sector progress so far is behind some other shipping sectors (e.g. containers, cars, passenger etc) in terms of green technology adoption with a number of hurdles to overcome; nonetheless a start has been made (even if by a limited number of companies)

Green facilities at ports will be a critical part of the transition; generally viewed as "lagging"; progress being made but concentrated at larger ports and regional variation

Major investment requirements will need financing; challenges around company and project profile

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