MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

Sixteenth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC)

Sliema, Malta, 13-15 May 2025

REMPEC/WG.61/INF.14
24 January 2025
Original: English only

Agenda Item 8: Reduction of GHG emissions from ships

Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region

Note by the Secretariat

This document presents the Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region.

Background

1 The European Union Emissions Trading System (EU ETS) for Shipping, which along with the FuelEU Maritime Regulation, the Energy Taxation Directive, and other related regulations, is a pioneering initiative by the European Union (EU) to reduce ship emissions, will also be applicable in parts of the Mediterranean region. The EU ETS Directive represents the largest cap-and-trade system in the world, covering around 45% of the EU's Greenhouse Gas (GHG) emissions. It has been extended to shipping on 1 January 2024, which laid on the foundation of the EU Monitoring, Reporting and Verification (EU MRV) Regulation. The imposition of the EU ETS costs and the costs associated with other related regulations will incentivise shipowners to reduce GHG emissions from their ships. This will result in the growth of green technologies such as dual-fuel vessels, Propulsion Improving Devices (PIDs) and Energy Saving Devices (ESDs)

2 Given the specific characteristics of the Mediterranean region, there are starkly contrasting approaches to decarbonising the maritime industry. Mediterranean coastal States that are EU Member States follow stringent EU legislation, while Mediterranean coastal States that are not EU Member States are not bound by similar mandates. This disparity presents significant challenges in harmonising decarbonisation efforts across the regional shipping sector. Moreover, geopolitical instability further complicates the establishment of a coordinated approach to this transition.

3 In this context, the Secretariat commissioned Drewry Maritime Services, to prepare a Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region., hereinafter referred to as the Study, in order to support any possible future regulatory or policy action by the Contracting Parties to the Barcelona Convention, in their efforts to mobilise and implement innovative solutions to reduce GHG emissions from ships in selected ports, including through energy efficiency and decarbonisation.

4 The Study was carried out, pursuant to the Programme of Work and Budget for 2024-2025 of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP), adopted by the Twenty-third Ordinary Meeting of the Contracting Parties to the Barcelona Convention and its Protocols (Portorož, Slovenia, 5-8 December 2023).

5 This activity was financed by the voluntary contribution from the French Ministry for Europe and Foreign Affairs.

6 The Study is presented in the **Appendix** to the present document.

Action requested by the Meeting

7 **The Meeting is invited to take note** of the information provided in the present document.

******

Appendix

Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

Final report

Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region

Prepared by Drewry Maritime Services, October 2024

This activity is financed by the voluntary contribution from the French Ministry for Europe and Foreign Affairs and is implemented by the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), in cooperation with the International Maritime Organization (IMO).

Table of Contents

List of Figures

List of Tables

Abbreviations

SHORT FORM	FULL FORM
CAPEX	Capital Expenditure
CBAM	Carbon Border Adjustment Mechanism
CFD	Computational Fluid Dynamics
CPP	Clean Petroleum Products
DOC	Document of Compliance
EC	European Commission
EEA	European Economic Area
EFTA	European Free Trade Association
EIB	European Investment Bank
ENP	European Neighbourhood Policy
EPL	Engine Power Limitation
ESD	Energy Saving Devices
ETS	Emissions Trading System
EU	European Union
EU ETS	European Union Emissions Trading System
EUA	European Union Allowances
EU MRV	European Union Monitoring, Registration and Verification
EUTL	European Union Transaction Log
FAME	Fatty Acid Methyl Ester
FDI	Foreign Direct Investments
GHG	Greenhouse Gas
HVO	Hydrotreated Vegetable Oil
IC	Internal Combustion
IMO	International Maritime Organization
IT	Information Technology
JIT	Just-In-Time
JTF	Just Transition Fund
JTM	Just Transition Mechanism
LDC	Least Developed Countries
LNG	Liquefied Natural Gas
MAP	Mediterranean Action Plan
MBM	Market Based Measures
MEPC	Marine Environment Protection Committee
MOHA	Maritime Operator Holding Account
MoU	Memorandum of Understanding
MRV	Monitoring, Reporting and Verification
NIP	Neighbourhood Investment Platform
OCCS	Onboard Carbon Capture and Storage
OMR	Outermost Region
OPS	Onshore Power Supply
PBCF	Propeller Boss Cap Fins
PID	Propulsion Improving Devices
PSC	Port State Control
PSCO	Port State Control Officer
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
RFNBO	Renewable Fuels of Non-Biological Origin
RTG	Rubber-Tired Gantry
SIDS	Small Island Developing States
SOLAS	International Convention of Safety of Life At Sea
STS	Ship-to-Ship
UCO	Used Cooking Oil
UK	United Kingdom of Great Britain and Northern Ireland

ULSFO	Ultra Low Sulphur Fuel Oil
UNEP	United Nations Environment Programme
USA	The United States of America
USD	United States Dollars
VFD	Variable Frequency Drive
VLSFO	Very Low Sulphur Fuel Oil
WAPS	Wind-Assisted Propulsion System

1 Executive Summary

Drewry was appointed by the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) to undertake a Study to Assess the Legal and Technical Implications of the European Union Emissions Trading System (EU ETS) for Shipping in the Mediterranean Region ("the Study"). The EU ETS Directive, which along with the FuelEU Maritime Regulation, the Energy Taxation Directive, and other related regulations, is a pioneering initiative by the European Union (EU) to reduce ship emissions. The EU ETS Directive represents the largest cap-and-trade system in the world, covering around 45% of the EU's Greenhouse Gas (GHG) emissions. It has been extended to shipping on 1 January 2024, which laid on the foundation of the EU Monitoring, Reporting and Verification (EU MRV) Regulation. The imposition of the EU ETS costs and the costs associated with other related regulations will incentivise shipowners to reduce GHG emissions from their ships. This will result in the growth of green technologies such as dual-fuel vessels, Propulsion Improving Devices (PIDs) and Energy Saving Devices (ESDs).

As per the EU ETS, shipowners will need to purchase European Union Allowances (EUAs) for emissions from their vessels. These revenues will be shared for technological advancements to support the modernisation of energy systems and improvement of energy efficiency in 13 lower-income EU Member States.

According to the World Bank, Emissions Trading Systems (ETS) and carbon taxes are implemented in 75 countries to drive decarbonisation which indicates that many countries are trying to reduce emissions by disincentivising them. Whilst the EU ETS applies to eight Mediterranean costal States that are EU Member States, it is worth noting that Türkiye is also taking the initiative to establish its own carbon pricing scheme comparable with the EU ETS.

Drewry conducted stakeholder engagement during the Study. Stakeholders believe that the EU ETS will result in revenue leakage in the Mediterranean region[1] as certain vessels will avoid EU ports, resulting in a loss of volumes for ports in EU Member States. However, Drewry's analysis shows minimal likelihood of such evasive actions for dry bulk and liquid bulk cargo, but there is a chance of revenue leakage within the Mediterranean region for the container sector.

Considering other factors, especially the potential reputational risks and the fact that EU neighbouring container transhipment ports list[2] will be reviewed every two years, we do not anticipate significant revenue leakage involving ports in Mediterranean coastal States. This is because any port which becomes a new transhipment hub, will be added to the list, and evaders would have to look for another port for evasive action, if any. Some stakeholders also mentioned that the current shift in trade routes within the Mediterranean region could not be directly linked to revenue leakage due to the EU ETS, as they could also have resulted from the Red Sea crisis.

[1] When vessels shift their operations from EU Member States to States that are not EU Member States to avoid exposure to the EU ETS for shipping, it results in revenue leakage for EU ETS (for example, by transhipment in ports of Mediterranean coastal States that are not EU Member States).
[2] To prevent revenue leakage in the container transhipment business, some ports which are less than 300 nautical miles from the EU and whose share of the transhipment of containers exceeds 65% of its total container traffic are classified as neighbouring container transhipment ports from the EU ETS perspective, even though they are not a part of any EU Member State.

There is also potential for carbon leakage in the Mediterranean region [3] due to the implementation of the EU ETS amid the evasive actions to avoid EU ETS costs. Such actions could include changing to smaller feeder vessels, frequent feeder services and calling additional ports such as the first/last port.

However, CBAM[4] implementation in 2026 will reduce the chances of carbon leakage. In addition, the EU ETS2 is expected to be launched in 2027 and will help curb carbon leakage in road transport.

A more frequent review process involving different ways of identifying evasive actions should be adopted, as any change in trade routes will be very difficult to shift back if it is not identified and acted upon in time.

Some stakeholders in the Mediterranean region believe that the EU ETS, being a regional measure, may not reduce GHG emissions due to possible evasive actions. They further stated that a global measure is required, especially considering that GHG flows in the atmosphere do not have any boundaries. The International Maritime Organization (IMO) also intends to propose market-based measures such as GHG levy. Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (the "Barcelona Convention") (CPs) could play a more active role in IMO decision-making for a global measure.

There are concerns due to a lack of technological developments, low-/zero-carbon fuel availability, high cost of such fuels, bunkering infrastructure, finance, and training and understanding of these regulations. There is also a need to increase skilled manpower for energy transition. In addition, there may be concerns about the capacity and capability of shipyards to retrofit vessels to dual-fuel operation or to install relevant PIDs and ESDs.

Some stakeholders agree that implementing the EU ETS boosts research on green marine fuels and propulsion systems. This creates few opportunities such as better infrastructure development of the region near the green corridor, strategic partnership between EU Member States and countries with renewable energy resources and encouragement for Mediterranean shipyards to carry out various retrofitting.

Drewry proposed recommendations based on the literature review and after a deep go-through of stakeholder analysis.

The cost of EUAs must be borne by the charterer based on the "polluter pays" principle. Mediterranean coastal States that are EU Member States should ensure that sufficient resources have been deployed to carry out the work of administrative authorities. CPs should train and educate the required staff about EU ETS and decarbonisation.

Decarbonisation in shipping requires investment in producing green fuel, creating bunkering infrastructure, providing onshore power at ports, building green ports, building low-emission modern ships and retrofitting existing vessels with dual-fuel engines and/or PIDs and ESDs.

[3] When manufacturing industries shift their operations from EU Member States to States that are not EU Member States, it could result in carbon leakage (i.e. an increase in overall GHG emissions due to, for example, less strict GHG emission constraints in Mediterranean coastal States that are not EU Member States).

[4] The Carbon Border Adjustment Mechanism (CBAM) was introduced in 2023. Under this mechanism, importers of goods into EU Member States must report the emissions embedded in their products, and from 2026 they have to start paying for these emissions.

Therefore, a decarbonisation fund among the Mediterranean coastal States could help with the green development of and the required investment in the Mediterranean region.

CPs should actively look into support and facilitation for the development of green corridors and Just in Time (JIT) system. Buyers and suppliers of green fuel should collaborate/work together for the development of green fuels to decarbonise. Capacity building of shipyards should be promoted and enhanced.

To curtail revenue leakage and carbon leakage, CPs should issue a circular stating that they are monitoring transhipment volumes to identify shifts in trade routes to avoid the EU ETS costs. CPs should reserve the right to declare certain ports for transhipment under the EU ETS, even if they do not meet the two criteria (i.e. 300 nautical miles from the EU and 65% transhipment volumes). CPs should also issue a circular warning shipping lines of any misuse of the EU ETS provisions that may cause carbon leakage; if such misuse is proven, CPs could publicly name the shipping line, potentially damaging its reputation.

Additionally, to tackle revenue and carbon leakage, CPs should expedite the process of implementing the EU ETS2 for road transportation. Smaller vessels between 400GT and 5,000GT should be included in the EU ETS, which are potential sources for carrying containers as feeder vessels.

Moreover, CPs should engage with Mediterranean coastal States that are not EU Member States about taking initiatives to align their local emission regulations with the EU ETS as far as possible. Moreover, CPs should prevent shipping companies from charging customers more than EU ETS costs.

In conclusion, implementing the EU ETS will promote research, development and deployment of low-/zero-carbon fuels and advance new propulsion systems. Therefore, Mediterranean coastal States that are EU Member States should work together with the Mediterranean coastal States that are not EU Member States to implement emission reduction measures to achieve net zero in the fight against climate change.

2 Introduction to European Union (EU) Fit for 55

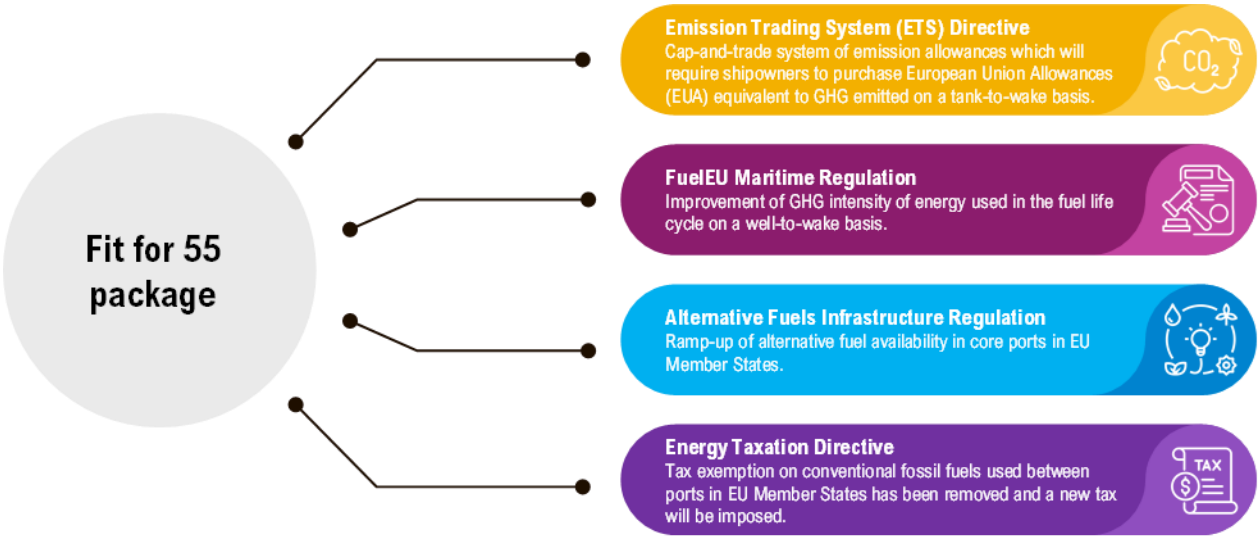
This section covers basic information about the European Union (EU) Fit for 55 package, notably the European Union Emissions Trading System (EU ETS) as well as its application and impact on the maritime industry. It also includes information on the timelines for implementing the EU ETS for shipping. The upcoming FuelEU Maritime Regulation is also covered briefly in this section because of its implications for ships and ports.

2.1 EU Fit for 55 package

In July 2021, the EU introduced its ambitious Fit for 55 package, aiming for a 55% reduction in greenhouse gas (GHG) emissions by 2030 across all industrial sectors. As part of this package, the shipping sector will be subjected to four new regulations, with the EU ETS extension to shipping set to beginning from January 2024.

1. Emissions Trading System (ETS) Directive: Cap-and-trade system of emission allowances which will require shipowners to purchase European Union Allowances (EUA) equivalent to GHG emitted on a tank-to-wake basis.
2. FuelEU Maritime Regulation: Improvement of GHG intensity of energy used in the fuel life cycle on a well-to-wake basis. Containerships and passenger vessels calling at ports in EU Member States will be powered by onshore power for a port stay longer than two hours.
3. Alternative Fuels Infrastructure Regulation: Ramp-up of alternative fuel availability in core ports in EU Member States by 2025 with a focus on Liquefied Natural Gas (LNG).
4. Energy Taxation Directive: Tax exemption on conventional fossil fuels used between ports in EU Member States has been removed and a new tax will be imposed. Alternative fuels will be exempted from tax for 10 years.

Figure 2.1 Fit for 55 Package affecting shipping and ports



Source: Drewry, European Commission

2.2 The European Union Emissions Trading System

The EU ETS Directive is a pioneering initiative at the forefront of global efforts to mitigate the climate change. Established in 2005, it represents the largest cap-and-trade system in the world, covering around 45% of EU's GHG emissions. At its core, the EU ETS Directive operates on a straightforward yet powerful premise – it sets a cap on the total amount of GHG that can be emitted by sectors deemed as high emitters, such as power generation, heavy industry and aviation. The Trade part of cap-and-trade works in the following manner.

Under the EU ETS framework, participating industries are allocated EUAs, which correspond to the maximum amount of CO_2 they can emit during a given period. These allowances can be bought, sold or traded among participants, fostering a dynamic market for emission reductions. By gradually reducing the total number of allowances available each year – a process known as cap tightening – the EU ETS incentivises and motivates industries to invest in cleaner technologies and practices, ultimately driving down emissions.

The Innovation Fund and the Modernisation Fund will be formed from the revenues collected from the EU ETS for shipping. The Innovation Fund will be used to help development of fuels generated from renewable sources and low-/zero-carbon fuels to accelerate the innovation of low-/zero-carbon technologies for shipping sector. The Modernisation Fund will be used to support the modernisation of energy systems and the improvement of energy efficiency in 13 lower-income EU Member States.

A key strength of the EU ETS Directive lies in its flexibility and scalability. The EU ETS Directive covers a wide range of sectors and gases ensuring a comprehensive approach to emissions reduction. Moreover, it allows for the inclusion of new sectors and the adjustment of emission caps over time, enabling continuous adoption of evolving climate goals and economic realities.

Since its inception, the EU ETS Directive has spurred innovation and investment in low-/zero-carbon technologies.

2.2.1 The EU ETS extension to maritime transport

The EU ETS Directive has been extended to maritime transport from 1 January 2024, laid on the foundation of European Union Monitoring, Reporting and Verification (EU MRV) Regulation. It is applicable to the 27 EU Member States and three of the European Free Trade Association (EFTA) States (Norway, Iceland and Lichtenstein), which are together referred as EU/ European Economic Area (EEA) Member States.

The following are the objectives of extending the EU ETS Directive to maritime transport[5]:

1. to reduce 55% GHG emissions by 2030 compared to 1990 levels and thereafter a gradual and balanced trajectory towards climate neutrality by 2050;
2. to incentivise low-/zero-carbon technologies; and
3. to increase cost-effective contribution from sectors to emission reductions currently not under the EU ETS Directive.

[5] There are no free allowances for maritime transport as each shipping company has to surrender a number of allowances that are equated with the total verified emissions.

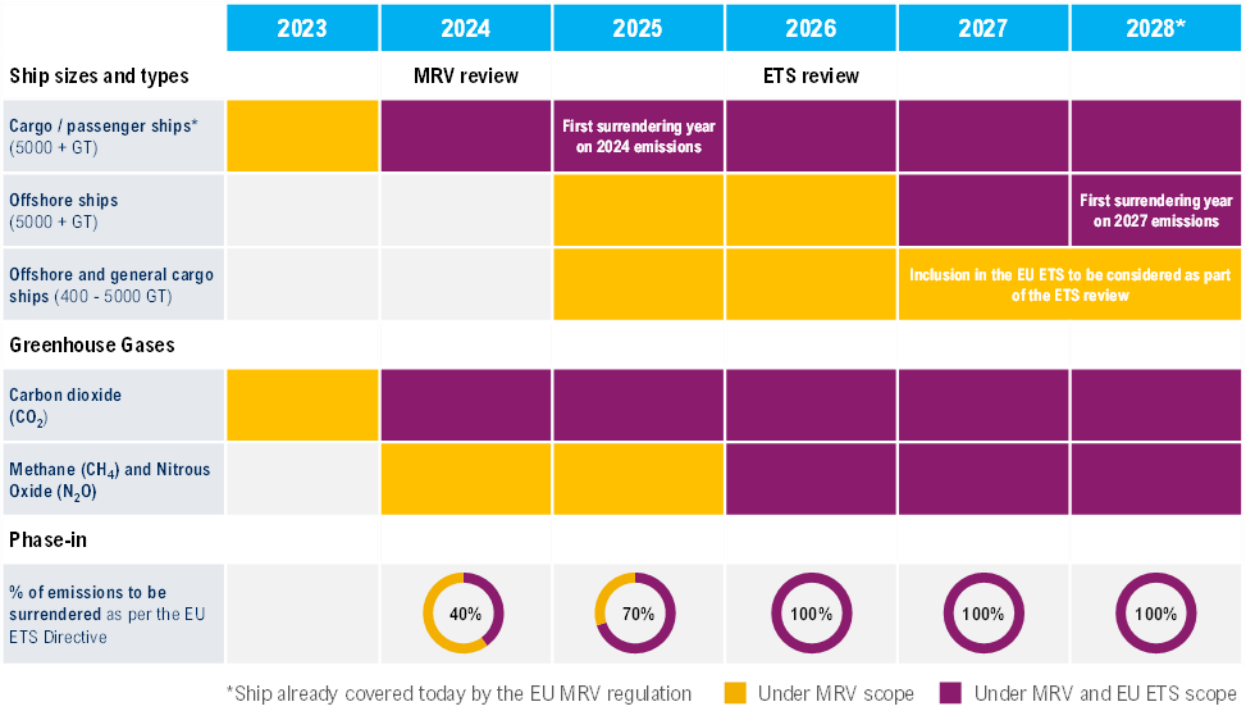
2.2.2 Scope of the EU ETS

The EU ETS is applicable to ships of 5,000 GT and above in respect of carbon dioxide (CO_2) (with methane (CH_4) and nitrous oxide (N_2O) added from 2026) released during the voyages for commercial purposes i.e. for transporting cargo or passengers from such ships, from one port of call to the next port of call, out of which at least one port has to be in EU. From 1 January 2027, emissions from offshore ships of 5,000 GT and above will also be included.

In order to ensure a smooth transition, a three-year phase-in period has been decided wherein a shipping company will surrender allowances for a portion of their emissions as mentioned in the below table (40% in 2024, 70% in 2025 and 100% from 2026).

The inclusion of ships between 400 GT and 5,000 GT will be reviewed by the European Commission (EC) by 31 December 2026.

Figure 2.2 Implementation timelines of the EU ETS Directive



Source: European Commission

Scope of emissions for the EU ETS:

1. 50% of emissions for voyages to/from ports in EU Member States;
2. 100% of emissions for voyages between ports in EU Member States; and
3. 100% of emissions at EU berths.

Emission reduction requirements:

1. reduce 55% emissions by 2030 compared to 1990 levels; and
2. achieve carbon neutrality by 2050

Deadlines:

1. 31 March 2025 – Shipping companies shall submit the verified emissions report for the entire fleet to the administering authority, flag State administration, and EC.
2. 30 September 2025 – Shipping companies to surrender their first EUA

2.2.3 Analysis of the EU ETS Directive financial impact

The price of EUA is variable as it depends on demand-supply conditions, energy prices, renewable power generation, weather conditions, market sentiments, and speculative investment. This creates challenges in financial modelling as the future price of EUA is expected to increase over time.

Based on 2022 verified EU MRV data, the financial impact on the shipping sector is predicted to be €9.1 billion and the impact on different ship types has been stated below:

1. Containerships – €2.4 billion
2. Dry bulk and General cargo ships – €1.5 billion
3. Tankers – €1.7 billion
4. Gas carriers – €0.8 billion
5. Others – €2.7 billion

Note: The EU ETS impact is calculated assuming EUA price at €100 per tonne of CO_2 and our calculations are based on 2026 when 100% emissions are to be surrendered.

2.3 Introduction to FuelEU Maritime Regulation

FuelEU Maritime, a key EU regulation that will come into force from 1 January 2025, will increase the consumption of low-/zero-carbon fuels. The FuelEU Maritime Regulation is briefly analysed below seeing its implication for ships and ports.

2.3.1 FuelEU Maritime Regulation

The FuelEU Maritime Regulation aims to increase the uptake of low-/zero-carbon fuels. Following are its key elements:

1. The FuelEU Maritime Regulation sets the limits on GHG intensity of energy used on board ships without prescribing the use of any particular fuel or technology. These limits are set in relation to a reference value, corresponding to the fleet average GHG intensity of energy used on board ships in 2020, based on verified EU MRV data; and
2. An obligation to use onshore power supply (OPS) or zero-emission technologies in ports in EU Member States for container and passenger vessels from 2030 when at major ports in EU Member States for more than two hours and from 2035 at all other ports in EU Member States.

The objective of the FuelEU Maritime Regulation is fuel transition to renewable and low-/zero-carbon fuels as well as green sources of energy. In FuelEU Maritime Regulation, vessels will be non-compliant from day one, if they are not using sustainable biofuels or do not have a Wind-Assisted Propulsion System (WAPS) installed onboard or using low-/zero-carbon fuels.

Following are the key differences between the EU ETS and the FuelEU Maritime Regulation:

1. In the EU ETS, only CO_2 emissions are included in the beginning (till 2025), whereas in the FuelEU Maritime Regulation - CH_4 and N_2O emissions are also included in addition to CO_2 emissions.
2. The EU ETS Directive accounts for only tank-to-wake emissions, while the FuelEU Maritime Regulation accounts for GHG intensity of the fuel from well-to-wake (life cycle analysis of fuels).
3. The EU ETS promotes energy savings while the FuelEU Maritime Regulation addresses fuel demand.

2.3.2 Scope of FuelEU Maritime Regulation

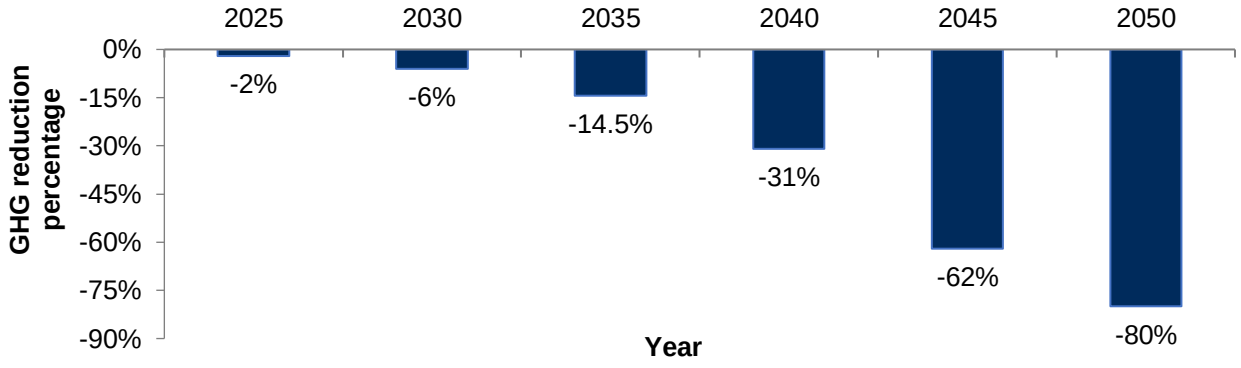
Similar to the EU ETS, the FuelEU Maritime Regulation applies to all ships of 5,000 GT and above that serve the purpose of transporting passengers or cargo for commercial purposes, regardless of their flag, in respect of:

1. 100% of energy used at ports in EU Member States;
2. 100% of energy used on voyages between ports in EU Member States; and
3. 50% of energy used on voyages to/from ports in EU Member States.

GHG intensity limit on energy used onboard by a ship:

- 91.16 gCO_2 eq/MJ is the reference value of GHG intensity of energy used, which is reduced by the following criteria to determine the set limits.

Figure 2.3 GHG intensity limit reduction



Source; Drewry and official journal of the EU

Deadlines:

1. 31 August 2024 – Submit the FuelEU Maritime monitoring plan to the verifier
2. 1 January 2025 – Start first reporting period for the FuelEU Maritime Regulation
3. 31 January 2026 – Submit the FuelEU Maritime reports to the verifier
4. 31 March 2026 – Record compliant the FuelEU Maritime report in the FuelEU Maritime database

5. 30 April 2026 – Approve compliance balance in the FuelEU Maritime database
6. 30 June 2026 – Prepare the FuelEU Maritime Regulation document of compliance (DOC) onboard, which is also the deadline for payment of penalty. FuelEU Maritime Regulation provides a mechanism to reward ships which use WAPS, sustainable biofuels, and Renewable Fuels of Non-Biological Origin (RFNBO). It also provides a mechanism of pooling by which vessels using green fuels and hence lower emissions can help reduce the liability of vessels having higher emissions.

2.3.3 Additional information pertaining to the FuelEU Maritime Regulation

Use of RFNBO

1. From 1 January 2023 to 31 December 2033, a multiplier of '2' can be used for reward purposes for the use of RFNBO;
2. The EC will annually publish the share of RFNBO in the yearly energy used onboard; and
3. If the share of RFNBO is less than 1% for the reporting period 2031, a sub-target of 2% shall apply for these fuels in the yearly energy used onboard from 1 January 2033, depending on the production capacity, availability of RFNBO, uneven geographical distribution or very high price for these fuels.

Wind Assisted Propulsion System

P_{wind} is the available effective power of the WAPS whereas P_{prop} is propulsion power of the ship. If a vessel has WAPS installed, a specific reward factor F_{wind} is accounted for, in the calculation of GHG intensity of energy used on board ships, which is determined by the ratio of P_{wind} and P_{prop} as per the table below.

Table 2.1 Reward factor in the Fuel EU Maritime Regulation for WAPS

Reward factor for wind-assisted propulsion – WIND (f_{wind})	$\frac{Pwind}{Pprop}$
0.99	0.05
0.97	0.1
0.95	>= 0.15

Source: European Commission

Banking and borrowing of compliance surplus

1. Compliance surplus – A positive compliance balance
2. Compliance deficit – A negative compliance balance
3. Total pool compliance balance – The sum of the compliance balances of all ships included in a pool:
   a. The company can bank the compliance surplus of a ship for one reporting period to the next reporting period in the FuelEU Maritime database on approval by the verifier.
   b. Once the FuelEU Maritime DOC is issued, the company can no longer bank the compliance surplus.

c. The company can borrow, for one reporting period, an advance compliance surplus from the next reporting period, but the compliance surplus borrowed multiplied by 1.1 will be subtracted from the same ship's compliance balance in the following reporting period.

d. The advance compliance surplus cannot be borrowed:
   i. for an amount exceeding 2% of the limit set by the FuelEU Maritime Regulation multiplied by the energy consumption of the ship.
   ii. for two consecutive periods.

e. If the company borrowed an advance compliance surplus and in the following reporting period the ship did not have any ports of call in the EU Member States then the administering authority is to notify the concerned company by 1 June regarding the amount of pending FuelEU Maritime penalty (which is 1.1 times the borrowed compliance).

Pooling of compliance

1. The compliance balances for GHG intensity and the RFNBO sub-target of two or more ships can be pooled for compliance purpose;
2. A ship's compliance balance can be included in only one pool in a single reporting period, but two separate pools can be used for GHG intensity target and for the sub-target of RFNBO;
3. The company has to register in the FuelEU Maritime database, its intention to include the ship's compliance balance to each individual ship, the allocation of the total pool compliance balance to each individual ship and the choice of verifier selected for verifying that allocation;
4. If the ships participating in the pool are controlled by two or more companies, the pool details should have been registered in the FuelEU Maritime database, the allocation of the total pool compliance balance to the pool's ships and the choice of verifier selected for verifying the allocation of the total pool compliance balance of the pool to each individual ship, are to be validated in the FuelEU Maritime database by all the concerned companies in the pool;
5. A pool is valid if the total pool compliance is positive;
6. If pooling results in a compliance surplus then that can be carried forward to the next reporting period; and
7. The selected verifier has to record in the FuelEU Maritime database the composition of the pool and allocation of the total pool compliance balance to each individual ship.

Utilisation of revenue generated by FuelEU Maritime Regulation

1. To promote the distribution and use of renewable and low-/zero-carbon fuels;
2. To facilitate the construction of appropriate bunker facilities or OPS infrastructure in ports; and
3. To support the development, testing and deployment of the most innovative technologies in the fleet to achieve significant emission reductions.

2.4 Other regulatory measures

There are other Emissions Trading Systems as explained below.

2.4.1 Emissions trading systems for vessels in other countries

In addition to the EU ETS, in the maritime sector, there is also the ETS for domestic shipping in the United Kingdom of Great Britain and Northern Ireland (UK), which has not been implemented yet as well as a proposed ETS in the United States of America.

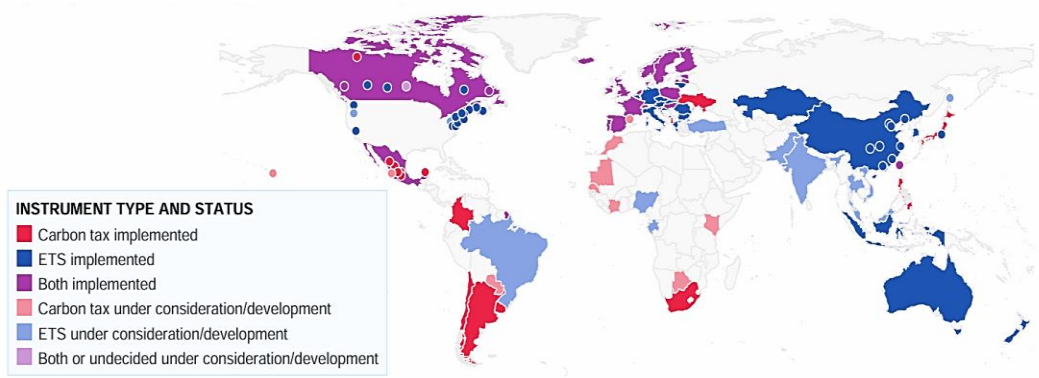
At the global level, International Maritime Organization (IMO) initiated the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures and adopted resolution MEPC.377(80) on 2023 IMO Strategy on Reduction of GHG Emissions from Ships (2023 IMO GHG Strategy) at the 80th session of the IMO's Marine Environment Protection Committee (MEPC 80). The 2023 IMO GHG Strategy envisages the mid-term measures to be approved at MEPC 83 (Spring 2025) for adoption at an extraordinary session of the MEPC set to be specially convened in Autumn 2025 to allow for the entry into force of the measures in 2027. In addition, MEPC 80 established a Steering Committee on the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, with a focus on possible impacts on Least Developed Countries (LDC), Small Islands Developing States (SIDS) and remotely located developing countries with long trading distances.

Regarding Market Based Measures (MBM), MEPC 63 had already agreed to undertake an impact assessment of the MBM proposals with a focus on possible impacts on consumers and industries in developing countries, in general, and in particular, LDC, SIDS and remotely located developing countries with long trading distances, and considered in detail the methodology and criteria it should be based on.

In case a global approach is taken by IMO to limit the GHG intensity of energy used onboard ships or to impose a tax on the GHG emissions from ships, the EU is likely to review the current regional regulation with a view to align it, as appropriate, with international rules.

The World Bank Group report on Carbon Pricing shows the implementation of ETS and carbon tax. Whilst an ETS is a cap-and-trade system that caps the total GHG emissions and allows industries with low emissions to sell their extra allowances to larger emitters, a carbon tax directly sets a price on carbon by defining a tax rate on GHG emissions. ETS and carbon taxes are implemented in 75 countries showing the initiative of other countries towards decarbonisation.

Figure 2.4 Various carbon pricing instruments around the world



Source: World Bank Group

1. Countries with ETS implemented: The 27 EU Member States and three of the EFTA States (Iceland, Liechtenstein and Norway), Serbia, Montenegro, Indonesia, Australia, provinces of the People's Republic of China, Republic of Korea, cities in Japan, New Zealand, UK, Kazakhstan, Switzerland, Mexico, provinces of USA and Canada.
2. Countries with ETS under consideration: Malaysia, Thailand, Argentina, Chile, a few provinces of the USA and Canada, Pakistan, Nigeria, and Gabon.
3. Countries with ETS under development: Vietnam, Japan, provinces of the Russian Federation, Ukraine, Türkiye, Brazil, Colombia, Province of USA, Canada, India.
4. Carbon tax implemented in countries: Singapore, Taiwan Province of China, Japan, Hungary, Luxembourg, the Netherlands, Portugal, Spain, France, UK, Ukraine, Ireland, Iceland, Albania, Liechtenstein, Switzerland, Latvia, Estonia, Slovenia, Denmark, Sweden, Norway, Poland, Finland, provinces of Mexico, Uruguay, Argentina, Colombia, Chile, Canada and South Africa.
5. Countries with carbon tax under consideration: New Zealand, Indonesia, Paraguay, provinces of Mexico, Morocco, Israel, provinces of Canada, provinces of USA, Mauritania, Kenya, Botswana, Senegal and Côte d'Ivoire.
6. Countries with Carbon tax under development: Catalonia (Spanish province) and San Luis Potosi (Mexico province).

Whilst the EU ETS applies to eight Mediterranean costal States that are EU Member States, it is worth noting that Türkiye is taking the initiative to establish its own carbon pricing scheme comparable with the EU ETS. The proposal is presently awaiting the president's approval.

2.4.2 EU ETS2

The EU ETS2 extends emissions trading to the buildings sector, road transport and the usage of fuels in other sectors. It is expected to be launched in 2027 at the earliest.

If a container is discharged in a port of a State that is not an EU Member State for any evasive action as explained in Chapter 6, it can be taken to its final destination via road transportation (which has higher emissions than transportation through sea), creating a potential source of carbon leakage. This could be curbed with the EU ETS2 coming into force in 2027.

2.5 Section summary

The EU ETS Directive, a pioneering initiative at the forefront of global efforts to mitigate climate change, has been extended to maritime transport from 1 January 2024.

It applies to ships of 5,000 GT and above that emit CO_2 (methane and nitrous oxide will be added from 2026) while transporting cargo or passengers from one port of call to the next, with at least one port in an EU Member State. From 1 January 2027, emissions from offshore ships of 5,000 GT and above will also be included. The inclusion of ships between 400 GT and 5,000 GT will be reviewed by the EC by 31 December 2026.

To ensure a smooth transition, a three-year phase-in period has been decided, wherein a shipping company will surrender allowances for a portion of its emissions (40% in 2024, 70% in 2025 and 100% from 2026).

EUAs are a type of carbon allowance that allows companies covered by the EU ETS to emit a certain amount of CO_2. It can be bought and sold on the market, and its cost will reflect the cost of reducing emissions.

EUA price is variable as it depends on demand-supply fundamentals, energy prices, renewable power generation, weather conditions, market sentiments, and speculative investment. This creates challenges in financial modelling as the current EUA forward curve is upward sloping, indicating a likely rise in the EUA prices in the future.

The vessels that arrive from or are destined to ports in the EU Member States have to submit EUAs for 50% emissions, and vessels sailing within the EU have to submit EUAs for 100% emissions. Shipping companies are required to submit the verified emissions report of 2024 for the entire fleet by 31 March 2025 and surrender their first EUAs by 30 September 2025.

Revenues collected from the EU ETS will be distributed in innovation and modernisation funds. The innovation fund will be used to help fuels generated from renewable sources and low-/zero-carbon fuels to accelerate the innovation of low-/zero-carbon technologies for the shipping sector. The modernisation fund will be used to support the modernisation of energy systems and the improvement of energy efficiency in 13 lower-income EU Member States.

Another important regulation worth mentioning is the FuelEU Maritime, which will be implemented from 1 January 2025. While the EU ETS promotes energy savings, FuelEU Maritime Regulation addresses fuel demand.

The FuelEU Maritime Regulation aims to increase the uptake of low-/zero-carbon fuels and requires mandatory use of OPS for container and passenger vessels from 2030. It also provides a mechanism to reward ships that use WAPS, sustainable biofuels and RFNBO. It also enables pooling whereby ships with lower emissions can help reduce the liability of those that have higher emissions.

At the global level, IMO initiated the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures at MEPC 80, which are expected to enter into force in 2027. In addition, MEPC 80 established a Steering Committee on the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, with a focus on possible impacts on LDC, SIDS and remotely located developing countries with long trading distances.

In case a global approach is taken by IMO to limit the GHG intensity of energy used onboard ships or to impose a tax on the GHG emissions from ships, the EU is likely to review the current regional regulation with a view to align it, as appropriate, with international rules.

According to the World Bank Group, ETS and carbon taxes are implemented in 75 countries as a drive towards decarbonisation. Whilst the EU ETS applies to eight Mediterranean costal States that are EU Member States, it is worth noting that Türkiye is taking the initiative to establish its own carbon pricing scheme comparable with the EU ETS.

The EU ETS2 is expected to be enforced in 2027 and will extend emissions trading to the building sector and road transport. These regulations will help curb carbon leakage through road transport in the form of any container discharged in a port of a State that is not an EU Member State and then carried to its final destination in the EU Member State.

3 Legal framework of the European Union Emissions Trading System

This section covers the legal framework of the EU ETS, including information on the authorities involved. Penalties for non-compliance with the regulations are also covered here.

3.1 Authorities involved in the EU ETS

Many authorities are involved in implementing and monitoring the EU ETS Directive.

3.1.1 Brief information on the authorities involved

European Commission

The EC, established in 1958, is the principal executive body of the EU that oversees the application of union law and ensures respect for the various treaties by different EU Member States. The main role of EC is to promote the general interest of the EU by proposing and enforcing legislation as well as by implementing policies and the EU budget.

Administering authority

An administering authority is the authority responsible for administering the EU ETS with respect to a shipping company[6]. Administering authorities are one of the key players and play a vital role in the implementation of the EU ETS.

The administering authority for a shipping company is decided based on the following rules:

- If the shipping company is registered in one of the Member States, that Member State will be its administering authority.
- If the shipping company is not registered in any of the Member States, its administering authority will be the Member State in which the shipping company had the maximum number of port of calls in the last four monitoring years.
- If the shipping company is neither registered in any of the Member States nor does it have any voyages falling under the scope of the EU ETS, its administering authority will be the Member State where the ship starts or ends its first voyage.

Roles of the administering authority

The administering authority has to ensure:

1. the shipping company under its responsibility, monitors and reports the relevant parameters during a reporting period and submits the verified aggregated emissions data at the company level; and
2. each shipping company surrenders a number of EUAs that are equal to its total verified emissions during the preceding calendar year.

[6] By 1 February 2026 and every two years thereafter, an updated list to reattribute shipping companies to the administering authority will be published, due to re-registration of companies or new companies falling under scope of the EU ETS. It will be revised again after two years, following which, it will be revised every four years.

3.1.2 Relations between the authorities

Central administrator

The EC designates a central administrator to maintain an independent transaction log recording the issue, transfer and cancellation of EUAs.

The central administrator has to conduct an automated check on each transaction in registries through the independent transaction log to ensure there are no irregularities in the issue, transfer and cancellation of EUAs.

If irregularities are identified through the automated check, the central administrator has to inform the concerned Member State, so that the Member State shall not register the transactions in question or any further transactions relating to the EUAs concerned until the irregularities have been resolved.

The central administrator's main responsibilities are to provide, operate and maintain the Union registry and the European Union Transaction Log (EUTL) to manage central accounts and to perform operations which are carried out centrally.

The central administrator has to provide a report on the relevant practices in place in each Member State to the national administrators every two years.

National administrator

National administrator means the entity responsible for administering, on behalf of an EU Member State, a set of user accounts under the jurisdiction of the Member State in the Union registry.

Each Member State has to designate a national administrator. The Member State can access and administer its own account and the accounts in the Union registry under its jurisdiction through its national administrator.

Member States and the Commission have to ensure that there is no conflict of interest among national administrators, the central administrator and account holders.

Each Member State has to notify the Commission of the identity and contact details of its national administrator, including an emergency telephone number, to be used in the case of a security incident.

3.2 Definition of 'Port of call'

A port of call is defined in the EU ETS Directive as follows:

"A port where a ship stops for commercial operations (cargo operation or embarking/disembarking of passengers) or ship-to-ship (STS) operation within the port limits or the port where an offshore ship stops to relieve the crew is known as a port of call."

3.3 Penalties, exceptions and derogations

Penalties will be levied for non-compliance with some exceptions to the rule.

3.3.1 Penalties and expulsion rules for non-compliance

Administering authorities are to ensure the EU ETS Directive compliance of shipping companies under their purview.

Shipping companies that fail to surrender EUAs have to pay an excess emissions penalty of €100 (corrected for inflation) per tonne of CO_2 equivalent and are still liable for the surrendering of required EUAs.

The names of the penalised companies will also be disclosed to the public.

In case a shipping company fails to comply with surrendering obligations for two or more consecutive reporting periods and if the enforcement measures also fail to ensure compliance:

1. the competent authority of the EU Member State of the port of entry can issue an expulsion order after allowing the concerned company to submit its observations;
2. the ships under the responsibility of the shipping company concerned will be refused entry into any port in every EU Member State until the surrendering obligations are fulfilled by the company; and
3. If a ship flying the flag of the Member State enters or is found in one of its ports, the concerned EU Member State after allowing the company concerned to submit its observations, can detain the ship until the company fulfils its obligations.

In addition, under the FuelEU Maritime Regulation, ships which do not meet the limits on the yearly average GHG intensity of energy used on board ships are subject to a FuelEU Maritime penalty which is in proportion to the extent of non-compliance:

1. The penalty is €2,400 per equivalent tonne of VLSFO.
2. The penalty will also be imposed for non-usage of onshore power by passenger and container vessels.

3.3.2 Exceptions and derogations

Exceptions and derogations of the EU ETS are listed below:

1. Ships with ice-class IA, IA super or an equivalent ice class, 5% less EUAs are to be surrendered than their verified emissions released until 31 December 2030.
2. For passenger ships and Ro-Pax vessels, no EUAs are to be surrendered until 31 December 2030 during voyages between ports of certain islands of EU Member States and ports located in the same EU Member State. An eligible island must have a population of less than 200,000 permanent residents and must not have any road or rail link with the mainland.
3. No emissions are to be surrendered until 31 December 2030 for: voyages between a port located in the outermost region (OMR) of an EU Member State and a port located in the same EU Member State; voyages between ports within an OMR; voyages between ports in the OMR of the same EU Member State, and from the emissions released within the ports in relation to the above voyages.
4. If a transnational public service contract is established by two EU Member States, with one having no land border with another EU Member State and the other being the closest, shipping companies are not obligated to surrender EUAs for emissions released by passenger and Ro-Pax ships operating under such a contract until 31 December 2030.

5. For classifying a port as a neighbouring container transhipment port, the following three criteria need to be met:

    a. Its share of the transhipment of containers exceeds 65% of its total container traffic during the recent 12-month period.

    b. It is located outside EU, but less than 300nm from a port under the jurisdiction of an EU Member State.

    c. Its country has no measures equivalent to the EU ETS Directive.

EU stops by containerships at neighbouring container transhipment ports do not count towards determining the start or end of the voyage as per the EU ETS Directive[7]. Tanger Med in Morocco and Port Said East in Egypt are presently identified as neighbouring container transhipment ports. The list will be revised every two years.

3.4 Section summary

The EC is the principal executive body of the EU that oversees the application of union law and ensures respect for the various treaties by different Member States. The main role of the EC is to promote the general interest of the EU by proposing and enforcing legislation and implementing policies and the EU budget.

An administering authority under the EU ETS, is the authority responsible for administering the regulations with respect to a shipping company. The Commission designates a central administrator to maintain an independent transaction log for EUAs. National administrator means the entity responsible on behalf of an EU Member State, for administering a set of user accounts under the jurisdiction of the Member State in the EU registry.

The EU ETS defines a port of call as 'A port where a ship stops for commercial operations (cargo operation or embarking/disembarking of passengers) or STS operation within the port limits or the port where an offshore ship stops to relieve the crew.'

Administering authorities are to ensure the EU ETS compliance of shipping companies under their purview. Shipping companies that fail to surrender EUAs have to pay an excess emissions penalty of €100 (corrected for inflation) per tonne of CO_2 equivalent and are still liable for surrendering the required EUAs. Similarly, ships which do not meet the GHG intensity of energy used on board ships are subject to a FuelEU Maritime penalty of €2,400 per equivalent tonne of Very Low Sulphur Fuel Oil (VLSFO).

There are some exceptions and derogations for ice-class vessels, passenger ships and Ro-Pax vessels. To prevent revenue leakage in the container transhipment business, some ports which are less than 300 nautical miles from the EU and whose share of the transhipment of containers exceeds 65% of its total container traffic are classified as neighbouring container transhipment ports from the EU ETS perspective, even though they are not a part of any EU Member State. Currently, Tanger Med in Morocco and Port Said East in Egypt are identified as neighbouring container transhipment ports. The list of neighbouring container transhipment ports will be revised every two years.

[7] If a container vessel, has three port of calls (e.g. Singapore, Tanger Med and then Valencia), as per the EU MRV regulation there are two voyages in this case. First from Singapore to Tanger Med, Morocco and then from Tanger Med to Valencia, Spain, thus EUAs for only 50% of emissions are to be surrendered for the second voyage and no emissions are to be surrendered for the first voyage. However, since Tanger Med is a neighbouring container transhipment port, it does not determine the start or end of the voyage. So, the voyage is from Singapore to Valencia and EUAs for 50% of emissions are to be surrendered for this voyage.

4 Analysis of administrative issues related to monitoring, collection of levy or disbursement of the revenue received

This section briefly explains the administrative framework with a special focus on the administrative challenges associated with the EU ETS.

4.1 Overview of administration framework

Below are the various authorities involved, which have been explained in section 3:

- The European Commission
- Administering authority
- Central administrator
- National administrator

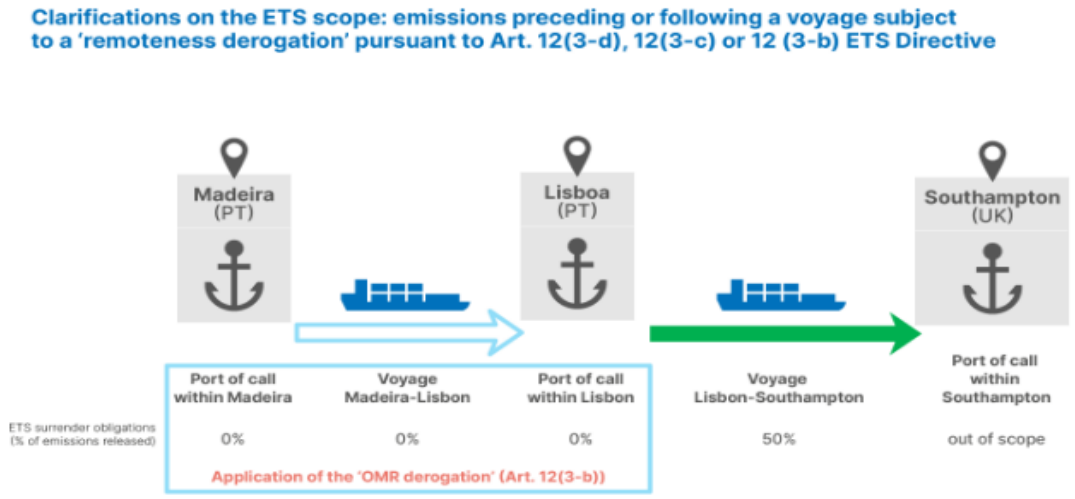
4.2 Challenges faced by different stakeholders

It is understood that there is an improving trend across the available reporting years for all key indicators of punctuality, quality and completeness of the submitted MRV data. This indicates that companies and stakeholders have familiarised themselves with the system, resulting in smooth internal procedures and better quality of the submitted data. However, there are other challenges faced by different stakeholders:

1. Understanding STS operation and port of call: The EU ETS specifies that STS operation within the port limits is considered the port of call whereas STS operation outside the port limits is treated as part of the voyage and not port of call. Since many port authorities lack clarity on this distinction, shipping companies end up paying penalties, through port State control (PSC), for not possessing a valid DOC even if the STS activity is performed outside the port limits in previous year. For example, if a ship has done STS outside port limits in a EU port in year 2021, since it is not a port of call, no emissions are to be reported as per EU MRV as the ship had no other port of call in EU Member States. However, in the next year, if the ship does cargo operation at a port in an EU Member State, then PSC asks for a valid DOC[8] for the previous year because some Port State control Officers (PSCOs) do not know that STS outside port limits is not considered as port of call, and the company has to pay a fine imposed through PSC for this.
2. Understanding Outermost Region scenarios: The EU ETS states that no emissions are to be surrendered for ports involved in voyages related to OMR. However, it has been observed that many classes/verifying bodies lack clarity on the OMR definition and thereby calculate EUAs. For example, for the voyage Madeira (OMR-Portugal) to Lisbon, no emissions are to be surrendered for the voyage between both ports as given in the below Figure.

[8] When vessel submits its emissions and verifier has verified them, the verifier gives a DOC to the vessel.

Figure 4.1 Example of OMR port emissions liability



Source: European Maritime Safety Agency

3. Information Technology (IT) system readiness: Most IT systems need to be updated to account for derogations as per the new EU ETS, but their failure to comply sometimes goes unchecked as IT systems are owned by verifying bodies and they verify the reports generated automatically. As a result, most shipping companies are opting for manual calculations of EUAs post completion of each voyage to avoid incorrect EUAs being calculated leading to over/underestimation of the EU ETS costs at the end of the year.
4. Missing charter party deadlines: Charter party deadlines, for finalisation of the dues for emissions, are sometimes missed due to back-and-forth communication between the charterer and the owner because of ambiguity in the EU ETS calculations for each completed voyage.
5. Lacking the knowledge of the EU ETS calculation rules: Unclear information and rules about the EU ETS calculations (berth-to-berth or shifting within berth) can lead to discussions and debates between charterers and the authority, wasting valuable time and resources.
6. Lack of clarity for responsible entity for MRV: In the past, ship management company was responsible for MRV, but now MRV has to be submitted by the shipowner, wherein the shipowner can, in turn, delegate the responsibility to the ship management company. However, since MRV has financial implications, ship management companies are reluctant to take on this responsibility. Another issue that needs to be addressed is that the shipowner can delegate the responsibility to only the ship management company, but not to the bareboat charterer.
7. Different responsible entities under two related regulations: In the EU ETS, either the shipowner or the ship management company is responsible for the ship's compliance with the EU ETS, but in the case of FuelEU Maritime Regulation, only the ship management company is responsible for compliance, which will cause some confusion.

4.3 Charter party clauses for collection of the EU ETS costs

Some of the charter party clauses for collection of costs due to the EU ETS Directive are mentioned below:

1. The EU ETS costs: EUAs need not be calculated as the EU ETS costs are included in the freight. The collection of EUA costs is done as per the charter party.
2. Worldscale roundtrip: Charterers will pay for 100% of emissions for the complete voyage. These emissions are not based on actual data but are calculated using the Worldscale calculation methodology.
3. Worldscale laden only: Charterers will pay only for 50% of the emissions for a laden voyage.
4. Actual laden: When the cargo is discharged, charterers can surrender or pay for the verified EUAs corresponding to the voyage performed under that particular charter. The payment along with the verified emissions statement needs to be submitted within seven working days.
5. Actual ballast and laden: On completion of the voyage, the charterer can surrender or pay for the verified EUAs corresponding to the voyage performed under that particular charter within seven working days. The verified emissions statement needs to be submitted along with the payment.
6. Demurrage: It is included in the EU ETS cost in some charter parties.
7. Cost of EUA: The cost of EUA should be borne by the charterer, based on the “polluter pays” principle. However, as per the clauses of private contracts, shipowners can get reimbursed by charterers, only if it is mentioned in the contract.

While the matter of non-compensation or less compensation due to a dispute in the calculation of emissions can usually be settled in court, they are likely to be settled under the UK law or the law of IMO Member States that are not Members of the EU such as Singapore, which could create challenges in the coming months.

4.4 Maritime Operator Holding Account (MOHA) responsibility

Information related to a Maritime Operator Holding Account (MOHA) is provided below:

1. The administering authority list for shipping companies is published. Within 40 working days of the publication of the list, the shipping company has to provide the name of the relevant national administrator to open a MOHA in the Union registry. However, for companies not included in the list, the time has been extended to 65 working days.
2. It must be noted that a shipping company cannot hold more than one MOHA account.
3. The national administrator has to open a MOHA account within 20 working days of receiving the required information.
4. The account can be opened upon instruction from the administering authority if the national administrator refuses to open a MOHA account.
5. The shipping company has to notify the administrator within 10 working days of its merger or split.

6. The national administrator has to review the account information once in three years for completeness, accuracy and trueness. If any amendments are needed, the national administrator has to notify the account holder.
7. The central administrator has to update the relevant national administrator if there is a change in the administering authority of a shipping company.

4.5 Section summary

The key challenges faced by stakeholders include a lack of understanding of STS and OMR port clauses in the EU ETS, as well as the inflexibility of IT systems to deal with exceptions. A lack of understanding of the EU ETS calculations may also delay agreements between owners and charterers concerning emission dues.

Issues could also crop up with the unwillingness of ship management companies to take responsibility for the EU ETS due to the associated financial risks. In the EU ETS, either the shipowner or ship management company is responsible for the ship's compliance with the EU ETS; meanwhile, in the case of FuelEU Maritime Regulation, only the ship management company is responsible for compliance, which will cause some confusion. Adding to the uncertainty, there are some issues related to the MOHA account.

There are also a few other issues related to charter party clauses which need to be ironed out, *inter alia*:

- The cost of EUA should be borne by the charterer, based on the "polluter pays" principle. However, as per the clauses of private contracts, shipowners can get reimbursed by charterers, only if it is mentioned in the contract.
- Any dispute in the calculation of emissions can usually be settled in court and they are likely to be settled under the UK law or the law of IMO Member States that are not EU Member States, such as Singapore, which could create challenges in the coming months.

5 Technical feasibility and challenges of implementing the EU ETS Directive

This section covers the various methods that can be used to reduce GHG emissions from ships. It also includes a sub-section on the development and deployment of low-/zero-carbon fuels, with green ports, onshore power, and green corridors explained as well. It also elucidates the need for promoting awareness, capacity-building, and cooperation on technical know-how of all green measures. Finally, infrastructure requirements for decarbonisation are briefly explained.

The EU extended coverage of the EU ETS Directive to include the maritime sector from January 2024. On the technical side of its implementation, there are several areas where feasibility studies or pilot projects are currently being carried out before its full-scale adoption. The shipowners are gradually adopting different energy efficiency improvement measures and/or propulsion improvement measures. However, the efficacies of many such technologies are still unknown. Therefore, precise quantification of fuel efficiency improvement is not possible. Any such quantification in the following section should be considered a ballpark estimate. The actual outcome may vary dramatically depending on vessel size, type, trade routes, operating conditions, weather etc.

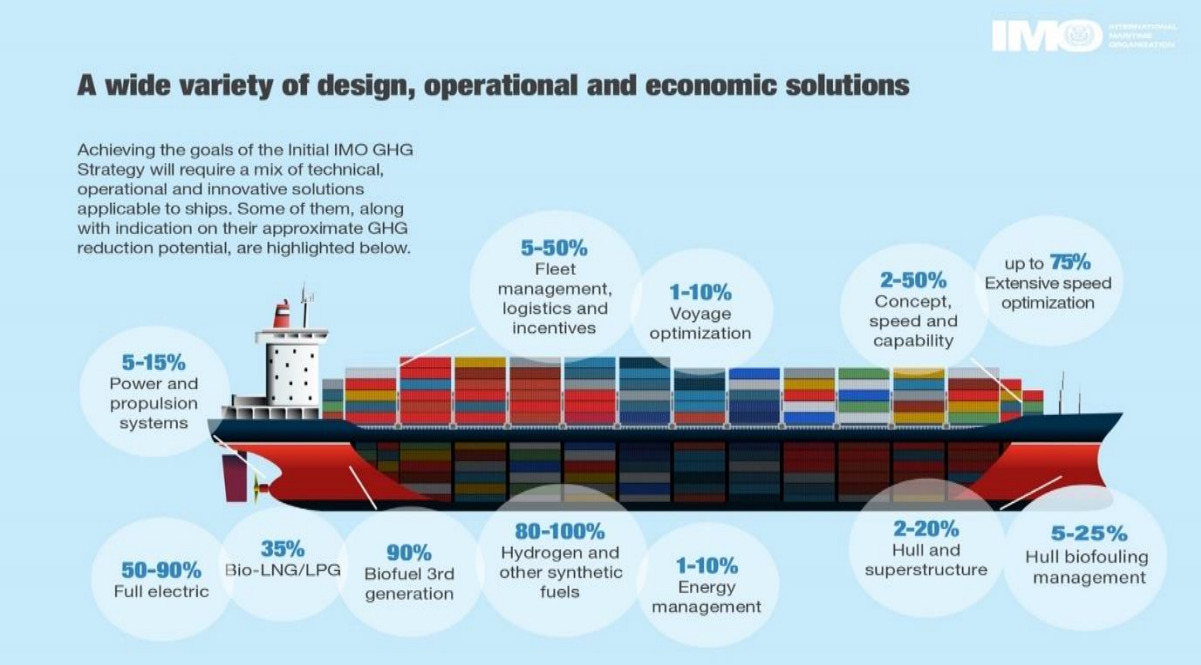
5.1 Adoption of energy efficiency measures

Energy efficiency in shipping can be achieved through a two-pronged approach – installing devices such as Energy Saving Devices (ESDs) and Propulsion Improving Devices (PIDs) on vessels, voyage optimisation, adequate maintenance of the vessels, weather routing or optimising the speed of the vessel.

5.1.1 Benefits of energy efficiency measures

The EU ETS requires shipowners and/or operators to purchase EUAs for emissions from vessels. These emissions can be reduced by adopting fuel-saving measures, such as Engine Power Limitation (EPL), and using some software tools, LED lighting, etc., which could produce immediate results as against ordering high capital-intensive new vessels running on low-/zero-carbon fuels.

Figure 5.1 Energy Efficiency & GHG Reduction Measures on Ships



Source: International Maritime Organization

5.1.2 Details of specific energy efficiency measures

Among the various energy efficiency measures available for ships in the Mediterranean region, the following are the most popular:

Engine Power Limitation (EPL)

EPL requires minimal changes to the ship and also retains the underlying performance of the engine, making it the simplest way for existing ships to meet EU's energy-efficiency requirements.

A ship's maximum power and, consequently, speed, are limited by EPL in a semi-permanent, overridable limit. This would take the form of a mechanical stop screw that is wire-sealed and restricts the amount of fuel that can enter an engine for engines that are mechanically controlled. A software fuel limiter secured by a password would be used to apply EPL to engines that are more recent and electronically controlled. If a ship needs additional engine power to operate in bad weather, EPL would take precedence. The override must then be documented and reported to the relevant regulatory body.

EPL could reduce fuel usage and CO_2 emissions if it results in lowering the operational speeds of affected vessels. However, a mandatory EPL will not directly reduce fuel use and CO_2 emissions if ships already operate slower than the de facto speed limit implied.

EPL is advisable up to a maximum of 60% power reduction as anything in excess would be counterproductive due to delays in targeted arrivals and deliveries.

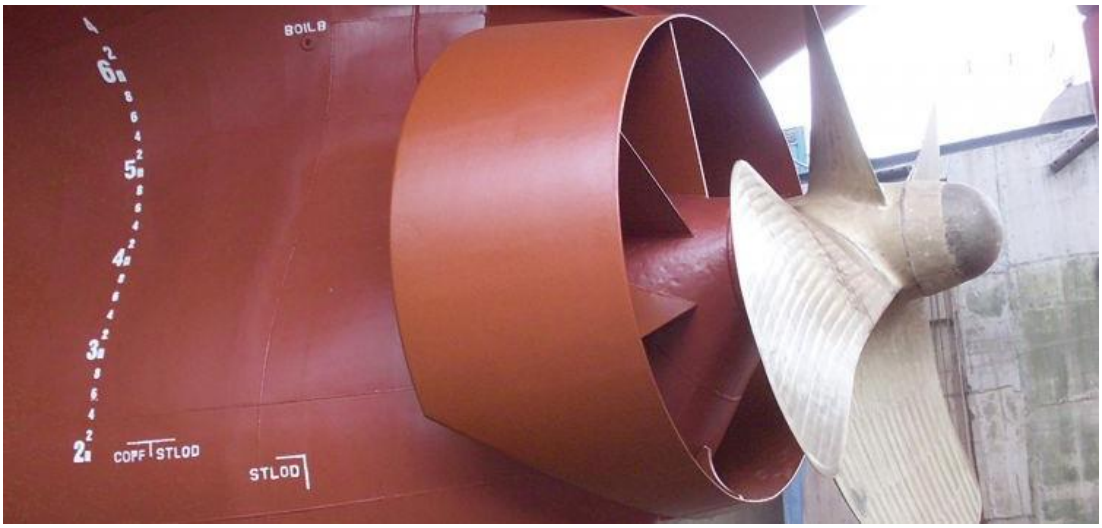
Propulsion Improving Devices (PIDs)

PIDs are fitted on the propeller/rudder, or in front of or behind the propeller/rudder to help improve the propulsion efficiency of a ship. However, retrofitting them on existing vessels requires the vessel to go to drydock and, hence, should be planned with its scheduled drydocking. In addition, PIDs require capex, which may not be justifiable in old vessels.

A few popular PIDs have been listed below:

1. Propeller ducting: A ducted propeller is a marine propeller fitted with a non-rotating nozzle. It is used to improve the efficiency of the propeller and is especially useful on propellers of vessels carrying heavy loads or propellers with limited diameter. The duct is made up of two sturdy, components that are fixed to the vessel: an integrated fin system and a duct that is placed in front of the propeller. The fin system gives the ship wake a pre-swirl that lowers losses in the propeller slipstream, increasing propeller thrust at a given propulsive power, while the duct straightens, accelerates, and creates a net forward thrust from the hull wake into the propeller. The two effects work well together. The power savings, which are virtually independent of ship speed, attainable from duct are strongly dependent on propeller thrust loading. The duct is ideally suited to both newbuild vessels as well as retrofitted in existing vessels. The propeller duct is estimated to save 3% to 8% of fuel and associated emissions.

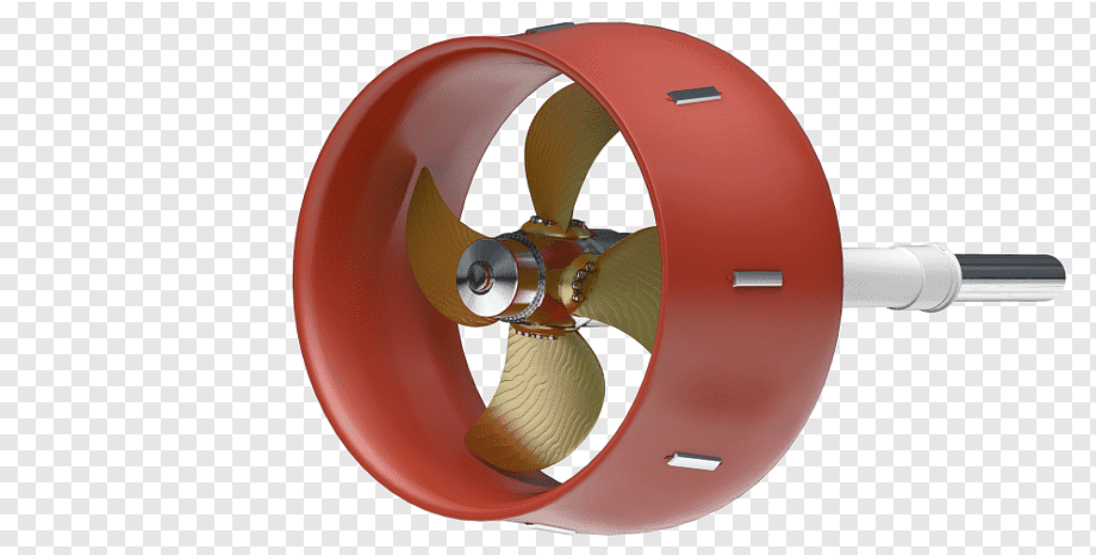
Figure 5.2 Propeller duct



Source: Becker marine systems

2. Propeller nozzle: The propeller nozzle is a circular casing enclosing the propeller which functions with a small space, approximately at the narrowest point, between the blade tops and the nozzle's internal wall. The cross-section of the nozzle ring resembles a hydrofoil. At low speed, the nozzle increases thrust, improving energy efficiency by 5% to 10%.

Figure 5.3 Propeller nozzle



Source: pngwing.com

3. Propeller boss cap fins (PBCF): PBCF is a boss cap that sits behind the propeller and has several tiny fins that can revolve in unison with the propeller blades to streamline the flow behind the propeller boss. The fins absorb the kinetic energy of the spinning flow around the boss, significantly weakening the hub vortex. This Enhances propulsion efficiency leading to an increase in energy efficiency by up to 5%.

Figure 5.4 Propeller Boss Cap Fins

Source: MOL Techno-Trade

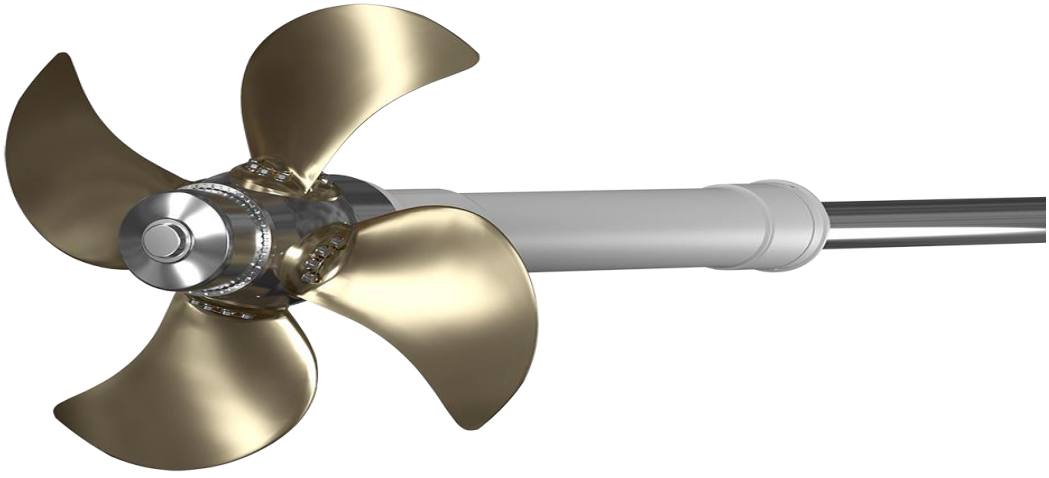
4. Propeller eco-cap: Energy is lost due to the hub vortex created behind the propeller cap by its trailing edge's circumferential direction of flow. A propeller eco-cap is like a cap on the propeller hub behind the propeller, diffuses the hub vortex, and recovers the lost energy. This produces an estimated energy saving of about 3% to 5%.

Figure 5.5 Eco-cap

Source: Nakashima

5. Controllable pitch propeller (CPP): A CPP is a type of propeller that can be adjusted to optimise the blade angle (pitch) under various circumstances. This results in increased efficiency under different speeds and under different loads. CPP is also often used on smaller boats and tugs as it facilitates better manoeuvring during berthing or other purposes and is estimated to save 3% to 5% in terms of fuel and emissions depending on vessel type and sea conditions.

Figure 5.6 Controllable pitch propeller (CPP)



Source: brunvoll

6. Propeller-rudder integration/alignment: A vessel's power efficiency depends upon the interaction between all its main components which need to form a single integrated design to achieve optimal performance. This also holds true for the interaction between the vessel's propeller and rudder, which, when in alignment, increases propulsion efficiency and therefore, results in energy efficiency increase by 2% to 10%. This is useful for offshore, shuttle tankers, ferries and Ro-Pax vessels. It leads to better propulsion efficiency, reduced level of emissions and vibration, lower operational cost and reduced pressure pulsations because of streamlining of flow from propeller to rudder.

Figure 5.7 Propeller-rudder integration/alignment

Source: brunvoll

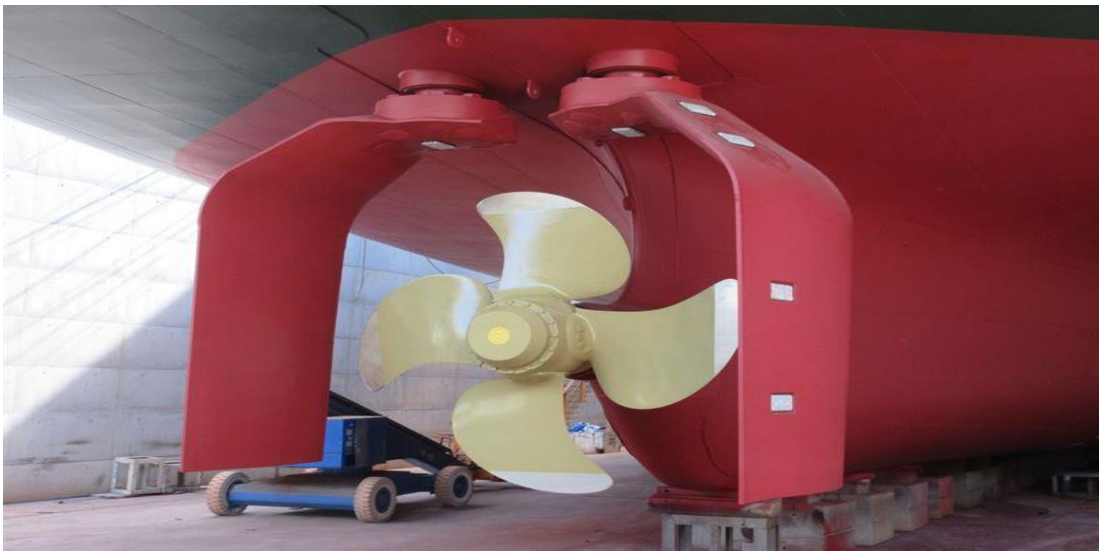
7. Rudder bulb: A rudder bulb is a streamlined bulb, which is fixed at the leading edge of the rudder. It improves the flow of water in front of the rudder and fills the vacuum behind the centre of the propeller. Direct fuel savings of up to 1.5% have been demonstrated by Computational Fluid Dynamics (CFD) calculations and tank tests, depending on the type of ship and its steering characteristics. Seagoing vessels with large propeller hub sizes and high thrust loads, such as bulk carriers, container ships, oil and chemical tankers, Ro-Ro vessels, and cruise ships, are the most suitable applicants for this energy-saving device. Newbuild ships can install a bulb and existing ships can have them retrofitted.

Figure 5.8 Rudder bulb

Source: Damen marine component

8. Gate rudder: The gate rudder is an advanced manoeuvring and energy-saving tool. It has a distinctive design with two foils on either side of the propeller. The hydrodynamic effects of the propeller and steering system enhance the resulting thrust performance during sailing. Gate rudder is estimated to save 5% to 20% of fuel/emissions depending on vessel type and sea conditions.

Figure 5.9 Gate rudder



Source: Wartsila

Shaft generator

The shaft generator operates as an alternator, driven from the main propulsion engine, to provide the primary power supply for the vessel's electrical systems. It generates electricity from the movement of the propellor shaft instead of the auxiliary engine and hence results in fuel savings of 3% to 5%. Provisioning a shaft generator along with the main propulsion system in the engine room when retrofitting may be challenging due to space constraints.

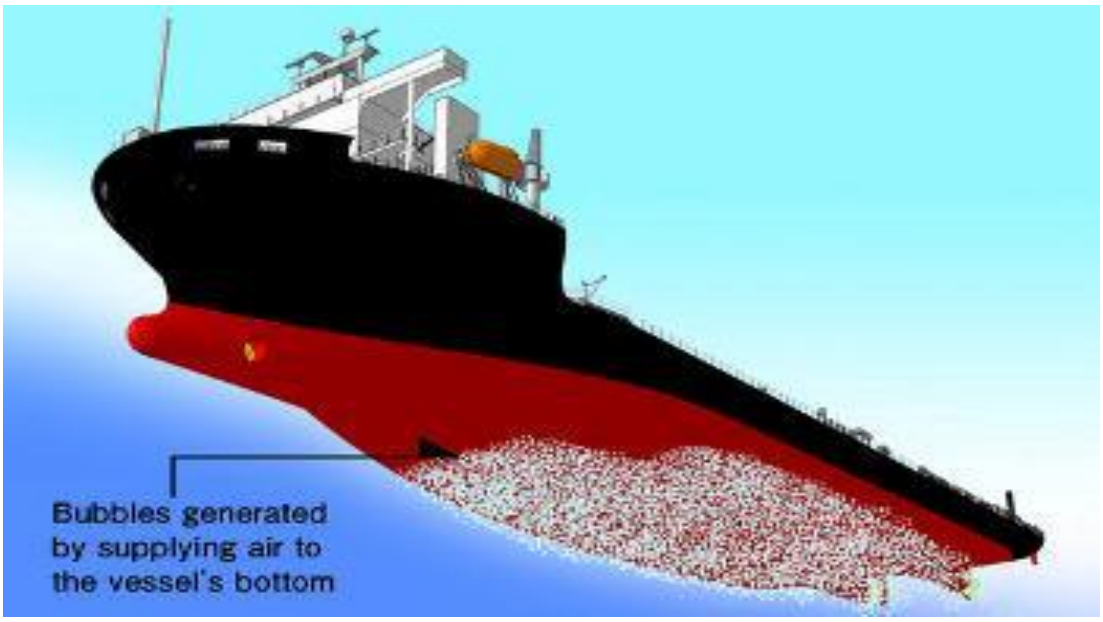
Waste heat recovery system

Waste heat recovery systems recover the thermal energy from the exhaust gas and convert it into electrical energy. This is an excellent way of cutting down on overall energy consumption and reducing GHG emissions by 5% to 10%.

Air lubrication system

By covering the entire flat bottom of a vessel's hull with a carpet of microbubbles, air lubrication lowers the frictional resistance of the hull. Fuel consumption and related GHG emissions can be lowered by up to 10% with air lubrication, subject to weather conditions.

Figure 5.10 Air lubrication system



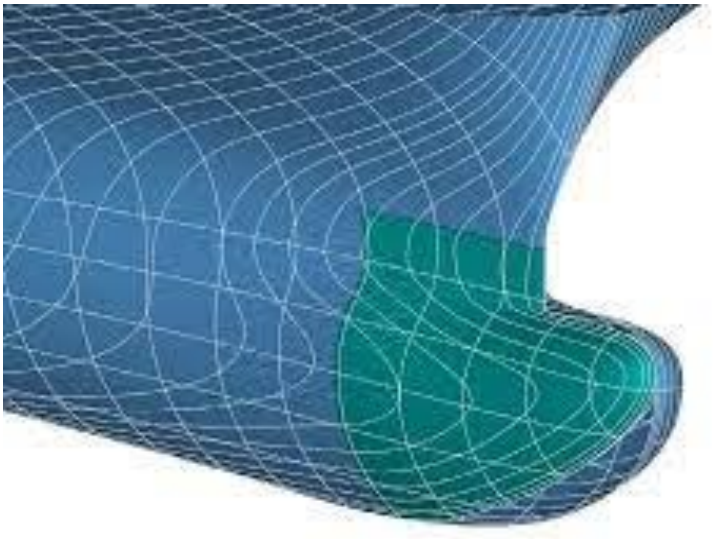
Source: Marine insight

Bow/hull optimisation

The bulbous bow and overall hull can be optimised using CFD analysis, resulting in less drag from water to the hull and therefore, less fuel/energy consumption for maintaining optimum speed.

Such optimisations are estimated to result in 5% to 10% energy efficiency. While they are generally preferred for newbuilds, they can also be retrofitted to existing ships.

Figure 5.11 Bow optimisation



Source: DNV GL

Wind-assisted propulsion system (WAPS)

WAPS using rotor, kites and sails, among others, are now available on ships which use wind for propulsion. While the performance of these systems traditionally depended on wind conditions, latest research shows that they can now be used to derive optimum benefits from most operating wind conditions, resulting in substantial savings of 5% to 20% in terms of fuel consumption and emissions depending on trading areas and wind conditions.

A point to note here is that WAPS is specifically encouraged under the FuelEU Maritime Regulation, as explained in Section 2.3.2.

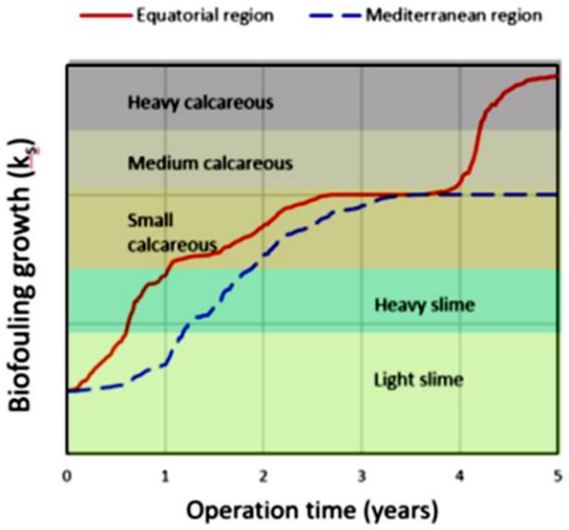
Figure 5.12 Wind-assisted propulsion system using rotors on deck

Source: DNV

Biofouling management measures

Biofouling is the accumulation of micro-organisms on the ship's hull which eventually increases the hull's roughness and results in higher fuel consumption.

Figure 5.13 Biofouling growth on the hull under the no-cleaning scenario in two different regions



Source: GloFouling Partnerships Project Coordination Unit, International Maritime Organization

In the Equatorial region, biofouling on the hull reaches a heavy slime level at the end of the first year of operation, while the process is relatively slow in the Mediterranean region.

High-performance anti-fouling paints are low-hanging fruits that can reduce fuel consumption by up to 20% compared to average antifouling coatings. However, anti-fouling paint alone is not sufficient to prevent biofouling and therefore biofouling management systems need to be carried out to reduce GHG emissions. A rough calculation suggests that if all international ships maintained a smooth surface (free from biofouling) GHG emissions from ships would reduce by 19% per year.

Biofouling management measures include but are not limited to:

1. Anti-fouling paint: it remains the first and foremost way to prevent marine growth on the hull.
2. Ultrasonic anti-fouling systems: they work using specific frequencies by emitting low-powered pulses to prevent marine growth from settling on the hull.
3. Hull cleaning: it is a reactive method, whereby the hull is cleaned to get rid of micro-organisms.
4. Hull grooming (hull skating system): it is a proactive method which is a frequent and gentle wiping of the hull to prevent micro-organisms from settling on its surface.

Other measures

In addition to the above, there are several other measures such as hull cleaning and painting, propeller polishing, voyage optimisation, trim optimisation, LED lighting and variable frequency drives (VFDs) for pumps, which may help in saving fuel/energy.

Regular hull cleaning helps in reducing the drag it faces from water. Also, special paint applications such as ultra-violet-based or silica-based paints on the hull are proven to help reduce marine growth thereby reducing the drag it faces from the water. Less drag results in less energy/fuel consumption for maintaining the speed. These measures are estimated to save 1% to 10% of fuel/emissions.

Propeller cleaning and polishing improves propulsion efficiency, which in turn will help in saving fuel/energy.

Voyage optimisation involves the selection of optimum voyage route for reaching point B from point A whereas trim optimisation involves sailing the vessel at an optimum trim condition in a particular load condition. Optimum conditions mean consuming the least amount of fuel/energy without hampering the minimum requirements of vessel operations. These measures can save fuel/emissions by 5% to 15%.

Using LED lights instead of conventional lights help conserve energy, though to a small extent, while VFDs in pumps reduce power consumption resulting in an increase in energy/fuel efficiency of 5% to 20%

Some of these, such as LED Lighting, VFD, voyage and trim optimisation, are low-cost measures that do not require vessels to be in drydock.

5.2 Investment and promotion of green technologies as well as building zero-carbon ships

Ships with high emissions will be considered a liability as their EUAs will be high which will reduce their net earnings. Therefore, inclusion of shipping under the EU ETS will result in growth of green technologies and lower emission from ships in the Mediterranean region.

5.2.1 Benefits of green technologies and low-/zero-carbon ships

The long-term solution for avoiding EUAs is emission-free or zero-carbon ships, which is the ultimate goal of all stakeholders. At present, small vessels can still achieve zero-carbon emissions as they can use electricity or fuel cells for their short voyages, which is not feasible for bigger vessels.

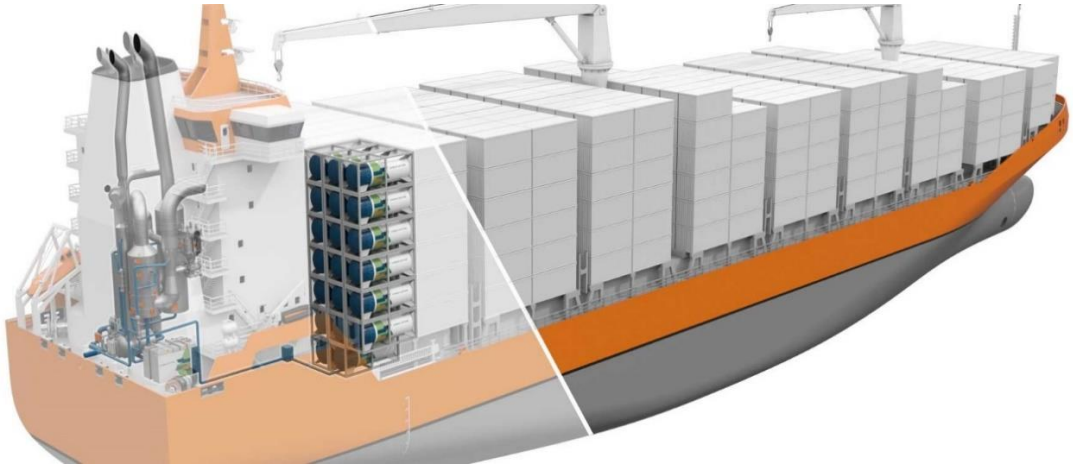
Battery-electric ferries have been deployed in some parts of the world and their fleet is already expanding. Although batteries appear to be the most cost-effective option, hydrogen fuel cell ferries are also in operation. However, the cost and weight of batteries as well as cost and storage difficulties of hydrogen fuel are currently limiting the scalability of hydrogen as a zero-carbon fuel. Use of sustainable biofuels is another popular option for reducing emissions. A point to note here is that sustainable biofuels are specifically encouraged under the FuelEU Maritime Regulation, as explained in Section 2.3.2.

The transition to low-/zero-carbon emissions remains much more challenging for larger ocean-going ships, such as dry bulk, containerships and tankers. The low energy density of fuel cells and electric batteries, among others, reduces their viability because of the long voyages between recharging/refuelling. Moreover, storing hydrogen in a compressed or liquid form over long voyages requires substantial modifications in the ship design, safety measures and regulations. Ammonia and other green fuels could be attractive substitutes. However, as the efficiency of conventional fuel engines is comparatively high, these new technologies become unattractive because of their high operational costs and larger storage space requirement which could reduce the cargo-carrying capacity of vessels.

Onboard carbon capture and storage (OCCS)

OCCS deploys a CO_2 scrubber through which the ship's exhaust gases are made to pass. The solution in the scrubber absorbs CO_2 and redirects it into liquid CO_2 storage containers onboard or in liquid CO_2 tanks. These containers can be discharged at receiving ports or liquid CO_2 from the tanks can be discharged via pipelines. Infrastructure to receive liquid CO_2 or CO_2 storage containers needs to be developed in ports. As of now, there are no clear regulatory guidelines applicable to OCCS, which also need to be taken care of on a priority basis.

Figure 5.14 Carbon capture technology on ships



Source: Wartsila Carbon Capture System

Carbon capture technologies are more useful for reducing emissions in hard-to-abate sectors such as power plants as well as cement and steel manufacturing. Once the supply chain develops, there could be great potential for deployment of carbon capture technology provided ports invest in infrastructure for receiving liquid CO_2 containers or liquid CO_2 via pipelines (liquid CO_2 terminals) or even CO_2 byproducts such as limestone. As OCCS technology may become increasingly popular, its pilot projects are picking up pace.

Low-/zero-carbon shipping options

Zero-carbon emissions can be achieved only when all fossil fuels from ships are replaced with (1) renewable energy that can be used to propel and power a ship where possible; and (2) development of supply of green fuels. With combined efforts in developing green fuels as well as various renewable energy forms, zero-carbon emission ships would become a reality in the future. Some of the available options are listed below.

1. Battery-operated electric ships: These are mostly small, fully electric ships, trading on short-sea or inland routes with no Internal Combustion (IC) engine but instead having adequate storage space for high-powered batteries. The batteries power the entire ship from propulsion to auxiliaries requirements. With battery power onboard and charging infrastructure onshore, there is practically no scope for carbon emissions. Examples of these ships include ferries, tugs and inland waterway vessels that sail short distances and can therefore operate on smaller batteries which weigh less and are faster to recharge.

2. Hydrogen-powered ships: Hydrogen, the most abundant element on Earth, can be used extensively in the maritime sector as one kg of hydrogen releases 4 times more energy than one kg of coal and almost 3 times more energy than one litre of gasoline. Hydrogen in fuel cells can be used to propel vessels using electric motors and to also power all electrical equipment onboard. Since the only emission is water with no traces of CO_2, hydrogen as a green fuel enables net-zero emissions from a ship. Several shipping companies are pursuing the commercialisation of hydrogen fuel cells, but there are challenges with respect to the high cost of fuel cells and the large storage space required onboard for liquid hydrogen.

   Use of hydrogen in an IC engine is also being explored despite the disadvantages. While large storage tanks required for hydrogen on vessels can significantly impact their cargo-carrying capacity, these tanks need to be specialised as the hydrogen molecule is extremely small and can escape from a normal steel container. There are other challenges as well, such as its inflammable and explosive characteristics.

3. Solar-powered ships: Ships trading in areas with sunlight, can use solar energy to propel and provide electrical power onboard. Some small boats have been using solar power for several years now, but a large vessel lacks enough area for solar panels to generate propulsion power. While placing solar panels on the deck is an option, it may be feasible for ships which do not carry cargo on deck such as car carriers.

Figure 5.15 Solar power generation on ships

Source: NYK line

Solar power by itself may not be enough to run a ship fully but it can be used in conjunction with other energy sources to advance towards carbon neutrality.

4. Wind-powered ships: Wind power is also a formidable renewable energy source for reducing emissions and is being tested for efficiency with several different configurations and sail types. Some popular options include flexible sails, rigid sails, kite sails and rotor sails. These designs are being developed by some of the biggest shipping companies in the industry such as NYK, STX and Wallenius Wilhelmsen, etc.

5. Wave-powered ships: Research is also underway to use wave energy as a step towards making a ship carbon-neutral. The setup would allow a ship to harness the power of waves and cut down its dependence on fossil fuels.

   The Fraunhofer Centre for Manufacturing Innovations has designed equipment that allows ships, whether moving or stationary, to produce electricity from the movement of waves. The company intends to test this on small boats that go out for about 20 hours. If successful, this system could also be commercialised for merchant vessels and reduce dependency on fossil fuel-based power generation systems.

5.2.2 Investment and R&D support requirements for green technologies/zero-carbon ships

As stated in Section 5.2.1, many viable options for zero-carbon ships are currently in development and these efforts require massive investment from interested stakeholders – be it for producing green fuel, creating bunkering infrastructure, building modern fuel-efficient ships or even retrofitting existing ships.

According to a report published by Denmark-based Global Maritime Forum, global investments of at least $1.4-1.9 trillion are needed to fully decarbonise shipping by 2050. This estimate should be seen in the context of annual global investments in energy, which amount to trillions of dollars.

As per the World Energy Investment Report, global energy investment is set to exceed USD 3 trillion for the first time in 2024, with USD 2 trillion dedicated to clean energy technologies and infrastructure.

5.3 Development and deployment of low-carbon and zero-carbon fuels (green fuels)

The inclusion of shipping under the EU ETS may prompt the stakeholders in the Mediterranean to switch to low-carbon or zero-carbon fuels in order to reduce their emission liability.

5.3.1 Development of low-/zero-carbon fuels

In recent years, the shipping industry has increasingly focused on the development and application of low-/zero-carbon fuels to reduce emissions and pollution due to the regulatory push from the IMO and the EU.

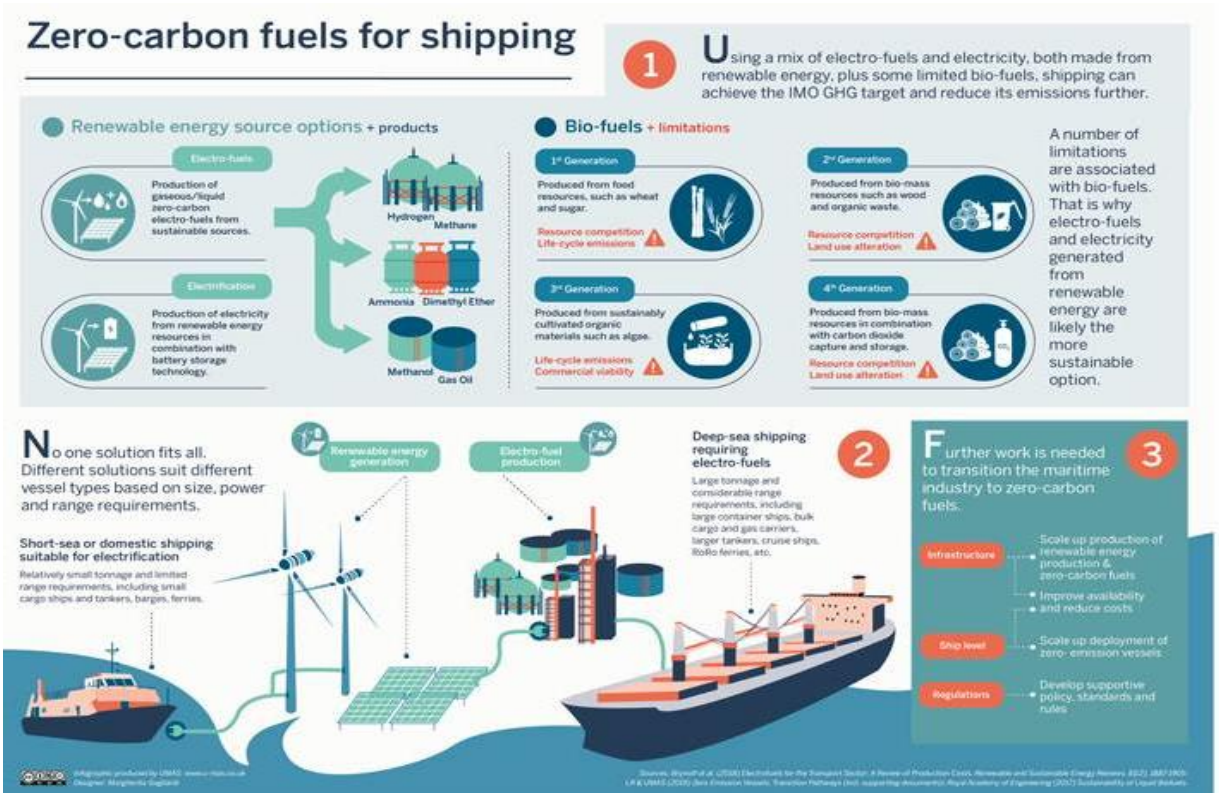
Green fuels include sustainable biofuels, LNG, methanol, ammonia and hydrogen. Most of these fuels can be categorised into different colours depending on their production processes. Grey and brown fuels are produced with natural gas and coal as feedstock, respectively, while blue fuels are produced by capturing and storing CO_2 exhaust gases during the production process and green fuels or e-fuels/synthetic fuels are produced from renewable sources and have the potential to significantly reduce emissions in the entire cycle. Low-/zero-carbon fuels include synthetic LNG, green methanol, sustainable biofuel, green hydrogen and green ammonia.

The use of low-/zero-carbon fuels can effectively address the current environmental problems.

While low-/zero-carbon green fuel, combustion technologies for low-/zero-carbon fuels in ships as well as some of the new clean power technologies are all work in progress, significant development has been made to power ships in the future.

At present, the available green fuels are fossil-based which will transition to blue fuels (in which CO_2 emissions are captured during the production process) and finally to e-fuels that use hydrogen either from electrolysis and CO_2 from the atmosphere or captured CO_2 or Nitrogen from the atmosphere. The present production of e-fuels is limited due to the high cost of generating renewable electricity, but their production is gradually increasing.

Figure 5.16 Zero-carbon fuels for shipping

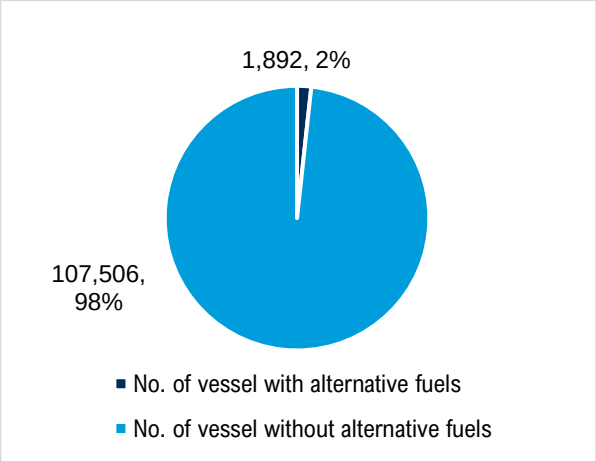


Source: UCL Energy Institute, UK

5.3.2 Alternative fuels[9]

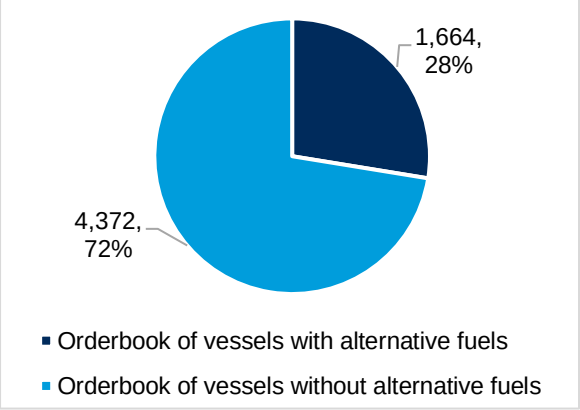
Decarbonisation of shipping is increasingly coming under pressure, necessitating suitable alternative green fuels to replace fossil fuels. Following are some of the alternative fuel options that are gaining ground:

Figure 5.17 Global fleet alternative fuel uptake



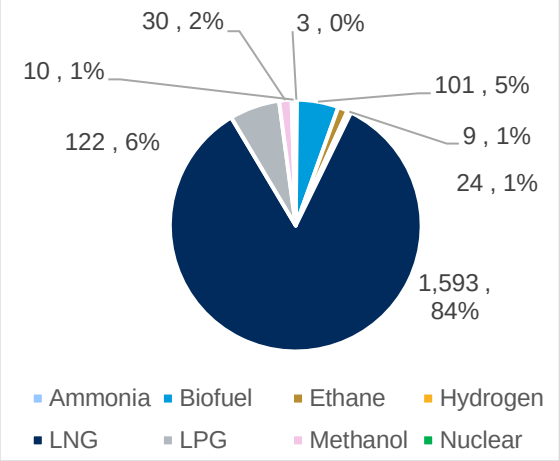
Source: Drewry, Clarksons

Figure 5.18 Global orderbook alternative fuel uptake



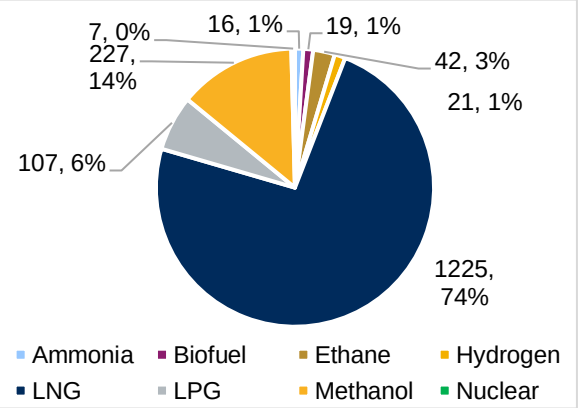
Source: Drewry, Clarksons

Figure 5.19 Alternative fuel type – total global fleet



Source: Drewry, Clarksons

Figure 5.20 Alternative fuel type - total global orderbook



Source: Drewry, Clarksons

[9] Most of the alternative fuels being used at present are not low-carbon or zero-carbon fuels, hence are referred to as alternative fuels in the title.

About 2% of the existing global fleet is capable of burning alternative fuel. LNG is still the preferred alternative fuel for shipowners, followed by LPG, biofuel, and methanol.

About 28% of the vessels on the orderbook are capable of using alternative fuel. LNG is currently the preferred fuel, while methanol is gaining momentum.

Biofuels

Biofuels are fuels derived from biomass or biomass residues. Fatty Acid Methyl Ester (FAME) as well as Hydrotreated Vegetable Oil (HVO) and Used Cooking Oil (UCO) are among the popular biofuels in the maritime industry. They are drop-in fuels that are blended with conventional fossil fuels to be used in existing engines and fuel infrastructure. Presently B24, which has 24% biofuel and 76% conventional fuel, is gaining popularity while pilot trials are being carried out for the use of B50 and B100. Biofuel needs to be sustainable not competing with human consumption or causing deforestation.

Since the reduction in CO_2 emissions is proportionate to the biofuel blending percentage, the use of sustainable biofuels offers a quick and efficient way to reduce emissions from the vessel. However, the key challenge is the limited supply of sustainable biofuels. And, with other sectors expected to be prioritised over the maritime industry, the availability of sustainable biofuels for the maritime sector could be limited.

Methanol

Methanol has been gaining traction as a marine fuel over the past few months due to its manageable hazards. The global fleet already comprises 30 vessels that are powered with methanol as an alternative fuel with 227 vessels on order. With the development of methanol supply chain and bunkering infrastructure, its adoption will only increase in the medium term. On the downside, when compared with conventional fossil fuels, methanol is toxic and also needs more storage space due to its lower energy content.

Liquefied Natural Gas (LNG)

LNG, with its well-developed global supply chain and bunkering infrastructure, has increasingly become popular as an alternative fuel to reduce SO_X and CO_2 emissions in the maritime industry.

Apart from being a fossil fuel, LNG as a bunker is not a good alternative fuel unless the methane slip, which represents the small quantities of methane that remain unburned and escape into the environment, is reduced. Methane as a GHG is about 30 times more harmful than CO_2 and efforts are on to reduce the slip. Vessels running on fossil versions of LNG will need to switch to bio-LNG and e-LNG in the future to remain compliant.

Ammonia

Ammonia when used as a fuel release only nitrogen and water vapour, eliminating direct CO_2 emissions. It is therefore touted as the best and perhaps the cheapest green fuel for future maritime applications. However, using ammonia as a fuel is not free from risks which include its high toxicity as well as the huge supply chain and bunkering infrastructure limitations. If ammonia is not used effectively, it can be a concern for GHG emissions because of ammonia slip.

Ammonia as a fuel is currently in the pilot trials stage with some ammonia ship designs approved in principle by the concerned authorities and a few newbuilding orders placed as well.

Hydrogen

Hydrogen is a promising future fuel for shipping and is considered a clean fuel emitting only water vapour. While hydrogen fuel cells are already being used by small ships on the water, the challenge is to use hydrogen IC engines, which could still take some time to develop despite the research and development in progress. The many issues of using this fuel include the massive storage space required for hydrogen on board ships, the highly inflammable characteristic of hydrogen, and the limited supply chain and bunkering infrastructure.

As hydrogen demands a huge storage area, its use as marine fuel by large ocean-going vessels is likely to be limited over the next few years.

5.3.3 Deployment of low-/zero-carbon fuels

While the development of low-/zero-carbon fuel is a work in progress and has its own challenges, the deployment of such fuels at scale is another challenge that needs to be overcome. Fuel producers are reluctant to produce clean fuels at scale as there is not enough demand and vessel owners shy away from investing in vessels that use clean fuels citing high price, lack of infrastructure and low availability of clean fuels.

Major challenges include establishing and scaling supply chains, revising fuel standards that directly or indirectly restrict the use of some low-/zero-carbon fuels, and accelerating the pace of infrastructure deployment and adoption of modern, fuel-efficient ships. Other challenges include high capital costs and long gestation periods in addition to low availability of sustainable biofuel for the maritime sector.

However, thanks to substantial efforts by industry first movers, low-/zero-carbon fuels such as LNG and methanol are being deployed. The progress in development and deployment of zero-carbon fuels such as hydrogen and ammonia is also visible with the order of the first ammonia-fuelled vessel. Collaboration and partnership among shipowners, ship management companies, charterers and fuel producers have been key factors in the progress thus far.

5.3.4 Green and Blue Ammonia in some of the Mediterranean coastal States

The analysis carried out in some of the Mediterranean costal States shows Spain having one operational project along with 10 speculative projects for green and blue ammonia. On the other hand, Egypt has 18 green ammonia speculative projects and one blue ammonia speculative project, whereas, Morocco has 9 speculative projects.

Table 5.1 Green and Blue ammonia projects in some of the Mediterranean region

Green ammonia project under analysis for some of the Mediterranean coastal States			
Country	**No. of Projects**	**Operational**	**Speculative**
Spain	11	1	10
Egypt	18	0	18
Morocco	9	0	9

Blue ammonia project under analysis for some of the Mediterranean coastal States			
Country	**No. of Projects**	**Operational**	**Speculative**
Egypt	1	0	1

Source: Argus

Development of green fuels have been undertaken and is ongoing at various ports in the Mediterranean region. Some of them are listed below:

- Spain (Gibraltar Strait) – Port of Algeciras: Green hydrogen (possible developments of green ammonia); produced using electricity generated through solar and wind power plants.
- Spain – Port of Barcelona: Biofuels (said to be able to achieve a reduction of CO_2 emissions by 90%).
- Portugal – Port of Lisbon and Port of Sines: Biofuels & LNG.
- Italy – Port of Genoa: Biofuels.

5.4 Development of onshore power supply, green ports and green corridors

Onshore power will supply electricity to vessels at berths, while green ports and green corridors will reduce overall emissions.

5.4.1 Onshore power supply

Since emission of vessels while at port will be considered in overall EUA liability under the EU ETS, OPS will gain momentum in the Mediterranean region. Provision of OPS (generated from clean sources such as solar and wind) for visiting ships/vessels is a vital component of this concept.

Figure 5.21 Onshore power supply to a ship at berth

Source: Cavotec website

Onshore power is the power that is provided by the shore to the ship at berth, allowing the ship's auxiliary engine to be switched off and thereby reducing pollution of water and air.

Onshore power can either be placed vertically or horizontally, giving it a degree of flexibility in finding a suitable installation location. It is usually lightweight and compact, and can be installed in small spaces otherwise unused onboard.

It can be designed from the ground up for marine use and produces regulated and stable output, regardless of changes in power from the berth or from load demand onboard. It is designed to work in marine environments, where it may be called upon for constant use in high-temperature environments. Additionally, onshore power works with any marine power system worldwide.

Onshore power is a key element of FuelEU Maritime Regulation for EU Member States with clear penalty for non-compliance. From 1 January 2030, container and passenger vessels calling any port in EU Member State for a port stay above two hours will be required to connect to the onshore power. The ports of Hamburg and Antwerp are among the first ports in the EU to provide onshore power to visiting ships. The first onshore power facility in the Mediterranean commenced operations in Malta in July 2024. However, such regulatory mechanisms are lacking in ports of Mediterranean coastal States that are not EU Member States.

The cost of installation of onshore power is very variable and can be high. Hence, some grants should be made available.

5.4.2 Green ports

A port can be classified as green when it optimally uses green/clean energy for all its operations including its interaction with visiting ships/vessels. Such a port is increasingly becoming an economic necessity rather than just a regulatory requirement.

With increased regulation from global bodies like IMO, EU, national maritime and port authorities, as well as growing customer demand for responsible handling practices, green ports have never been more important. More and more shipowners are now deciding to route their ships to green ports in order to avoid emission and carbon tax liabilities.

Figure 5.22 Solar power generation in a port

Source: Port of Seattle

Figure 5.23 Wind power generation in a port

Source: Teri website

A green port goes beyond traditional port operations by investing in environmentally friendly and sustainable practices in all aspects of the maritime industry. On a global scale, international maritime and shipping coalitions are uniting supply chain stakeholders to reduce power consumption and carbon emissions collectively. The Port of Antwerp is considered to be a leading example of a green port. The following aspects are typical elements of green port concepts:

- In order to reduce emissions as well as the carbon footprint, ports have been expanding electricity-powered operations such as electric Rubber-Tired Gantry (RTG) cranes with most stakeholders investing in increasing electrification.
- Ports can invest in infrastructure to provide electrical onshore power as well as low-/zero-emission fuel to vessels at berth and thereby contribute significantly to reducing their carbon footprint.
- A powerful tool, digitalisation can help improve energy efficiency and reduce the carbon footprint by enabling the monitoring and analysis of operations. Moreover, stakeholders can take informed decisions when they are aware of what needs to be done.
- Ports can significantly contribute towards reducing emissions by investing in Just-In-Time (JIT) system and providing vessels with important information ahead of time. As a result, vessels can adjust their speeds and thereby reduce harmful emissions.

5.4.3 Green corridors

Inclusion of shipping under the EU ETS in January 2024 has paved the way for establishing green corridors in the Mediterranean region.

A green shipping corridor is a shipping route that allows for the deployment of low-/zero-carbon emission ships while also measuring and enabling emission reductions through both private and public actions and policies. Due to the risks associated with some low-/zero-emission fuels, every port in the green corridor will have to conduct a risk analysis to allow vessels using these fuels, berth. Some elements must be taken into account in order to establish a green corridor: a feasible fuel pathway, consumer demand for sustainable shipping, supportive laws and regulations, and cooperation across value chains.

Figure 5.24 Green corridor

Source: ABS website

If a port becomes part of a green corridor in the Mediterranean region, it will help uplift the whole region by developing better infrastructure while improving the availability of green fuels and efficient technologies. Interestingly, some studies have pointed out the potential for multiple green corridors around Spain in the Mediterranean region which could be developed soon. These green corridors represent a significant opportunity for the Spanish economy. Spain is well-positioned to become a first-mover nation in the Mediterranean region.

Figure 5.25 Example of shortlisted possible green corridors involving Spanish ports

Source: Global Maritime Forum

In addition, CMA CGM acquired freight and passenger company La Méridionale to use the latter's lines for creating green corridors in the Mediterranean region. In another example, the Singapore-Rotterdam Green and Digital Shipping Corridor through the Mediterranean Sea unites more than 20 partners from across the shipping industry's value chain in an effort led by two of the biggest bunkering hubs in the world. The corridor is established on one of the busiest trade routes in the world and features participation from all major container lines active on that route.

To gradually eliminate the carbon footprint in shipping, cooperation among all stakeholders is crucial. Strong initiatives by the relevant controlling authorities to bring all Mediterranean coastal States on one platform would be the need of hour. This could possibly be done by adequately explaining the technical and commercial benefits of adopting suitable decarbonisation technologies. The authorities might need to provide certain additional benefits or incentives to Mediterranean coastal States that are not EU Member States to encourage them to adopt decarbonisation technologies.

5.5 Promoting awareness, capacity-building and cooperative green measures

In order to reduce emissions, it is critical to create awareness, build capacity and foster cooperation among various stakeholders.

Promotion of technical awareness on green measures

Technical awareness on various decarbonisation methods among the stakeholders is of vital importance as they need to take informed decisions on the measures that suit them best.

Capacity-building measures

The implementation of technical measures would achieve the desired result only if it is done on a large scale. There is a need to bring the buyers and suppliers of green fuels together and also to enhance capacity and capabilities of shipyards.

Cooperation between interested parties

For shipping to gradually eliminate the carbon footprint, cooperation among all stakeholders is crucial.

5.5.1 An example of capacity-building measures: Namibia

Decarbonisation is critical for all countries, including the Mediterranean coastal States, and the EU, as a whole, which is forming a green partnership to help achieve this goal. It is in this vein that the region partnered with Namibia to procure clean hydrogen at competitive prices since the country is rich in renewable energy resources.

The suitability and adaptability of regulations, economic and investment policies, and trade routes from Namibia to Europe are important conditions for unlocking the partnership's goals. EU needs to ensure that its regulations are practical, adaptable, transparent and evidence-based to effectively govern renewable hydrogen trade with Namibia. At the same time, Namibia will need to maintain its political stability through inclusive government policies and fair political power transitions, while working towards achieving reliable exports, and stable transport corridors to continue trade with EU Member States.

To support this goal, Namibia will need to amend certain laws and acts to reflect current plans for clean hydrogen development and export, including the Water Resource Management Acts of 2004 and 2013, the Electricity Act of 2007, the Standards Act of 2005 and the equitable economic empowerment bill of 2016.

In turn, the EU has promised to mobilise €1 billion in investment for renewable hydrogen and raw materials infrastructure in Namibia, wherein the German government has agreed to invest € 40 million for technical and financial support. In parallel, the European Investment Bank (EIB) has signed a joint declaration towards renewable energy and hydrogen investments and also plans to partner with European companies to co-finance this project in Namibia.

This initiative of strategic partnership between the EU and Namibia has caused the ports of Rotterdam and Antwerp to establish Memorandums of Understanding with Namibian port authority to upgrade the ports of Walvis Bay and Lüderitz in the country.

Inspired by this example, Tunisia – a Mediterranean coastal State – signed six Memoranda of Understanding (MoUs) with a few European companies in July 2024 to export around 6 million tonnes of green hydrogen, and other Mediterranean coastal States could follow suit.

5.6 Development of an ecosystem and infrastructure that support and promote green measures

The maritime shipping ecosystem and its supporting infrastructure are needed to promote emission reduction measures.

5.6.1 Establishment of conducive ecosystem

The ecosystem consists of many relevant players such as policy makers, regulators, ports, shipowners/managers, charterers, ship agents, ship builders, fuel producers, educational/training and research institutes, among others.

Each player of the ecosystem would need to be sensitised towards the emerging green technologies and how best to adopt them for the overall benefit of their region. Full potential of all technical measures in this regard can be realised only when the entire ecosystem works towards one common goal of decarbonisation.

Figure 5.26 Maritime shipping ecosystem

Source: Drewry

The Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP) and its components, including REMPEC, have taken initiatives under the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (the "Barcelona Convention") and its seven protocols, to preserve and improve the marine environment in the Mediterranean region.

Other examples:

- The Green Marine Med Project is supporting innovations, building capacity and improving sustainable finance in Mediterranean ports and maritime transport industries.
- The Just Transition Fund (JTF) is the first pillar of the Just Transition Mechanism (JTM) under EU to support the territories most affected by the transition towards climate neutrality, providing tailored technical support to authorities drafting the Territorial Just Transition Plan.

European Neighbourhood Policy and Neighbourhood Investment Platform

The European Neighbourhood Policy (ENP) was launched in 2004 to foster stability, security and prosperity in the EU's neighbouring regions in the south and east. It builds on the commitment of the EU and its neighbours to work together on key priority areas.

The agenda focuses on five policy areas:

- Human development, good governance and the rule of law;
- Resilience, prosperity and digital transition;
- Peace and security;
- Migration and mobility; and
- Green transition: climate resilience, energy and environment.

There are 16 partner countries covered under ENP, which are categorised down below as Mediterranean coastal States that are not EU Member States and other countries/territories.

Table 5.2 Countries covered under ENP

Mediterranean coastal States that are not EU Member States	Other countries/territories
Algeria	Armenia
Egypt	Azerbaijan
Israel	Belarus
Lebanon	Georgia
Libya	Jordan
Morocco	Palestine
Syrian Arab Republic	Republic of Moldova
Tunisia	Ukraine

Source: European Union External Action

The Neighbourhood Investment Platform (NIP) is a mechanism aimed at mobilising additional funds to finance capital-intensive infrastructure projects in EU partner countries covered under ENP in transport, energy, environment and social development sectors.

5.6.2 Infrastructure support requirements

Infrastructure may need to be built to support the development and implementation of new green technologies:

New infrastructure would be necessary at ports and shipyards where they could adopt clean/green operations and also support the construction and operations of ships using clean/green methods.

New infrastructure would be required for fuel producers to produce and supply the green fuels at scale.

New infrastructure would be required to store and transfer the green fuels such as onshore storage tanks, bunkering vessels/barges and berth with fuel transfer structure.

Other requirements such as healthy demand and supply of fuel, approved bunkering guidelines, competitive fuel pricing and location of bunkering ports in major trade lanes are also vital.

The usual methods of bunkering such as STS bunkering, shore-to-ship bunkering and truck-to-ship bunkering would need to be re-visited for green fuels. While biofuels can use the existing bunkering infrastructure, new infrastructure would be necessary for green fuels such as LNG, methanol, hydrogen and ammonia. Of these, the bunkering infrastructure for LNG is fairly developed and evolving for methanol, but for hydrogen and ammonia it is still under development.

An infrastructure upgrade or a new infrastructure may be necessary even for the ship and port equipment providers such as manufacturers of engines and ESDs/PIDs in order to support manufacturing as per new green technologies.

Ship owners/managers/agents may need improved infrastructure in terms of equipment, manpower and training centres in order to cope with the new green technologies.

Infrastructure requirements for green corridors will need to be worked out separately depending on the participants and routes.

Service providers such as repair agencies for various machinery onboard may either need to upgrade their services to support the machinery for green technologies or in some cases, build a completely new range of services due to the nature of machinery/equipment.

5.7 Section summary

The EU ETS requires shipowners and/or operators to purchase EUAs for vessel's GHG emissions. Ships with high GHG emissions will be considered a liability as their EUAs will be high, reducing their net earnings. Therefore, the inclusion of shipping under the EU ETS will lead to the adoption of green technology and lower emissions from ships in the Mediterranean region.

These emissions can be reduced by adopting fuel-saving measures, such as EPL, LED lighting PIDs, ESDs, as well as using some software tools. These could produce immediate results in the short term as against ordering high capital-intensive new vessels running on low-/zero-carbon fuels.

Few examples of such fuel-saving measures are:

- Engine Power Limitation
- Propeller ducting
- Propeller nozzle
- Propeller boss cap fins
- Propeller eco-cap
- Controllable pitch propeller
- Propeller-rudder integration/alignment
- Gate rudder
- Shaft generator
- Waste heat recovery system
- Air lubrication
- Bow/hull optimisation
- Wind assisted propulsion system

Biofouling is the accumulation of micro-organisms on the ship's hull which eventually increases the hull's roughness and results in higher fuel consumption. High-performance anti-fouling paints are low-hanging fruits that can reduce fuel consumption by up to 20% compared to average antifouling coatings. However, they are not sufficient to prevent biofouling and some new innovative technologies such as robotic hull cleaning are under development to free the vessels from unwanted biofouling, which could reduce friction, and hence, emissions.

Retrofitting PIDs on existing vessels requires the ships to go to drydock and hence, should be planned with their next scheduled drydocking. Since such devices require Capital expenditure (capex), it may not be justifiable in old vessels where ESDs may be more suitable as they are cheaper and may not require the vessel to go to drydock for retrofitting.

OCCS is a technological advancement where CO_2 scrubber is installed to pass exhaust gases where CO_2 is absorbed and stored in a container or in liquid tanks which can be discharged at receiving ports. As OCCS technology may become increasingly popular, its pilot projects are picking up pace.

Other ways to comply with strict environmental regulations is the use of zero-carbon emission options like:

- Battery-operated electric ships
- Hydrogen-powered ships
- Solar-powered ships
- Wind-powered ships
- Wave-powered ships

Decarbonisation of shipping is increasingly coming under pressure, necessitating suitable green fuels to replace fossil fuels. We already have electric and hybrid ships that combine renewable energy sources with IC engines to improve sustainability. They use batteries, fuel cells and renewable energy to run electric motors for propulsion and can switch between traditional and green propulsion as required. It may likely take a few more years or possibly a decade to run on 100% renewable energy as it is a comparatively new and growing industry. The sector is faced with unique challenges at every milestone as we move towards commercialisation, with solutions for each challenge ensuring a bright future for shipping with zero-carbon emission ships in sight.

The growth in use of green fuels can be seen in the new order book with many vessel owners going for green fuel options like:

- Biofuels
- Methanol
- LNG
- Ammonia
- Hydrogen

The analysis carried out in some of the Mediterranean coastal States shows Spain having one operational project along with 10 speculative projects for green and blue ammonia, while Mediterranean coastal States that are not EU Member States have 28 projects combining blue and green ammonia and all are under speculation. In addition, the development of green fuels have been undertaken and is ongoing at various ports in the Mediterranean region. However, there is a need to bring the buyers and suppliers of green fuel together.

These efforts/steps require massive investment from interested stakeholders – be it for producing green fuel, creating bunkering infrastructure, building modern fuel-efficient ships, retrofitting existing ships and enhancing of capacity and capabilities of shipyards.

Since emission of vessels while at port will be considered in the overall EUA liability under the EU ETS, OPS will gain momentum in the Mediterranean region. Provision for OPS (generated from clean sources such as solar and wind) for visiting ships is a vital component of this concept.

For a port to be classified as a green port, it needs to optimally use green/clean energy for all its operations including its interaction with visiting ships. Such ports are becoming an economic necessity rather than just a regulatory requirement. Additionally, if a port becomes part of a green corridor in the Mediterranean region, it will help uplift the whole region by developing better infrastructure while improving the availability of green fuels and efficient technologies. In fact, there is potential for multiple green corridors around Spain in the Mediterranean region which could be developed soon.

In recent years, the shipping industry has increasingly focused on the development and application of low-/zero-carbon fuels to reduce emissions and pollution due to the regulatory push from IMO and EU. Moreover, methods such as electrification of port equipment, digitalisation and JIT arrivals could lower port emissions.

Zero-carbon emissions can be achieved only when we replace all fossil fuels for ships with

1. Renewable energy that can be used to propel and power a ship where possible; and
2. Supply of green fuels which will make zero-carbon emission ships a reality.

Capacity-building measures are ongoing as reflected by the EU-Namibia partnership that has been formed to increase the supply of hydrogen to EU Member States. In addition, Tunisia signed six MoUs with a few European companies in July 2024 to export around 6 million tonnes of green hydrogen.

Organised efforts to preserve and improve the marine environment are evident in the Mediterranean region with, notably, the initiatives taken by UNEP/MAP and its components, including REMPEC, under the Barcelona Convention and its seven protocols.

Projects such as the Green Marine Med Project can go a long way to support innovations, capacity-building and sustainable finance in Mediterranean ports and maritime transport industries. JTF is under EU to provide tailored technical support to authorities for drafting the Territorial Just Transition Plan for supporting countries transitioning towards climate neutrality.

The ENP was launched in 2004 for the prosperity of EU's neighbouring regions and covers eight Mediterranean coastal States that are not EU Member States. The main agendas focus on human development, digital transition, peace and security, migration, green transition to tackle climate resilience, energy and the environment. They have established NIP for mobilising funds to finance capital-intensive infrastructure for countries under ENP in transport, environment and social development sectors.

Various infrastructure support will be required for implementation of new green technologies at ports, shipyards, fuel producers, bunkering infrastructure, equipment modification, manpower requirement, repair agencies and other service providers.

6 Potential of revenue leakage, carbon leakage, and impact on trade

This section examines the potential for revenue leakage in dry bulk, liquid bulk and container sectors due to transhipment of these commodities at ports in Mediterranean coastal States that are not EU Member States to reduce the vessel's emission liabilities. The possible impact on the export volumes from Mediterranean coastal States that are EU Member States due to the increase in the cost because of EUAs is also examined. In addition, the potential for carbon leakage is also examined in this section.

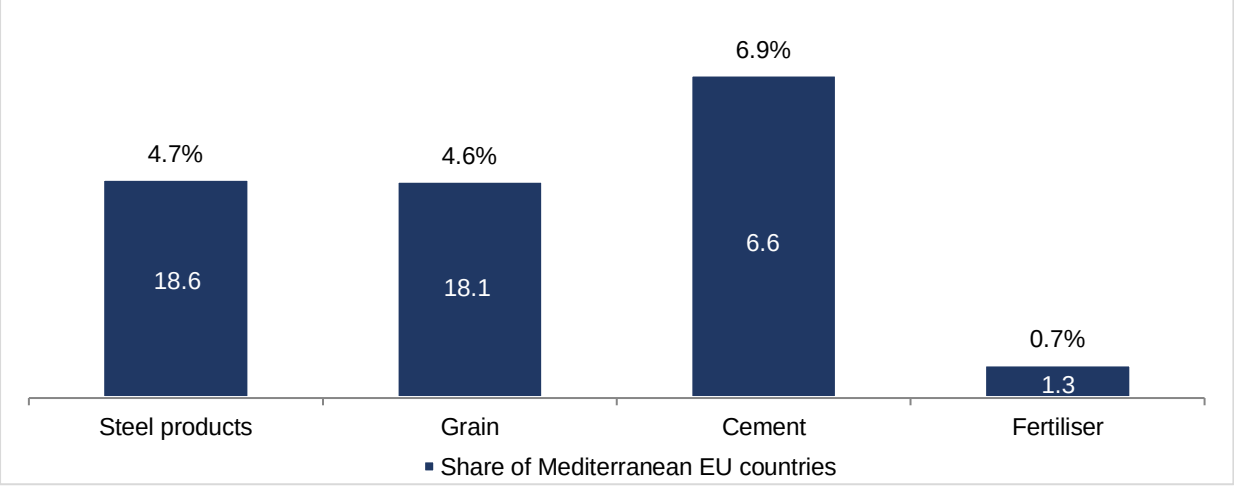
Revenue leakage: When vessels shift their operations from EU Member States to States that are not EU Member States to avoid exposure to the EU ETS for shipping, it results in revenue leakage for the EU ETS (for example, by transhipment in ports of Mediterranean coastal States that are not EU Member States).

Carbon Leakage: When manufacturing industries shift their operations from EU Member States to States that are not EU Member States, it could result in carbon leakage (i.e. an increase in overall GHG emissions, due to, for example, less strict GHG emission constraints in Mediterranean coastal States that are not EU Member States).

6.1 Analysis of possible impact of the EU ETS costs on dry bulk exports from Mediterranean EU Member States

Mediterranean coastal States that are EU Member States are relatively small players in the export of dry bulk commodities with cement comprising the largest share of less than 7% of the global seaborne cement exports, estimated at about 95 million tonnes annually. While steel products, grain, cement and fertilisers are the primary export commodities traded on long-haul routes, some cargoes such as aggregates are mostly traded on short-haul routes.

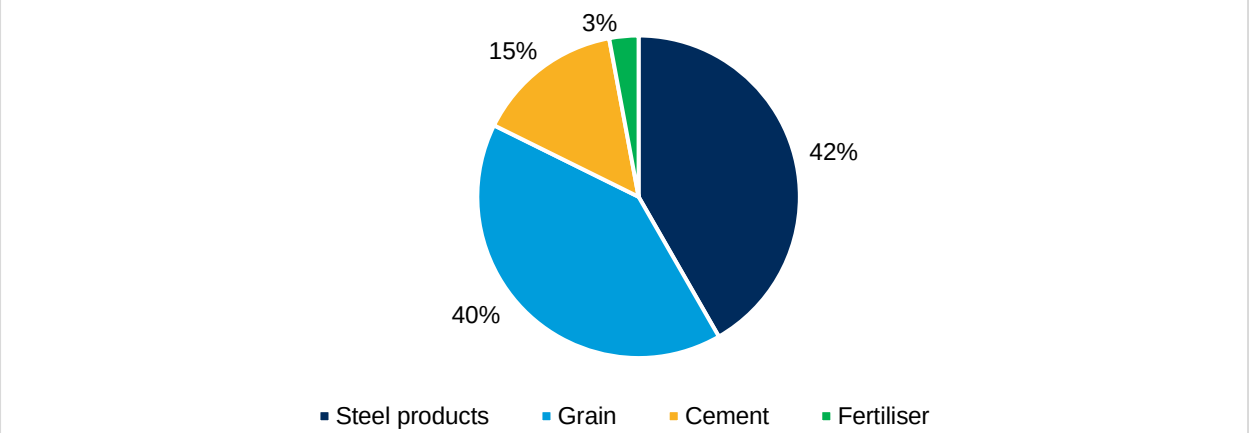
Figure 6.1 Share of Mediterranean coastal States that are EU Member States in global exports



Note: The numbers in the chart represent the total exports in million tonnes from Mediterranean coastal States that are EU Member States in 2023

Source: Drewry Maritime Research

Figure 6.2 Share of major dry bulk commodity exports from Mediterranean coastal States that are EU Member States



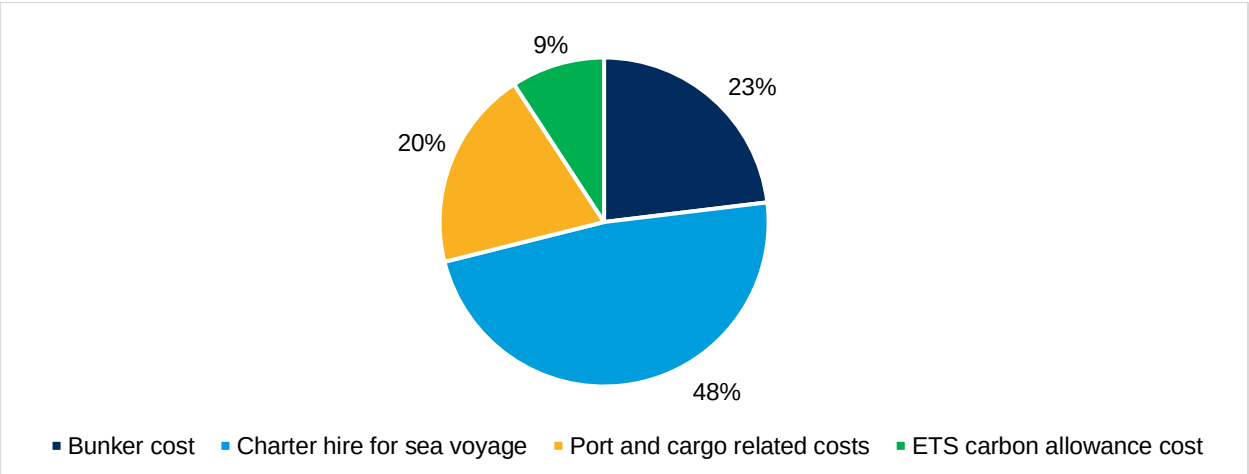
Source: Drewry Maritime Research

From 1 January 2024, dry bulk owners are required to buy EU Allowances (EUAs) as part of the EU ETS which could take costs progressively higher until 2026.

6.1.1 Potential for revenue leakage

In order to estimate the impact of the EU ETS costs on the overall transportation cost, we have taken a representative case whereby we examined the export of 50,000 tonnes of fertiliser (phosphate) on a 58,000 dwt Supramax vessels from the port of Barcelona, Spain, in the Mediterranean to Santos, Brazil. When the EU ETS costs are fully enforced by 2026, Drewry estimates additional costs of $94,881 ($1.9 per tonne) which is 9% of the total voyage cost of about $0.99 million ($19.8 per tonne).

Figure 6.3 Breakdown of voyage cost from the Port of Barcelona, Spain to Port of Santos, Brazil for Supramax vessels



*EU ETS year 2026

Source: Drewry Maritime Research

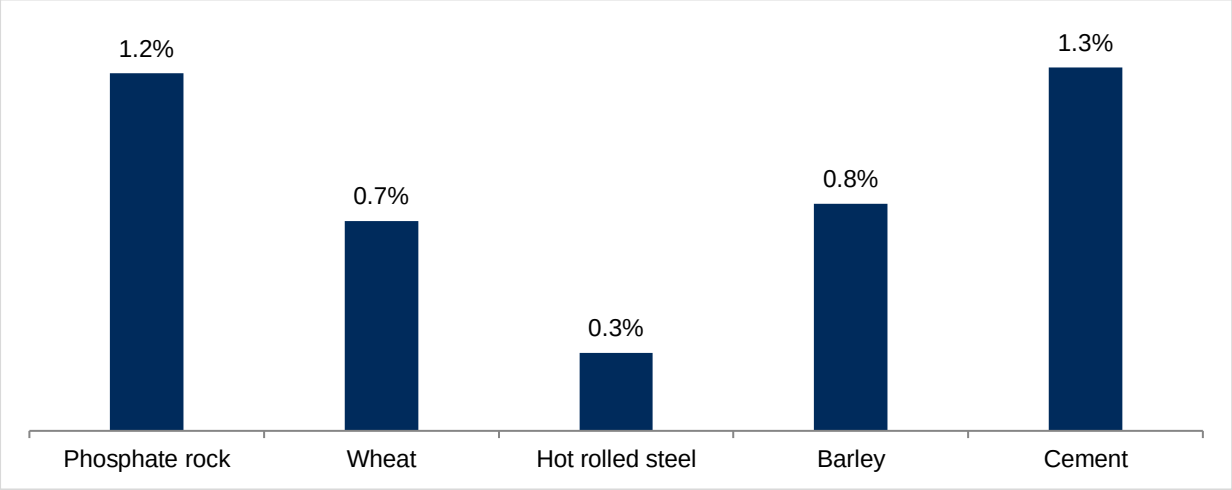
Revenue leakage because of the EU ETS is unlikely. Considering the above example, the incremental cost on the usual voyage due to the EU ETS is $94,881. However, to save the EU ETS cost, if the cargo is transhipped via Algeria (Arzew port), the additional cost of transhipment would be $416,445 per voyage, excluding cargo-handling charges, such as stevedoring. Hence, transhipment could result in a loss of $328,422, and if cargo handling charges are also factored in, the additional costs could go even higher.

6.1.2 Impact on trade

When compared to the value of the cargo, the EU ETS costs appear inconsequential. The EU ETS cost of $1.90 per tonne of cargo translates to only 1.2% of the fertiliser price of $152 per tonne. Since the EU ETS costs form a relatively low proportion of the cargo value, exporters from EU Member States are unlikely to lose their cargo to exporters from States that are not EU Member States as importers will willingly absorb these extra costs.

In the base case, which is the most probable case, the impact of the EU ETS on export volumes from Mediterranean coastal States that are EU Member States is negligible, therefore, we have skipped the high and low cases.

Figure 6.4 The EU ETS costs as % of cargo value for dry bulk cargoes



Source: Drewry Maritime Research

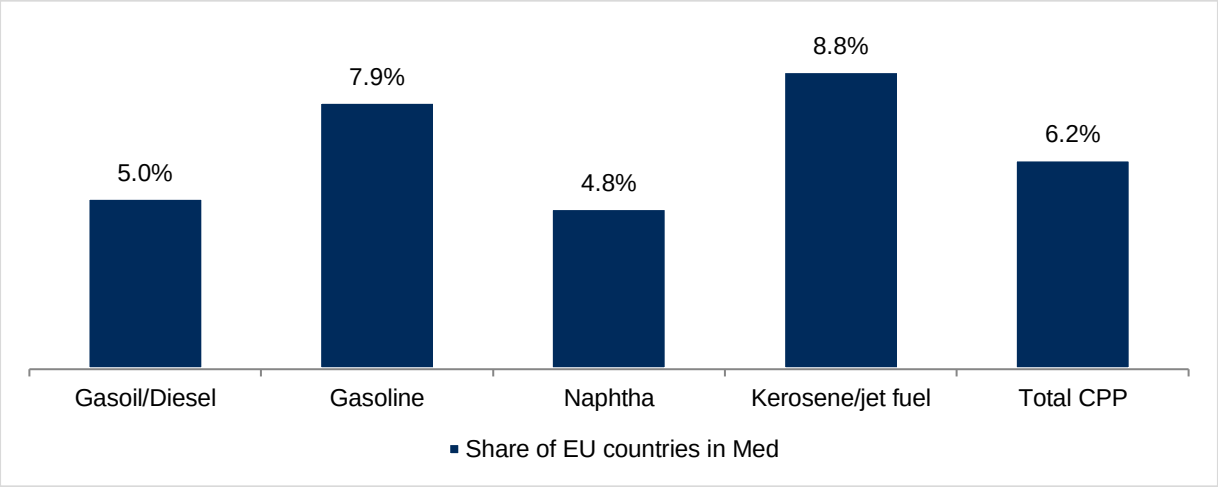
6.1.3 Conclusion

Enforcing the EU ETS is unlikely to fundamentally alter the market dynamics for dry bulk exports from Mediterranean coastal States that are EU Member States as this resultant small increase in transportation costs due to the EU ETS can be absorbed by importers. The volume of dry bulk exports from Mediterranean coastal States that are EU Member States will likely remain unchanged, thereby continuing to contribute to their share of the world seaborne trade of dry bulk cargoes. Exporters from Mediterranean coastal States are well-poised to deal with the incremental costs pertaining to the EU ETS, ensuring their market presence and competitiveness.

6.2 Analysis of possible impact of the EU ETS costs on liquid bulk exports from Mediterranean EU Member States

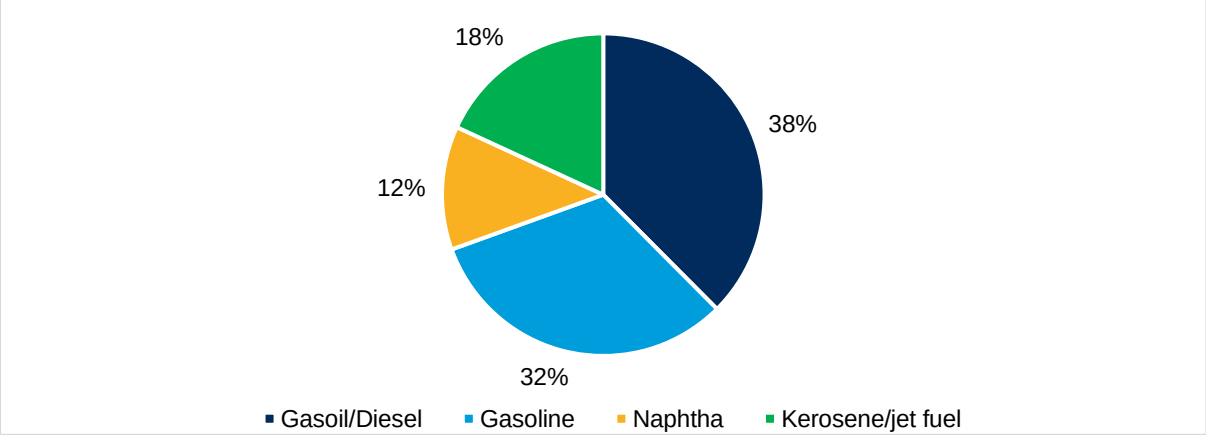
Mediterranean coastal States that are EU Member States are not major exporters of refined products, collectively accounting for only about 6% of the global seaborne trade of Clean Petroleum Products (CPP). Gas oil/Diesel and gasoline are the two major commodities exported by EU Member countries in the Mediterranean, contributing 38% and 32% respectively to their total seaborne CPP exports of about 44 million tonnes.

Figure 6.5 Share of Mediterranean coastal States that are EU Member States in global CPP exports



Source: Drewry

Figure 6.6 Share of products in CPP exports of Mediterranean coastal States that are EU Member States



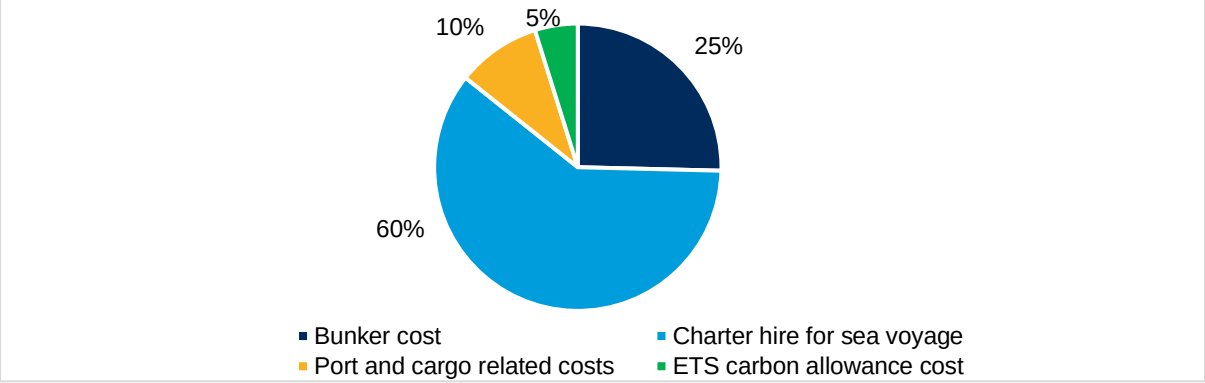
Source: Drewry

6.2.1 Potential for revenue leakage

As tanker owners must buy EUAs from 1 January 2024, and there will be a gradual increase in these costs in the next few years, it is important to assess the possible impact of this incremental cost on exports of refined oil products from the Mediterranean. Since the EU ETS costs will inflate the cost of transportation, any significant surge might hurt the attractiveness of CPP exports from Mediterranean coastal States that are EU Member States.

In order to assess the impact of the EU ETS costs on the overall transportation cost we have taken gasoline exports from the Port of Lavera in France located in the Mediterranean region to New York in the United States of America (USA) as an example. According to Drewry's estimates, the EU ETS costs (from 2026, when they are charged in full) will be $71,400, accounting for about 5% of the total voyage cost of around $1.46 million on this route. The EU ETS cost per tonne of cargo on this route will be $1.9/tonne compared to the $41.4/tonne freight cost.

Figure 6.7 Breakdown of voyage cost from Port of Lavera, France to New York, USA on MR tankers



Source: Drewry

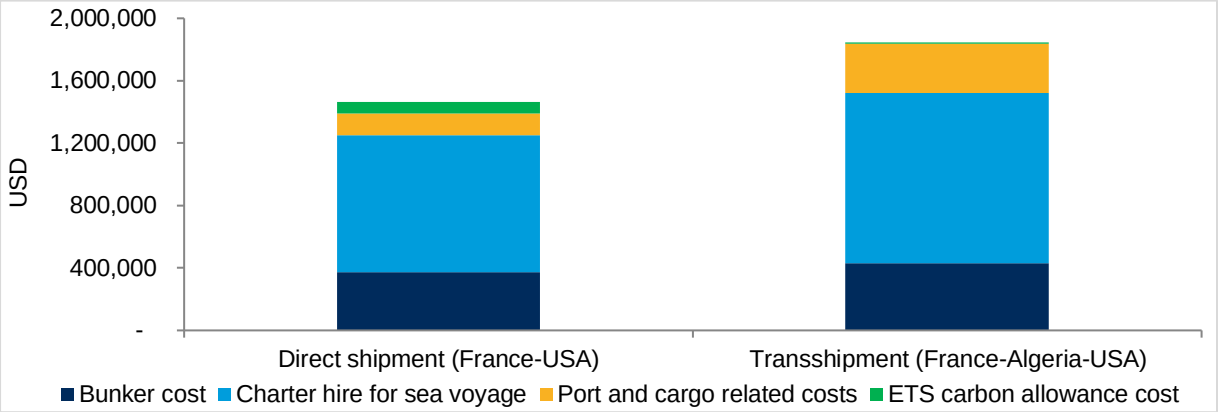
Note: EU ETS cost in 2026

We have carried out a cost-benefit analysis to assess the possibility of transhipment at a port in a Mediterranean coastal State that is not an EU Member State. In our analysis, we have considered a Port of Bejaia, Algeria as a transhipment hub for the France-to-USA trade discussed above. We compared the cost of transporting gasoline from France directly to USA on a 50,000 dwt MR tanker with the cost of transporting the same cargo from France to Algeria and then eventually to USA.

As the distance between the origin port (France) and the transhipment port (Algeria) is significantly lower than between the origin port (France) and the destination port (USA), the EU ETS costs plunge when gasoline cargo is transhipped at Port of Bejaia, Algeria. However, the doubling of port and cargo handling charges and the increase in charter and bunker costs because of the deviation will increase the freight costs significantly in the case of transhipment, making it uneconomical.

If the gasoline cargo is transhipped, we estimate a decline in the cost of emissions by about $63,900, whereas the shipping costs (excluding the EU ETS) will increase by about $470,900, translating to a net loss of more than $406,000 per voyage or $11 per tonne of cargo. Accordingly, we believe transhipment is not a viable solution to minimise the EU ETS costs for refined product exports from Mediterranean coastal States that are EU Member States, which rules out any possible revenue leakage.

Figure 6.8 Cost-benefit analysis of transhipment (USD)



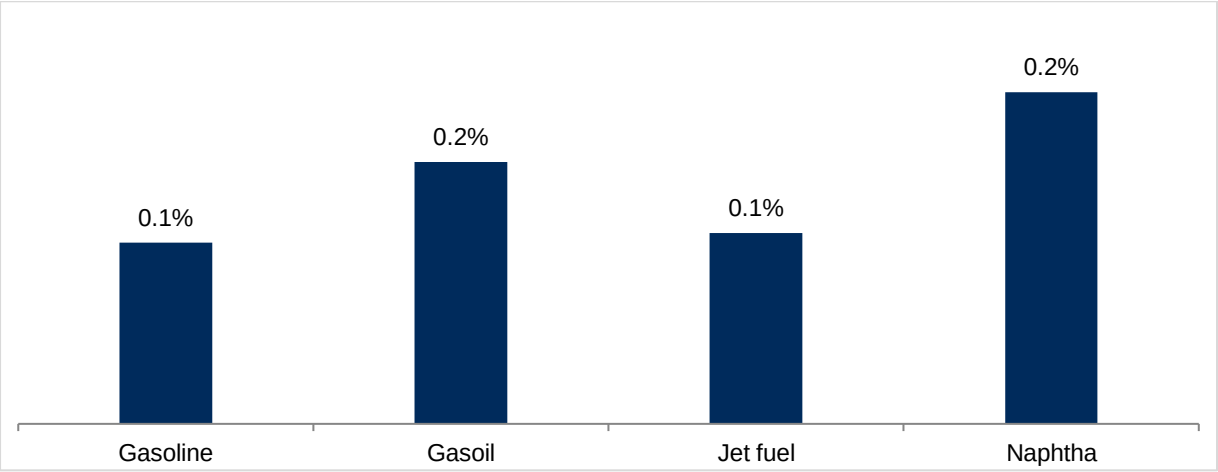
Source: Drewry

6.2.2 Impact on trade

When compared to cargo values, the EU ETS costs will still be minimal. The EU ETS cost per tonne of cargo will be $1.9, which will be only 0.1% of the gasoline price of $1,442 per tonne and 0.1% of the jet fuel price in the Mediterranean in April 2024. As the EU ETS costs are insignificant when compared with the cargo value, they can be easily absorbed by exporters/refiners from EU Member States enabling them to still compete with exporters from States that are not EU Member States. Accordingly, we do not foresee any significant change in CPP exports from Mediterranean coastal States that are EU Member States on account of the EU ETS costs.

The impact of the EU ETS on dry bulk and liquid bulk export volumes from Mediterranean coastal States that are EU Member States is negligible, which encourages us to conclude that the EU ETS will have an insignificant impact on total EU exports.

Figure 6.9 The EU ETS costs as % of cargo value for refined products



Source: Drewry

Note: EU ETS cost in 2026

6.2.3 Conclusion

Enforcing the EU ETS is unlikely to fundamentally alter the market dynamics for liquid bulk exports from Mediterranean coastal States that are EU Member States as this resultant small increase in transportation costs due to the EU ETS can be absorbed by importers. The volume of liquid bulk exports from Mediterranean coastal States that are EU Member States will likely remain unchanged, thereby continuing to contribute to their share of the world seaborne trade of liquid bulk cargoes. Mediterranean exporters are well-poised to deal with the incremental costs pertaining to the EU ETS, ensuring their market presence and competitiveness.

6.3 High-level analysis of leakage of container transhipment cargo

There is potential for revenue leakage by shifting container transhipment from highly regulated ports of EU Member States to the ports in the Mediterranean coastal States that are not EU Member States. This section is focused on potential revenue leakage in the Mediterranean region and does not cover an analysis of other regions.

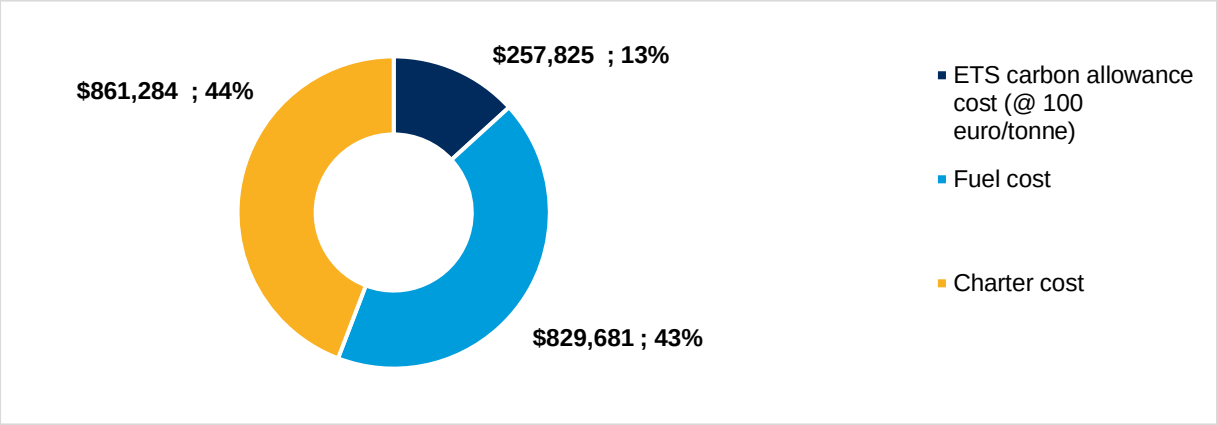
6.3.1 Potential of the EU ETS to change the behaviour of shipping lines

As container shipping lines are profit-oriented companies active in a highly competitive and cost-driven industry, they always seek to minimise their costs and regularly review their ports of call and their ship networks.

In this context, the new requirements that carriers must buy emission allowances (The EU ETS costs), from 1 January 2024, and the gradual tightening of this new regime, in the next few years, will be considered in the carriers' decisions about which ports they will call at and where they will tranship containers.

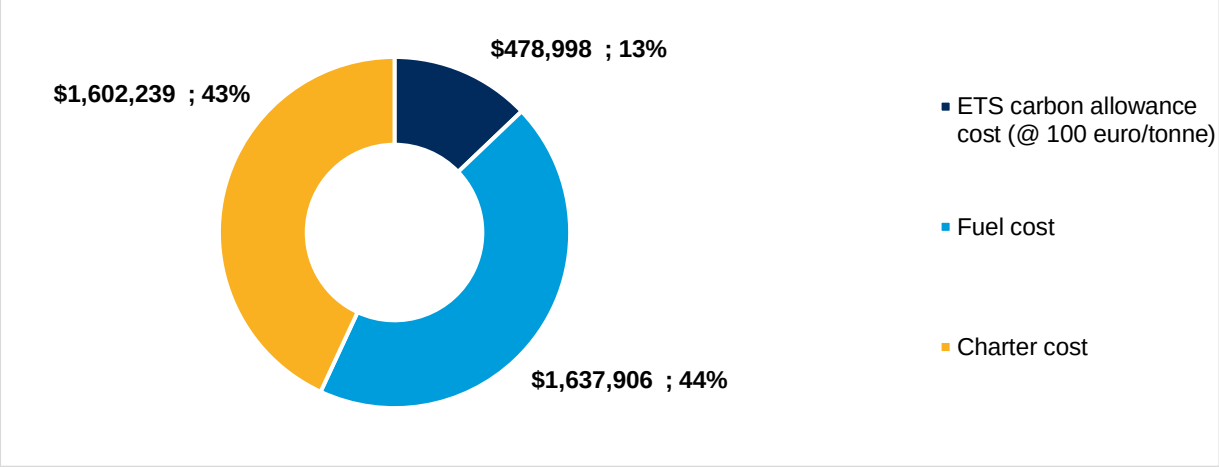
Taking the example of a westbound voyage on the Asia-Mediterranean route using 13,000teu containerships, The EU ETS costs (when they are fully applied from 2026) will represent roughly 13% of the voyage costs (defined as charter, fuel and the EU ETS costs, excluding port dues). The estimated 13% will apply irrespective of the ship routing via the Suez Canal (Egypt) or via the Cape of Good Hope (South Africa), but with higher absolute amounts – see 2 charts below.

Figure 6.10 Breakdown of voyage cost from Singapore to Port of Piraeus, Greece and Port of La Spezia and Genoa, Italy (via Suez Canal)



Source: Drewry

Figure 6.11 Breakdown of voyage costs from Singapore to Port of Piraeus, Greece and Port of La Spezia and Genoa, Italy (via Cape of Good Hope)



Source: Drewry

The EU ETS costs of over $200,000 for a westbound voyage via the Suez Canal and over $400,000 per voyage via the Cape of Good Hope will attract the attention of carriers.

Carriers have an incentive to minimise the EU ETS costs by changing their ports of call, provided their decision does not cause other costs to increase by more than the reduced EU ETS costs – and provided there are no other strategic considerations (see discussion of these considerations in section 6.3.5.)

6.3.2 Types of relocations of container transhipment cargo under review

In this high-level analysis of revenue leakage of container transhipment cargo, we consider several types of relocations in which EU container transhipment ports could lose cargo volumes to competitors based outside the EU, including ports that are on the EU target list (e.g. Tanger Med, Morocco, and Port Said East, Egypt) as well as ports that are not on the EU target list.

We also assessed the impact of access or no access to the Suez Canal by considering the following four examples, each using an example of a current container service (April 2024) or a recent container service (April 2023, pre-Suez Canal disruptions):

1. Example no. 1: An Asia-Piraeus-Italy container service potentially switching its container transhipment from Piraeus, Greece (in the EU Member State) to Mersin, Türkiye (Mediterranean coastal State that is not an EU Member State, a port not on the EU target list), routed via the Suez Canal or via the Cape of Good Hope.
2. Example no. 2: An Asia-Piraeus-Italy container service potentially switching its container transhipment from Piraeus, Greece (in the EU Member State) to Port Said East, Egypt (Mediterranean coastal State that not an EU Member State, a port on the EU target list), routed via the Suez Canal or via the Cape of Good Hope.
3. Example no. 3: A North Europe-Algeciras-Asia container service potentially switching its container transhipment port from Algeciras, Spain (in the EU Member State) to Tanger Med, Morocco (Mediterranean coastal State that is not an EU Member State, on EU port target list), routed via the Suez Canal or via the Cape of Good Hope.

4. Example no. 4: A Mediterranean-Northern Africa container feeder service potentially switching from two container transhipment ports – one in Algeciras, Spain (EU Member State) and one in Tanger Med, Morocco (Mediterranean coastal State that is not an EU Member State) - to only Tanger Med, Morocco (on EU port target list).

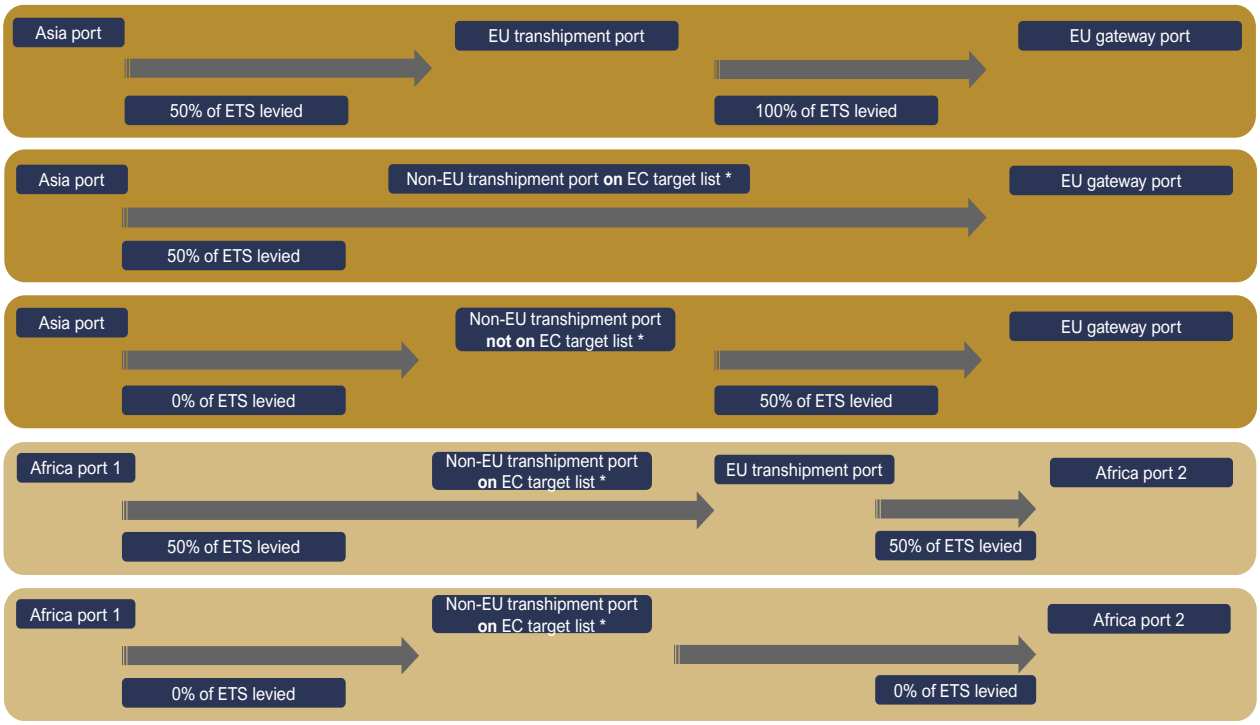
The assessments are mainly considering swapping an EU Member State transhipment port for a transhipment port in a Mediterranean coastal State that is not an EU Member State. We have assumed that the vessel sizes, fuel consumption per day and daily charter costs remain the same and that revenues remain unchanged, as these aspects will not vary if a container transhipment port is relocated. We have not sought to calculate feeder costs for the first three examples, but believe feeder costs from a Mediterranean coastal State that is not an EU Member State transhipment port will be marginally higher than from an EU transhipment port intended to serve mainly European ports. We tried to address this aspect qualitatively in the written analysis.

The fourth example above is the only example where we look at a feeder service changing its container transhipment ports – in this case a big feeder service between Mediterranean container transhipment ports and Northern Africa.

6.3.3 Cost comparisons between the four examples

The CO_2 emissions from containerships calling at ports in the EU as part of their voyage will be subject to different levels of the EU ETS costs depending on whether the next/previous port is a port in EU Member State, a port in State that is not an EU Member State and part of the EU target list (Tanger Med, Morocco and Port Said East, Egypt) or a port in a State that is not an EU Member State and is not on the EU target list (see chart below).

Figure 6.12 Applicable EU ETS costs depending on the location of the transhipment port and the sequence of ports



* European Commission target list of ports is Port Said East, Egypt and Tanger Med, Morocco

The summary is provided below.

1. An Asia-Piraeus-Italy container service potentially switching its container transhipment from Piraeus, Greece (port in EU Member State) to Mersin, Türkiye (port in a Mediterranean coastal State that is not an EU Member State and a port not on the EU target list), routed via the Suez Canal or via the Cape of Good Hope:

Table 6.1 Example no. 1 - Relocation of container transhipment port from Piraeus, Greece (EU Member State) to Mersin, Türkiye (Mediterranean coastal State that is not an EU Member State, not on EU port target list)

Description	Unit	Via the Suez Canal	Via the Cape of Good Hope
Average ship capacity	teu	13,000	13,000
Service name			
The EU ETS with no relocation of transhipment port	$/voyage	$257,825	$478,998
The EU ETS with relocation of transhipment port	$/voyage	$50,551	$50,551
Impact of relocation on shipping company			
Extra distance of mainline vessel	nautical miles	242	960
ETS cost avoided	$/voyage	-$207,274	-$428,447
Change in fuel cost and charter cost of mainline vessel	$/voyage	$57,167	$226,778
Net cost change	$/voyage	-$150,107	-$201,669
Conclusion		Relocation would lead to a cost reduction for the carrier (if feeder costs remained the same)	Relocation would lead to a cost reduction for the carrier (if feeder costs remained the same)

Relocating to a port in a State that is not an EU Member State like Mersin, Türkiye, which is also geographically close to Europe (586 nautical miles from Piraeus, Greece), would result in cost reductions for the carrier, whether the route is via the Suez Canal or via the Cape of Good Hope.

The shipping line would save about $150k per voyage (leg), which if considered from a pure cost perspective, is high enough to encourage leakage of container transhipment cargo.

2. An Asia-Piraeus-Italy container service potentially switching its container transhipment from Piraeus, Greece (port in EU Member State) to Port Said East, Egypt (port in State that is not an EU Member State, a port on the EU target list), routed via the Suez Canal or via the Cape of Good Hope:

Table 6.2 Example no. 2 - Relocation of container transhipment port from Piraeus, Greece (EU Member State) to Port Said East, Egypt (port in Mediterranean coastal State that is not an EU Member State and on the EU port target list)

Description	Unit	Via the Suez Canal	Via the Cape of Good Hope
Average ship capacity	teu	13,000	13,000
EU ETS with no relocation of transhipment port	$/voyage	$257,825	$478,998
EU ETS with relocation of transhipment port	$/voyage	$219,652	$476,911
Impact of relocation on shipping company			
Extra distance of mainline vessel	nautical miles	-113	957
EU ETS cost avoided	$/voyage	-$38,174	-$2,087
Change in fuel cost and charter cost of mainline vessel	$/voyage	-$26,694	$226,070
Net cost change	$/voyage	-$64,868	$223,982
Conclusion		Relocation would result in marginal saving on mainline vessel costs for the carrier	Relocation would result in higher mainline vessel costs for the carrier

Relocating to a port in a State that is not an EU Member State and part of the EU target list like Port Said East, Egypt would result in marginal cost reductions for the carrier (about $60k per voyage via the Suez Canal and none via the Cape of Good Hope) because the EU ETS cost avoidance is minimal.

This example shows that the EU regime of “sanctioning” certain large, transhipment ports in States that are not EU Member States by limiting the ability of shipping lines to avoid paying for emission allowances when relocating to these ports, makes a big difference on costs.

From a pure cost perspective, the risk of leakage of container transhipment cargo in such an example is low.

3. A North Europe-Algeciras-Asia container service potentially switching its container transhipment port from Algeciras, Spain (port in EU Member State) to Tanger Med, Morocco (port in a Mediterranean coastal State that is not an EU Member State and a part of EU port target list), routed via the Suez Canal or via the Cape of Good Hope:

Table 6.3 Example no. 3 - Relocation of container transhipment port from Algeciras, Spain (port in EU Member State) to Tanger Med, Morocco (port in Mediterranean coastal State that is not an EU Member State, on EU port target list)

Description	Unit	Via the Suez Canal	Via the Cape of Good Hope
Average ship capacity	teu	16,000	16,000
EU ETS with no relocation of transhipment port	$/voyage	$324,703	$451,478
EU ETS with relocation of transhipment port	$/voyage	$275,973	$401,096
Impact of relocation on shipping company			
Extra distance of mainline vessel	nautical miles	3	-46
EU ETS cost avoided	$/voyage	-$48,730	-$50,383
Change in fuel cost and charter cost of mainline vessel	$/voyage	$709	-$10,866
Net cost change	$/voyage	-$48,021	-$61,249
Conclusion		Relocation would result in marginal saving on mainline vessel costs for the carrier	Relocation would result in marginal saving on mainline vessel costs for the carrier

Relocating to Tanger Med, Morocco another port in a State that is not an EU Member State and a part of the EU target list, would also result in marginal cost reductions for the carrier, whether the route is via the Suez Canal or via the Cape of Good Hope.

This example also confirms the effect of the EU regime of “sanctioning” certain large, transhipment ports in States that are not EU Member States by limiting the ability of shipping lines to avoid paying the EU ETS costs when relocating to these ports.

4. A Mediterranean-Northern Africa container feeder service potentially switching from two container transhipment ports – one in Algeciras, Spain (a port in EU Member State) and one in Tanger Med, Morocco (port in Mediterranean coastal State that is not an EU Member State) - to only Tanger Med, Morocco (on EU port target list):

Table 6.4 Example no. 4 - Relocation of container transhipment port from Algeciras, Spain (port in EU Member State) and Tanger Med, Morocco (Port in Mediterranean coastal State that is not an EU Member State) to only Tanger Med, Morocco (on EU port target list) for feeder vessel

Description	Unit	Value
Average ship capacity	teu	4,000
EU ETS with no relocation of transhipment port	$/voyage	$129,132
EU ETS with relocation of transhipment port	$/voyage	$0
Impact of relocation on shipping company		
Extra distance of feeder vessel	nautical miles	-55
EU ETS cost avoided	$/voyage	-$129,132
Change in fuel cost and charter cost of mainline vessel	$/voyage	-$61,435
Net cost change	$/voyage	-$190,567
Conclusion		Relocation would result in large saving on feeder vessel costs for the carrier

Concentrating container transhipment operations currently distributed between Algeciras, Spain and Tanger Med, Morocco (a port in the State that is not an EU Member State and a part of the EU port target list) on just Tanger Med, Morocco would result in large cost reductions for the carrier (about $190k per voyage). This is the case even though Tanger Med, Morocco is on the EU target list. The relocated service would no longer touch ports in EU Member States and would, in our view, be outside the jurisdiction of the EU ETS. If a vessel only call ports in the State that is not an EU Member State, EU will be unable to enforce the EU ETS costs.

Further, since there would be no real additional sailing distance, the shipping line could avoid the EU ETS costs without incurring any additional vessel costs.

From a pure cost perspective, there is high risk of leakage of container transhipment cargo in such a situation.

6.3.4 Competition between container transhipment ports of EU Member States and Mediterranean coastal States that are not EU Member States

There are eight container ports in the Mediterranean coastal States that are not EU Member States already providing transhipment operations plus two other container ports which could potentially provide such operations (see table below). Together, these 10 a port of States that are not EU Member State have approximately 45% of the total port capacity of EU and container transhipment ports in Mediterranean coastal States that are not EU Member States.

Table 6.5 Current or potential new container transhipment ports located in the Mediterranean coastal States that are not EU Member States and their EU competitors

EU and non-EU container transhipment ports	Country	Transhipment traffic (teu) in 2023	Total throughput (teu) in 2023	% transhipment	Main EU transhipment rival	Distance to EU transhipment rival (nm)	Port capacity (teu)	Port capacity utilisation (%)	Spare port capacity (teu)
Tanger Med	Morocco (Non-EU)	8,060,901	8,617,410	94%	Algeciras	32	9,619,000	90%	1,001,590
Algeciras	Spain	*3,954,193*	*4,728,209*	*84%*			*6,075,000*	*78%*	*1,346,791*
Piraeus	Greece	*3,669,200*	*4,586,500*	*80%*			*7,500,000*	*61%*	*2,913,500*
Port Said East	Egypt (Non-EU)	3,584,610	3,982,900	90%	Piraeus/Malta/ Gioia Tauro	593	4,300,000	93%	317,100
Gioia Tauro	Italy	*3,535,893*	*3,535,893*	*100%*			*4,200,000*	*84%*	*664,107*
Malta Freeport	Malta	*2,755,000*	*2,900,000*	*95%*			*3,600,000*	*81%*	*700,000*
Valencia	Spain	*2,351,232*	*4,803,995*	*49%*			*8,600,000*	*56%*	*3,796,005*
Damietta	Egypt (Non-EU)	1,674,052	1,969,473	85%	Piraeus/Malta/ Gioia Tauro	593	1,800,000	109%	-169,473
Barcelona	Spain	*1,297,164*	*3,262,821*	*40%*			*5,100,000*	*64%*	*1,837,179*
Asyaport	Türkiye (Non-EU)	1,225,805	1,707,642	72%	Piraeus	about 300	2,500,000	68%	792,358
Ambarli	Türkiye (Non-EU)	1,050,969	3,221,584	33%	Piraeus	337	5,050,000	64%	1,828,416
Mersin	Türkiye (Non-EU)	357,735	1,950,704	18%	Piraeus	586	2,600,000	75%	649,296
Beirut	Lebanon (Non-EU)	355,796	741,834	48%	Piraeus	643	2,100,000	35%	1,358,166
Port Said	Egypt (Non-EU)	154,000	400,000	39%	Piraeus/Malta/ Gioia Tauro	593	1,500,000	27%	1,100,000
Cagliari	Italy	*38,485*	*122,737*	*31%*			*300,000*	*41%*	*177,263*
Taranto	Italy	*31,696*	*45,280*	*70%*			*2,000,000*	*2%*	*1,954,720*
Malaga	Spain	*11,744*	*40,548*	*29%*			*550,000*	*7%*	*509,452*
Yarimca	Türkiye (Non-EU)	1,781	616,000	0%	Piraeus	385	1,160,000	53%	544,000
Izmir	Türkiye (Non-EU)	0	296,655	0%	Piraeus	204	900,000	33%	603,345
Sub-total EU Med ports		17,644,607	24,025,983				37,925,000	63%	0
Sub-total non-EU Med ports		16,465,649	23,504,202				31,529,000	75%	0
Total Med ports		34,110,256	47,530,185				69,454,000	68%	0

Colour coding:

Non-EU ports
EU ports

Notes: Colour codes for ports in EU Member States and those in Mediterranean coastal States that are not EU Member States are mentioned at the bottom of the table; the table is based on the data for 2023; transhipment volumes and % are estimated; port capacities are estimated.

Source: Drewry

We note that the top three container transhipment ports (highlighted in red in the table) in the Mediterranean coastal States that are not EU Member States that are fully or nearly fully utilised in terms of capacity, whereas five second-tier container transhipment ports (highlighted in green in the table) have spare capacity.

It is important to note that Tanger Med, Morocco and Algeciras, Spain – located within 32 nautical miles of each other – have the same role in the container shipping industry and are nearly substitutable. However, neither Tanger Med, Morocco nor Algeciras, Spain has enough capacity, on its own, to handle the total combined container transhipment traffic.

Below is a high-level evaluation of the competition between the EU and container transhipment port in Mediterranean coastal State that is not an EU Member State and the risk of transfer of cargo from the former to the latter.

- Tanger Med, Morocco could handle up to about 1 mteu of additional volume (based on 2023 capacity); any relocation requiring more cargo volume exchanges would require capacity expansion at Tanger Med, Morocco.
- The second-tier ports in Türkiye (Asyaport, Ambarli, Mersin), the port of Beirut in Lebanon and the smaller Port Said in Egypt (to be distinguished from Port Said East) have about 6 mteu spare capacity, if carriers decide to relocate or increase their transhipment ports outside the EU.

Availability of capacity is one of the conditions to consider in assessing the potential relocation of a container transhipment port.

6.3.5 Other considerations which would discourage assessing the potential relocation of a container transhipment port

Besides cost considerations, there are several strategic and other factors which will influence carrier decisions on the location of their container transhipment ports in or outside the EU:

- Availability of sufficient capacity at container transhipment terminals (capacity shortage would prevent a wholesale relocation of transhipment from Algeciras, Spain to Tanger Med, Morocco for example).
- Good connectivity between the transhipment port and ports served by feeder services (the second-tier container transhipment ports in Türkiye and Lebanon are less well-connected than the major EU container transhipment ports).
- Ownership by the carrier of container transhipment terminals or long-term leases at these terminals (Maersk, COSCO, Hapag-Lloyd and CMA CGM all own container transhipment terminals in the Mediterranean, both in the EU and outside the EU).
- Greater reliance on fewer key container transhipment ports and the resulting use by carriers of fewer mainline ports of call (new policy adopted by Maersk and Hapag-Lloyd).
- Ten of the world's largest liner shipping companies collectively operate about 84% of global fleet capacity. There is a risk of bad publicity if a carrier is seen publicly as avoiding the EU ETS costs while polluting the environment.
- Awareness among carriers that regulators will monitor the application of the EU ETS and will review the EU port target list every two years.
- Transhipment at more distant, container transhipment ports in States that are not EU Member State requires longer voyages by feeder ships (which emit more CO_2 per container than mainline vessels) would run counter to the carrier's policy of reducing CO_2 emissions.

- Potential for cost reductions when switching from an EU container transhipment port to a more distant container transhipment port in States that are not EU Member State will reduce as the costs of marine fuel permissible under future environmental regulations increase over the medium and long term.
- Introduction of some "Market-Based Measures" or GHG Levy by IMO would punish longer voyages and close potential loopholes in the earlier application of the EU ETS.

Concerning the trend towards greater reliance on fewer key container transhipment ports, we note that most of the container services which use the container transhipment port of Algeciras, Spain (in the EU Member State) also use the container transhipment port in State that is not EU Member States, Tanger Med, Morocco (see table below).

Table 6.6 Example of the use of Algeciras, Spain and Tanger Med, Morocco container transhipment hubs (list of mainline services)

Carrier/Alliance and service name	Calls at Algeciras (1=yes)	Calls at Tanger Med (1=yes)	Calls at Algeciras and Tanger Med (1=yes)	Average ship capacity (teu)
2M - TA5/MEDUSEC	1	1	1	9,640
CMA CGM - MEDCARIB	1	1	1	6,881
CMA CGM - MEDWAX	1	1	1	3,091
CMA CGM - REDEX	1	1	1	4,367
CMA CGM - Wazzan service	1	1	1	1,740
CMA CGM/ANL - EURAF1	1	1	1	4,957
CMA CGM/COSCO - EPIC/EPI3	1	1	1	14,074
CMA CGM/Hapag-Lloyd - EURAF5/WMA	1	1	1	4,612
CMA CGM/Marguisa Shpg. - EURAF4	1	1	1	3,600
Hapag-Lloyd - JMCSA	1	1	1	4,115
Maersk - Ecumed	1	1	1	4,258
Maersk - ME8	1	1	1	7,849
Maersk - WAF1	1	1	1	4,532
Maersk - WAF10	1	1	1	1,740
Maersk - WAF12	1	1	1	1,304
Maersk - WAF2	1	1	1	2,496
Maersk - WAF6	1	1	1	4,496
Maersk - WAF7	1	1	1	3,534
Maersk/CMA CGM - NeoBossanova/Sirius	1	1	1	10,034
Maersk/Hamburg-Sud - ME2	1	1	1	10,500
Maersk/Sealand - WAF3	1	1	1	4,431
Ocean Alliance - FAL1/AEU2/LL4	1	1	1	17,859
THE Alliance - FE2	1	1	1	20,150
THE Alliance - FE4	1	1	1	23,964
Turkon Line - MED & USA Service (USM)	1	1	1	2,824
2M - AE10/Silk	1			20,568
2M - AE11/Jade		1		24,232
2M - AE12/Phoenix		1		15,516
2M - AE5/Albatross		1		20,568
2M - AE55/Griffin		1		19,224
2M - AE6/Lion	1			24,346
2M - AE7/Condor		1		18,270
2M - TA6/MEDGULF	1			9,200
CMA CGM/COSCO - MEDGULF/MDGX/MDG		1		2,824
CMA CGM/Hapag-Lloyd/ARKAS Group - MWX/EURAF2/WAS		1		4,360
COSCO/ONE/CMA CGM/OOCL - EMA	1			4,600
GS Lines - Guiver Service	1			1,708
Hamburg-Sud - Jed-Med Shuttle		1		7,154
Hamburg-Sud/Maersk - SAEC1/Neo Samba		1		9,669
Hapag-Lloyd - Jeddah Express (JDX)		1		8,749
Hapag-Lloyd - MSW		1		2,837
Hapag-Lloyd - WA1		1		1,740
Hapag-Lloyd/ONE/Niledutch - IOS/EPIC2		1		10,114
Hapag-Lloyd/Zim - TEX/ZCT		1		3,237

HMM/COSCO - FIM - Med	1			8,652
Maersk - MECL	1			6,802
Maersk/Hapag-Lloyd/ONE - SAECS/SAX/SRX	1			7,154
MSC/Hapag-Lloyd - ECX/NWC TO SAEC - STRING I		1		11,519
Ocean Alliance - Columbus JAX/PE1/SEAP/AWE5		1		16,020
Ocean Alliance/THE Alliance - Amerigo/MEN/ATM1/AL6	1			8,749
ONE/COSCO/OOCL - LUX/ESE2/EEX	1			5,047
ONE/Hapag-Lloyd - WAX/EAS		1		4,308
THE Alliance - MD1	1			15,258
Total number of services	**36**	**42**	**25**	
% of mainline services	68%	79%	47%	

Source: Drewry Route Capacity Database, as of April 2024 (with Suez Canal access restricted)

The two neighbouring, “twinned” container transhipment ports of Algeciras, Spain and Tanger Med, Morocco appear to be in a unique position in the Mediterranean, where they serve nearly the same market, the same carriers and the same services – as if it were a single port.

This also makes Port of Algeciras in Spain vulnerable, in the context of the EU ETS, because Algeciras can be replaced by Tanger Med, Morocco and Tanger Med (and the carriers calling there) are, in effect, not subject to the same EU ETS as Algeciras, Spain.

6.3.6 Conclusions

Of the four examples reviewed concerning potential relocation of container transhipment hubs, two examples (no. 1 and no. 4) would result in a large reduction in the EU ETS costs and in net cost savings for the shipping companies, while the other two examples (no. 2 and no. 3) would result in a marginal cost reduction.

In example no. 1, shipping companies would potentially reduce their costs significantly and avoid paying a high proportion of the EU ETS costs by switching their container transhipment to a small, geographically close ports in Mediterranean coastal States that are not EU Member States and is not on the EU target list (like Mersin, Türkiye). But these are currently only second-tier ports – with inferior port connectivity and port infrastructure. In our view, it is unlikely that many of the alliance carriers that have interests in established, large container transhipment ports, will relocate their transhipment to a second-tier container transhipment port, particularly as there are also other strategic and reputation risks of doing so. We regard the risk of leakage of container transhipment cargo to ports in Mediterranean coastal States that are not EU Member States in example no. 1 as low (much less than the spare capacity of about 6 mteu a year at the second-tier ports in Mediterranean coastal States that are not EU Member States).

In example no. 2, shipping companies would reduce their costs marginally by switching their container transhipment to a large ports in Mediterranean coastal States that are not EU Member States like Port Said East, Egypt. Again, the risk of leakage of container transhipment cargo will depend on which carriers already have their own container transhipment terminals in the EU and which do not, and there are other strategic and reputation risks of doing so for the shipping lines. We know that the new Gemini alliance (alliance between Maersk Line and Hapag Llyod) will use Damietta, Egypt, and Port Said East, Egypt, as their sole hubs in eastern Mediterranean from 1 February 2025 (Maersk Line is already present in Port Said East, where it controls a terminal). We regard the risk of leakage of more container transhipment cargo being transferred to large ports in Mediterranean coastal States that are not EU Member States like Port Said East, Egypt as low overall (possibly using up the spare capacity of Port Said East of about 0.3 mteu a year).

In example no. 3, shipping companies would reduce their costs marginally by switching their container transhipment to a large ports in Mediterranean coastal States that are not EU Member States like Tanger Med, Morocco. We regard the risk of leakage of container transhipment cargo to ports in Mediterranean coastal States that are not EU Member States ports in example no. 3 as low.

In example no. 4, shipping companies would reduce their costs substantially and avoid paying any EU ETS cost by concentrating container transhipment operations currently distributed between Algeciras, Spain and Tanger Med, Morocco (a port in a State that is not an EU Member States and part of the EU port target list) on just Tanger Med. Then, the ship would stop calling at any port in an EU Member State. Here we see a medium risk of leakage under the current EU ETS: the cost savings would be large, but there is currently little spare capacity in Tanger Med, Morocco. The potential leakage may be of the order of 1 mteu initially (current spare capacity at Tanger Med), but would be more if and when Tanger Med, Morocco expands its capacity.

6.4 Carbon Leakage

Overall emissions in the Mediterranean region could increase due to the potential actions to evade the EU ETS costs.

6.4.1 Potential shift of industries and Carbon Border Adjustment Mechanism (CBAM)

The EU has strict policies for emission reduction. On the other hand, most States that are not EU Member States have less stringent policies. Therefore, there is a risk of 'carbon leakage'. It occurs when companies based in EU move carbon-intensive production to countries where less stringent climate policies are in place than in EU, or when EU products get replaced by more carbon-intensive imports.

Anticipating such likely repercussion, the CBAM was introduced in 2023 whereby importers of goods into EU have to report on the emissions embedded in their products, and from 2026 they have to start paying for these emissions. It will initially apply to certain goods which are carbon-intensive with other major sectors coming under its ambit by 2030.

It is formulated to prevent EU producers, who have been paying high amounts for their emissions in the EU ETS, from being at a competitive disadvantage to imports from countries where carbon is not priced. It seeks to address the risk of carbon leakage by ensuring equivalent carbon pricing for imports and domestic products.

CBAM is a tool to put a fair price on the carbon emitted during the production of carbon-intensive goods that are entering EU and to encourage cleaner industrial production in States that are not Members of the EU. CBAM is likely to support carbon abatement technologies in States that are not Members of the EU, which will lead to developing green and sustainable economies using innovative technologies.

The EC will conduct a study before the end of the transitional period in 2025 on the impact of CBAM on developing countries, particularly LDCs, and assess the effects of the technical assistance provided. The eventual result of CBAM will be to establish carbon as a new cost factor in international trade.

Figure 6.13 Implementation and payment flow chart

Source: WOOD MACKENZIE and Official Journal of the European Union

6.4.2 Other potential sources of carbon leakage

Carbon leakage and revenue leakage may occur due to various scenarios, some of which are discussed below.

Shift in transhipment hub

If there is a change in transhipment from ports in Mediterranean coastal EU Member States to ports in Mediterranean coastal States that are not EU Member States, it could result in an overall increase in carbon emissions in the Mediterranean region.

Some containers that move to ports in Mediterranean coastal States that are not EU Member States may reach the final destination by road, which could spike the overall emissions in the region if the distance by road is longer from the new transhipment port. However, this source of carbon leakage is expected to reduce to a certain extent once the EU ETS2 is implemented (planned to be launched around 2027).

Containers could reach the final destination either by a new feeder service or the existing feeder service could add another port call, which could increase overall emissions from the region.

Shift to smaller vessels

Shipping lines could switch to smaller vessels below 5,000 GT as they are not covered under the EU ETS and, therefore, will need to deploy more vessels on the same route. Since there is ample feeder service in the Mediterranean region, which requires smaller ships, this could result in considerable carbon leakage and revenue leakage in the Mediterranean region.

Additional port calls

Vessels could also start calling additional ports on the last leg before visiting a port in an EU Member State and or on the first leg after leaving ports in EU Member States. This would require deviations of vessels from the planned route, increasing fuel consumption, which would lead to further carbon leakage and revenue leakage. Since this could also happen in the Mediterranean region, it could result in carbon leakage and revenue leakage in the region.

Drewry's hypothetical case study of the potential for carbon leakage due to additional port call, assuming that this is done in five services, shows annual carbon leakage of 33,000 tonnes of CO_2 in the Mediterranean region.

High emitting vessels will go to Mediterranean coastal States that are not EU Member States

In order to reduce the cost of EUA, shipping companies will put low-/zero-emission vessels in EU and higher emissions vessels in States that are not EU Member States, including those in the Mediterranean. Such measures are likely to increase the overall emissions in the Mediterranean region.

Carbon leakage through low-income households

The strategy to reduce emissions is likely to increase the prices of household consumables. Since low-income households generally purchase low-priced items, which are associated with high carbon emissions, it might lead to a rise in carbon leakage. These can take place due to various loopholes present in society not only in low-income Mediterranean coastal States that are not EU Member States, but also in Mediterranean coastal States that are EU Member States.

6.5 Section summary

The implementation of the EU ETS is likely to result in revenue leakage and carbon leakage due to the shift in transhipment volumes to Mediterranean coastal States that are not EU Member States. This could also impact the trade in this region.

Impact on the dry bulk market/sector

Possible revenue leakage was evaluated in the dry bulk sector after the implementation of the EU ETS from 1 January 2024 since ships are now required to buy EUAs, which are likely to become more expensive progressively until 2026. The analysis concludes that revenue leakage because of the EU ETS is unlikely in this sector for trades involving ports in the Mediterranean coastal States that are EU Member States.

Mediterranean coastal States that are EU Member States are relatively small players in the global export of dry bulk commodities, and since the EU ETS costs form a relatively low proportion of the cargo value, exporters from EU Member States are unlikely to lose their cargo as importers will most likely absorb these extra costs. Hence, enforcing the EU ETS is unlikely to fundamentally alter the market dynamics for dry bulk exports from Mediterranean coastal States that are EU Member States.

Impact on liquid bulk

Drewry analysed potential revenue leakage in the Mediterranean region and carried out a cost-benefit analysis to assess the possibility of transhipment of liquid bulk at ports in Mediterranean coastal States that are not EU Member States and concluded that revenue leakage because of the EU ETS is unlikely in this sector for trades involving ports in Mediterranean coastal States that are EU Member State since the additional EU ETS cost is not high enough to encourage such a transhipment.

Mediterranean coastal States that are EU Member States are not major exporters of clean petroleum products. As the EU ETS costs are insignificant when compared with the cargo value, they can be easily absorbed by exporters/refiners of EU Member States, enabling them to remain competitive. Accordingly, we do not foresee any significant change in CPP exports from Mediterranean coastal States that are EU Member States on account of the EU ETS costs.

Impact on containers

Container shipping lines operate in a highly competitive and cost-driven market, seeking to minimise their costs by reviewing their ports of call and shipping network regularly. Thus, carriers will be encouraged to minimise the EU ETS costs by changing their ports of call, provided their decision does not cause other costs to rise by more than the reduced EU ETS costs – and provided there are no other strategic considerations.

Drewry analysed potential revenue leakage in the Mediterranean region and evaluated four examples where swapping a transhipment port in an EU Member State for a transhipment port in a Mediterranean coastal State that is not an EU Member State seemed probable. Of the four examples, two would result in a massive reduction in the EU ETS costs for shipping companies.

Apart from costs, factors such as available capacity, feeder connections, fewer transhipment hubs and bad publicity also have to be considered. In addition, considering that the regulators are monitoring the application of the EU ETS and reviewing the EU port target list every two years, we do not anticipate significant revenue leakage in the container sector due to the implementation of the EU ETS involving ports in the Mediterranean coastal States that are EU Member States. However, the revenue leakage in other areas could be more pronounced, and the potential for these will increase from 2025 when the FuelEU Maritime Regulation is implemented.

Potential carbon leakage

The EU has stringent policies for emission reduction, but lenient policies prevail in many States that are not EU Member States; hence, there is a risk of ‘carbon leakage’. It occurs when companies based in the EU move carbon-intensive production to countries with less stringent climate policies. The EU introduced the concept of CBAM to counter such a likely impact. CBAM will be enforced in 2026, whereby importers of goods into the EU will have to pay for the emissions embedded in their products.

CBAM is a tool to put a fair price on the carbon emitted during the production of carbon-intensive goods entering the EU and to encourage cleaner industrial production in States that are not EU Member States. It will support carbon abatement technologies in States that are not EU Member States.

If there is a change in transhipment from ports in Mediterranean coastal States that are EU Member States to ports in Mediterranean coastal States that are not EU Member States, it could result in an overall rise in carbon emissions in the Mediterranean region. Movement of containers by road could increase the overall emissions in the region if the distance by road is longer from the new transhipment port. However, this source of carbon leakage is expected to reduce to an extent once the EU ETS2 is implemented (planned to be launched around 2027).

Containers could reach the final destination either by starting a new feeder service or the existing feeder service would add another port of call; thereby adding to the overall emissions from the Mediterranean region.

Shipping lines could change to smaller feeder vessels below 5,000 GT in the Mediterranean region, resulting in considerable carbon leakage and revenue leakage.

Vessels could also start calling additional ports in the Mediterranean region on the last leg before visiting a port in a Mediterranean costal State that is an EU Member State and or on the first leg after leaving ports in Mediterranean costal States that are EU Member States, which would lead to considerable carbon leakage and revenue leakage in the Mediterranean region.

There are other sources of carbon leakage; for example, the strategy of shipping companies to send low-/zero-emission vessels to the ports in EU Member States to reduce EUA costs and diverting high emitting vessels to ports in Mediterranean coastal States that are not EU Member States could increase the overall emissions in the Mediterranean region. Moreover, low-income households generally try to purchase low-priced items associated with high carbon emissions, which will increase carbon leakage.

7 Stakeholder analysis

Drewry engaged with the Contracting Parties to the Barcelona Convention (CPs) to seek feedback on various issues related to the legal and technical implications of the EU ETS for shipping in the Mediterranean Region. The online copy of the questionnaire was shared with other stakeholders as well. In addition, a few interviews were also conducted.

This section covers the feedback from multiple stakeholders, which has further been considered in Section 8 (Challenges, opportunities and recommendations) and Section 9 (Roadmap and action plan to address the challenges of implementing the EU ETS).

7.1 List of stakeholders involved

Many stakeholders from Mediterranean coastal States that are EU Member States as well as Mediterranean coastal States that are not EU Member States, were approached for their feedback.

Figure 7.1 Types of stakeholders

Source: Drewry

7.2 Questionnaire, survey and stakeholder interviews

A questionnaire that covered various aspects of the Study was developed and shared with all CPs for their feedback, while its online version was prepared and shared with stakeholders. Some interviews were also conducted to gather feedback from stakeholders. The collated feedback from various stakeholders has been shared below.

7.2.1 Feedback related to legal issues

The following legal issues were raised by stakeholders:

- Legal challenges can occur due to the different political priorities in the Mediterranean region. Coming up with a harmonised approach would require coordination among the Mediterranean coastal States that have diverse cultures and priorities.
- Creating a section for air pollution and the environment in the International Convention of Safety of Life At Sea (SOLAS) can help in resolving such issues.
- Ports in Mediterranean coastal States that are not EU Member States near the EU region should voluntarily join the EU ETS. Revenue collected from EUAs could be returned to these countries for development funds.
- The definition of offshore vessels and the inclusion of these vessels in the scope of the EU ETS port call needs more clarity.
- It is important to ensure that the charter party is clear on the responsible party to pay for EU ETS costs.
- There is a lack of clarity on how the EU ETS will be applied to Mediterranean coastal States that are not EU Member States like ports in Morocco (Tanger Med) and Egypt (Port Said East) designated as “neighbouring transhipment ports”.

7.2.2 Feedback related to administrative issues

Several stakeholders reported that administrative issues regarding the responsibility of submitting allowances are often encountered. Thus, they are in internal discussion to arrive at an amicable solution.

A stakeholder mentioned that many vessels visited the ports in their country as it is strategically located, which adds pressure on the manpower available to manage their documentation and verification. They recommended an increase in manpower. The inclusion of offshore vessels and vessels above 400 GT and below 5,000 GT will add to the shortage of manpower.

7.2.3 Feedback related to technical issues

With the phased-in implementation of the EU ETS, the following technical issues were highlighted by stakeholders:

- The inclusion of vessels above 400 GT and below 5,000 GT will bring many tugboats into the scope of the EU ETS; meanwhile, emissions from tugboats are high, which will have to be paid by tug owners.
- No technology is good enough to avoid the EU ETS costs. Companies will continue paying EUAs for a long time.
- Submission of the required plans and data in a timely manner, not closer to the deadline.
- Certification of sustainable biofuels is not easy and could be an issue.
- Education of stakeholders and training of staff involved in the EU ETS calculations and enforcement, especially PSC.
- Reduction of emissions from old vessels is not easy and may not be commercially viable.

7.2.4 Feedback related to revenue leakage

The trade patterns could shift because of the EU ETS, which needs to be addressed in a timely manner. A stakeholder stated that the geopolitics factors and global trade patterns are affecting maritime behaviour, as illustrated currently by the disruptions in the Red Sea. The stakeholders being interviewed, mentioned that the revenue leakage in the Mediterranean region cannot be attributed to the EU ETS as the impact of the Red Sea crisis is larger. Although, as it has been only a few months since the EU ETS' maritime provisions entered into force, it is still too early to draw conclusions regarding potential evasion behaviours in relation to the EU ETS implementation.

With EU being an attractive market for any business, the increase in costs due to the EU ETS will be sustainable in the long term, but similar patterns in other regulated sectors suggest that revenue leakage is a real risk in the short term. Shippers could be increasingly encouraged to avoid a port in an EU Member State with the phase-in of the EU ETS, which will be 100% implemented by 2026, and the likely increase of EUA prices over time.

In order to tackle revenue leakage, the EU ETS has included the criteria of transhipment ports for container vessels with the EU port target list subject to review every two years. Several stakeholders suggested that the criteria to include transhipment ports under the EU ETS should be changed because the 65% transhipment volume threshold is unlikely to be crossed since many ports in Mediterranean coastal States that are not EU Member States are dominated by gateway volumes. So either this threshold of 65% should be lowered or the shift in volumes should be monitored. If any red flags become apparent, there should be a provision for adding or removing ports from the EU port target list, irrespective of the two criteria for a transhipment port.

According to a stakeholder, it is agreed to review the EU port target list every time an authority requests for the same.

A stakeholder highlighted that GHG moves in the atmosphere and its spread is not limited by geographical boundaries. Therefore, the need of the hour is a global measure and not a regional measure.

7.2.5 Feedback related to carbon leakage

Stakeholders raised concerns about the shipping business looking for gaps in legislation in order to reduce their expenses related to the EU ETS, which could result in carbon leakage. Tackling these issues on a regional level will end up increasing overall carbon emissions. For example, there is a possibility of carbon leakage because the EU ETS has not yet been introduced to road transport. This could encourage transport companies to avoid ports of call in Mediterranean coastal States that are EU Member States and instead transport the goods to their destination from Mediterranean coastal States that are not EU Member States via road, thereby covering a longer distance by road which would increase the overall carbon emissions. However, if the goods are sent to the final destination by sea, it would require more feeder services or the existing feeder service will have to call more ports, hence increasing the overall emissions.

A stakeholder mentioned that CBAM is a good measure to reduce carbon leakage. The stakeholder also stated that it is important to track the goods from origin to destination.

According to a stakeholder, fostering regional cooperation and building capacity in Mediterranean coastal States that are not EU Member States are crucial steps towards achieving global emission reduction goals.

There should be a detailed and thorough evaluation of the impact and proposed corrective actions. The corrective action plan should not result in unwanted side effects. However, a stakeholder stressed that the EC is closely monitoring potential carbon leakage, and it will report from 2024 biennially on the implementation of the EU ETS in respect of maritime transport to detect and prevent evasive behaviours and, if appropriate, to propose measures to ensure the effective implementation of the legislation.

The need of the hour is a set of global measures that are followed by all countries, including the Mediterranean coastal States, in addition to regional cooperation, policy harmonisation, green technology incentivisation, as well as robust monitoring and reporting systems.

7.2.6 Feedback related to other issues

A stakeholder indicated that production and availability of renewable and low-/zero-carbon fuels in the maritime transport sector will be driven by the regulations. The scaling up of production of these fuels will contribute to reducing the price gap with fossil fuels. Hence, the green transition offers opportunities to decarbonise the maritime sector and increase its competitiveness.

A stakeholder emphasised that the lack of clarity and/or volatility in EUA prices has encouraged a few shipping companies to charge exorbitant amounts from their customers, shifting the entire burden to them. As a result, it was suggested that the EC could take initiatives to better manage the market so as to prevent such practices.

Since the EU ETS may result in evasive calls, a stakeholder raised concerns about reduction in Europe's connectivity as the cargo will take additional days to be delivered after factoring in the time taken for transhipment, in turn increasing the prices of imported goods.

A stakeholder mentioned that the STCW convention can be amended to include training on the concept of the EU ETS.

Another stakeholder indicated that a global framework of MBM will ensure that a level playing field is maintained in the Mediterranean region and elsewhere as well. However, these processes are very slow, and once cargo routes change it will be challenging to shift them back.

Another stakeholder suggested that local emission regulations need to be reviewed by the Mediterranean coastal States that are not EU Member States as they need to be aligned with the EU ETS as far as possible.

Another stakeholder highlighted that the implementation of the EU ETS is already boosting the research for green marine fuels and propulsion systems. For example, in France, the propulsion by sails as an alternative is picking up pace. The EU ETS will drive countries in the same regions to cooperate on preserving their maritime areas through regional agreements. In the long term, Mediterranean coastal States that are not EU Member States will become aware of the benefits and will implement similar mechanisms for preserving the environment. Investments in more media campaigns are recommended to increase awareness of the benefits of the EU ETS.

Several stakeholders mentioned that, while the EU ETS poses challenges, particularly in terms of increased costs and potential competitive disadvantages, it also offers significant opportunities for innovation, public health improvements, and environmental benefits. The overall success of this initiative will depend on careful planning, international cooperation, and support mechanisms to ensure a balanced transition to a more sustainable maritime sector.

Some stakeholders had the view that Mediterranean coastal States can collectively work towards a more sustainable and environment-friendly shipping industry by leveraging opportunities for regional cooperation, investment in cleaner technologies, development of green infrastructure, in addition to enhanced monitoring and reporting, capacity-building, and international collaboration. A decarbonisation fund among Mediterranean coastal States could help with the green development of and the required investment in the Mediterranean region.

In addition, one stakeholder mentioned that there are other international agreements that Mediterranean coastal States that are not EU Member States are a part of. These other environmental treaties will eventually drive all countries to improve their environmental policies.

A stakeholder mentioned that meetings should be organised in collaboration with REMPEC to reach a consensus amongst the Mediterranean coastal States.

In response to the question on the impact of the EU ETS in the Mediterranean region, some stakeholders stated that faster demolition of aged fleets as well as an increase in cargo transit time due to slow steaming could be possible outcomes of the implementation of the EU ETS.

Stakeholders were also concerned about developing countries, including LDCs and SIDS, which have no financial resources to invest in low-/zero-GHG emission vessels or infrastructure for green fuel bunkering.

7.3 Section summary

The Mediterranean region is a mix of coastal States that are EU Member States and coastal States that are not EU Member States, hence implementing measures could create legal challenges because of diverse cultures and priorities. Stakeholders added that the ports from Mediterranean coastal States that are not EU Member States should be encouraged to voluntarily join the EU ETS in any way that benefits both parties; for example, revenue collected could be shared with these ports/countries.

A stakeholder mentioned that many vessels visit the ports in their country because of favourable geographical location, which adds pressure on the resources available to manage their documentation and verification. They recommended increasing manpower for all administering authorities to prepare for the expansion of the EU ETS scope in future.

Most stakeholders mentioned that port authorities have a major role to play in supporting and facilitating the development of green corridors and the JIT system. A decarbonisation fund among Mediterranean coastal States could help with the green development of and the required investment in the Mediterranean region.

Some stakeholders mentioned that the shift in trade routes within the Mediterranean region cannot be directly linked to revenue leakage due to the EU ETS as they could also have resulted from the Red Sea crisis. However, they mentioned that there is a real risk of revenue leakage from the EU perspective as shipping companies will keep looking for gaps in legislation to reduce their expenses, which will result in revenue leakage and carbon leakage. Although, as it has been only a few months since the EU ETS entered into force, it is still too early to draw conclusions regarding potential evasion behaviours in relation to the EU ETS implementation.

A stakeholder stressed that the EC is closely monitoring potential carbon leakage, and it will report from 2024 biennially on the implementation of the EU ETS in respect of maritime transport to detect and prevent evasive behaviours and, if appropriate, to propose measures to ensure the effective implementation of the legislation.

To address this issue, stakeholders suggested that the EU port target list needs to be expanded by reducing the selection criteria for neighbouring transhipment ports under the EU ETS from the present 65% transhipment values. Also, a more frequent review process, involving different ways of identifying evasive actions should be adopted as any change in trade routes will be very difficult to shift back if it is not identified and acted upon in time. Moreover, CBAM should be promoted to spread awareness.

Some stakeholders believe that the EU ETS may not reduce GHG emissions due to possible evasive actions. Therefore, a global framework of MBM would ensure a level playing field was maintained in the Mediterranean region and elsewhere.

A stakeholder mentioned that greenhouse gases moves in the atmosphere and does not have any boundaries. Therefore, the need of the hour is a global measure and not a regional measure.

Another stakeholder recommended that meetings should be organised in collaboration with REMPEC to reach a consensus amongst the Mediterranean coastal States.

As the price of EUA is volatile and unregulated, shipping companies have been charging high amounts from their customers to cover the EU ETS costs. A stakeholder suggested that initiatives should be taken to better manage the market to prevent such practices.

However, several stakeholders agree that the implementation of the EU ETS is boosting the research for green marine fuels and propulsion systems. Production and availability of renewable and low-/zero-carbon fuels in the maritime transport sector will be driven by the regulations. The scaling up of production of these fuels will contribute to reducing the price gap with fossil fuels. Hence, the green transition offers opportunities to decarbonise the maritime sector and increase its competitiveness. One stakeholder suggested that local emission regulations need to be reviewed by Mediterranean coastal States that are not EU Member States and should be aligned with the EU ETS as far as possible.

It was mentioned by another stakeholder that developing countries, including LDCs and SIDS, have no financial resources to invest in low-/zero-GHG emission vessels or infrastructure for green fuel bunkering.

Stakeholders also indicated that:

- The STCW convention can be amended to include training on the concept and application of the EU ETS. There is also a need to educate stakeholders in the EU ETS calculations and enforcement, especially PSC.
- Reducing the emissions from the older vessels will not be easy and commercially viable.
- CBAM is a good measure to reduce carbon leakage, and it is also important to track the goods from origin to destination.
- There should be a detailed evaluation of the impact and proposed corrective actions to be taken. The corrective action plan should not result in other unwanted side effects.

8 Challenges, opportunities and recommendations

While implementing the EU ETS is challenging, it also provides for various opportunities. Both challenges and opportunities were considered to devise a set of recommendations for the Mediterranean region.

8.1 Challenges in the implementation of the EU ETS

There are many challenges in the implementation of the EU ETS for shipping, which are discussed below:

- The coastal States of the northern shore of the Mediterranean Sea appear to have more economic resources, dedicated to preserving the environment. Moreover, there are different ways to look at the environmental issues in various coastal States on the northern and southern shores of the Mediterranean Sea. This creates an imbalance and challenge in implementing the EU ETS. Legal challenges can occur due to the different political priorities of the Mediterranean coastal States. Implementing EU policies in the Mediterranean coastal States that are not EU Member States would require coordination among countries with divergent cultures and priorities.
- If Mediterranean coastal States that are not EU Member States are to be motivated to voluntarily join the EU ETS, it will first require the EC to evaluate the EU ETS and see whether and how this could be done, as it may have legal and other implications. For example, it will require the Mediterranean coastal States that are not EU Member States to reduce overall emissions by 55% by 2030 in all industries, including maritime.
- The cost of European Union Allowance (EUA) should be borne by the charterer, based on the “polluter pays” principle. However, as per the clauses of private contracts, shipowners can get reimbursed by charterers, only if it is mentioned in the contract.
- Any dispute in the calculation of emissions will usually be settled in court under the law of the States that are not EU Members States, such as the UK or Singapore, which could create challenges in resolving the issue.
- According to the EU ETS, either the shipowner or the ship management company is responsible for compliance with the EU ETS, but in the case of FuelEU Maritime Regulation, only the ship management company is responsible for compliance, which will create challenges.
- The high cost of low-/zero-carbon fuels is a critical barrier that needs to be addressed by the MBM.
- Lack of availability of green fuels and insufficient infrastructure can discourage owners from ordering new dual-fuelled vessels.
- There are technical challenges when implementing the EU ETS for shipping. Teething issues, such as IT system readiness for EUA calculation, missing the charter party deadlines and the lack of knowledge to calculate the EU ETS cost, are likely to be resolved in a few months though.
- A feasible fuel pathway, consumer demand for sustainable shipping, supportive laws and regulations and cooperation across value chains are some of the challenges for forming a green corridor.
- Availability of the required certificate (in particular for sustainable biofuels) can be an issue. The EU is working towards addressing the issues related to the proof of sustainability documentation.
- Reducing emissions from old ships is tough and may not make them commercially viable.

- Many shippers/shipping companies find ways to work around the legal framework, as for some stakeholders, the motivation to save cost is more important than reducing emissions, leading to revenue leakage and carbon leakage. This will motivate them to shift industries to countries with less stringent emission reduction regulations.
- Increasing revenue and volumes is important from the perspective of ports, and if there are no regulations to discourage this, ports with low volumes of Mediterranean coastal States that are not EU Member States will be motivated to carry out transhipment.
- The data collection and monitoring mechanism may not be robust enough in Mediterranean coastal States that are not EU Member States and the data shared by ports with authorities might be insufficient, resulting in improper assessment of the revenue leakage.
- Tracking and monitoring of commodities from their origin to their final destination may not be fully possible, resulting in improper assessment of the carbon leakage.
- EUA price uncertainty will create problems with financial modelling.
- Many viable options are available for zero-carbon ships, which are currently in the development stage and this requires massive investment and infrastructure. Options such as green fuel production, bunkering infrastructure, construction of modern ships and retrofitting require massive financial support and technological advancements.

8.2 Opportunities arising from the implementation of the EU ETS

The implementation of the EU ETS is already boosting the research for green marine fuels and propulsion systems. The EU ETS will drive all Mediterranean coastal States to cooperate on preserving their maritime areas through the Barcelona Convention and its Protocols. In the long term, Mediterranean coastal States that are not EU Member States will become more aware of the benefits and will implement similar mechanisms for preserving the environment. There could be opportunities arising from the training of stakeholders on green transition as it will increase the awareness and importance of green transition. Training institutes can introduce new courses to train stakeholders involved in the Mediterranean region about EU ETS and decarbonisation.

Similarly, there are opportunities for engine manufacturers, equipment manufacturers, software developers, etc., who can provide emission reduction solutions. These will ultimately drive emission reduction and improve human health, and reduce the impact of climate change on the environment.

States that have renewable energy sources, can cash in for the economic development of the country. Therefore, MoUs and strategic partnerships will increase between States that are EU Member States and States that are not EU Member States to achieve net zero emission (for example, the EU-Namibia Partnership).

Demand for shipyards is likely to increase. Hence, shipyards in the Mediterranean region can expand their capacity for retrofitting PIDs and ESDs or conversion to dual-fuel engines on vessels.

The potential for the development of multiple green corridors in the Mediterranean region represents a significant opportunity. These corridors would support the Mediterranean region to develop better infrastructure and improve the availability of green fuels. Production and availability of renewable and low-/zero-carbon fuels in the maritime transport sector will be driven by the regulations. The scaling up of production of these fuels will contribute to reducing the price gap with fossil fuels. Hence, the green transition offers opportunities to decarbonise the maritime sector and increase its competitiveness.

In addition, below are some of the other opportunities:

- Mechanisms such as the CBAM will push other countries to create their own net-zero framework to avoid losing potential clients.
- The EU's MRV data is available to the public, which can be used by others to gather insights related to emission reduction and plan their growth strategy or emission reduction strategy.

8.3 Recommendations

While the EU ETS poses challenges, particularly in terms of increased costs and potential competitive disadvantages, it also offers significant opportunities for innovation, public health improvements and environmental benefits. The overall success of this initiative will depend on careful planning, international cooperation and support mechanisms to ensure a balanced transition to a more sustainable maritime sector. A set of recommendations is proposed below.

8.3.1 Recommendations related to legal issues

Any dispute regarding non-compensation or less compensation by the charterer to the owner due to a dispute in the calculation of emissions can usually be settled in court. They are likely to be settled under the law of IMO Member States that are not EU Member States such as the UK and Singapore, which could create challenges in the coming months. Therefore, the country for dispute settlement for such issues needs to be investigated and addressed because it may not be an EU Member State.

Local emission regulations should be reviewed by Mediterranean coastal States that are not EU Member States and should be aligned with the EU ETS as far as possible.

8.3.2 Recommendations related to administrative issues

In the EU ETS, either the shipowner or ship management company is responsible for the ship's compliance with the EU ETS, but in the case of FuelEU Maritime Regulation, only the ship management company is responsible for compliance. As this variance could cause some confusion, it is recommended that both Regulations have the same entity for compliance.

The cost of EUAs should be borne by the charterer, based on the "polluter pays" principle, and so it is recommended to have regulations to this effect.

Mediterranean coastal States that are EU Member States should evaluate the work of administrative authorities from the perspective of delays in their role attributed to lack of resources and ensure that they have sufficient resources to carry out their role, keeping in mind that more vessels will be included under the EU ETS in the next few months.

Mediterranean coastal States should educate the various stakeholders and train the required staff to make them fully aware of green transition underway and take action accordingly.

8.3.3 Recommendations related to technical issues

Decarbonisation of shipping is increasingly coming under pressure, necessitating suitable green fuels to replace fossil fuels. These efforts/steps require massive investment for producing low-/zero-carbon fuel, creating bunkering infrastructure, providing onshore power at ports, building green ports, building modern low-/zero-emission ships and retrofitting existing vessels with duel fuelled engines and or PIDs/ESDs.

Investment needed for decarbonisation in the Mediterranean region may not be as huge as the global requirement, but it would still be substantial. Ideally, all stakeholders in the region should get together and create a decarbonisation fund, which could be exclusively used for such activities in the region.

A study of the Mediterranean shipyards capable of carrying out retrofitting of vessels for various PIDs or ESDs or conversion to duel-fuelled vessels could be carried out to evaluate their capacity and capability to undertake the required retrofitting for decarbonisation of vessels. The shortlisted shipyards could be given the required support. In addition, the potential opportunities for shipyards due to retrofitting, in terms of creating employment and economic growth it will bring, should be explained to Mediterranean coastal States that are not EU Member States. This will lead to investment in shipyards and also help in decarbonising the shipping sector. For example, shipyards of Türkiye are already reaping the benefits from these investments. Such a study should be carried out by a neutral third party, which could later play the role of a facilitator in terms of capacity-building and resource mobilisation.

Mediterranean coastal States should showcase their requirement for green fuels, which would give a clear indication of the demand from Mediterranean coastal States that are EU Member States. On the other hand, Mediterranean coastal States that are not EU Member States should continue to be encouraged to develop renewable energy and green fuels. A neutral third party could facilitate the coalition of demand and play the role of a facilitator between Mediterranean coastal States to push the demand for fuels, which would increase the supply of fuels from Mediterranean coastal States that are not EU Member States.

Green corridors would make it achievable for policymakers to create an ecosystem that is supportive of decarbonisation by allowing them to implement safety regulations, targeted regulatory actions, and financial incentives. Policy makers could do their part in contributing to the demand for green shipping by creating regulations and incentives to lower the production cost of green fuels. Green corridors could also provide other effects, which may encourage a reduction of shipping emissions on other routes. As an example, readily available zero-emission fuel infrastructure can be used for shipping on other, adjacent routes, thereby reducing emissions in the entire Mediterranean region.

These corridors would ideally be large enough to include all relevant value-chain actors, such as fuel producers, cargo owners and regulatory authorities. They would provide offtake certainty to fuel producers and send strong signals to vessel operators, shipyards and engine manufacturers to ramp-up investment in zero-emission shipping, making the risks more acceptable for all involved.

The selection process for initial green corridors is crucial. Four critical building blocks are required for a potential green corridor:

- stakeholders that are committed to decarbonisation and are willing to collaborate across the value chain;
- a viable fuel pathway;
- customer demand for green shipping and initiatives to pool demand and
- policy and regulation that can narrow cost gaps and expedite adoption.

JIT arrivals could also contribute to lowering emissions, and port authorities in the Mediterranean region need to play an active role in supporting and facilitating these.

If OCCS gains popularity, ports in the Mediterranean region should invest in infrastructure for receiving liquid CO_2 containers or liquid CO_2 via pipelines or even CO_2 byproducts such as limestone.

An organised effort for increasing technical awareness among stakeholders is recommended. This could be done through workshops, seminars, webinars, classroom sessions and conferences, amongst others, in the Mediterranean region, with a clear focus on disseminating the correct technical awareness amongst the stakeholders. There is also a need to train those involved in the calculation and enforcement of the EU ETS. This could be facilitated by a neutral third party for all Mediterranean coastal States.

While Mediterranean coastal States that are EU Member States would be easy to convince to implement these measures, Mediterranean coastal States that are not EU Member States may not go along with it after seeing to the associated cost, focusing on other priority areas of the development, and country economics. Hence arriving at a consensus amongst all Mediterranean coastal States is of paramount importance, along with the availability of funds for building the required capacity.

To gradually eliminate the carbon footprint in shipping, cooperation among all stakeholders is crucial. Strong initiatives by the relevant controlling authorities to bring all Mediterranean coastal States on one platform would be the need of hour. This could possibly be done by adequately explaining the technical and commercial benefits of adopting suitable decarbonisation technologies. The authorities might need to provide certain additional benefits or incentives to Mediterranean coastal States that are not EU Member States to encourage them to adopt decarbonisation technologies.

The implementation of technical measures would achieve the desired result only if it was done on a large scale rather than a few small pockets and regions or sub-regions implementing these measures.

8.3.4 Recommendations related to revenue leakage

The list of neighbouring transhipment ports could be reviewed more frequently than every two years especially when any EU Member State requests for the same.

The threshold of 300 nautical miles and 65% transhipment volumes for neighbouring container transhipment ports should only be used as a basis and could be reviewed as required without the two-year restriction. In addition, it is recommended to review changes to shipping line routing as well as transhipment volumes of ports in Mediterranean coastal States that are EU Member States regularly to evaluate revenue leakage.

A circular could be sent informing that EU is monitoring transhipment volumes from a revenue leakage perspective and reserves the right to declare ports as transhipment ports from the EU ETS perspective even though they do not meet the two criteria.

In the same circular, it could be stated that any shipping line found to be misusing the provisions of the EU ETS and engaging in activities resulting in revenue leakage, will be publicly declared, which may result in reputational damage for the concerned shipping lines.

8.3.5 Recommendations related to carbon leakage

Most recommendations for reducing potential revenue leakage will also help in reducing carbon leakage, in addition to the following recommendations that will mostly prevent carbon leakage:

- Regional measures are not effective in reducing/eliminating carbon leakage as GHG moves in the atmosphere and in not limited by geographical boundaries. Hence, the IMO should prepare a global measure.
- It is recommended to expedite the implementation of the EU ETS2 for road transportation to reduce cargo leakage via road.
- Capacity expansion of ports in Mediterranean coastal States that are not EU Member States could be for organic growth but also to facilitate evasive actions by shipping lines. Hence, capacity expansion in any port of a Mediterranean coastal State that is not an EU Member State should be monitored closely and clarification should be sought on the volume projections of these ports after expansion.

Vessels could also start calling additional ports in Mediterranean coastal States that are not EU Member States on the last leg before visiting ports in Mediterranean costal States that are EU Member States and/or on the first leg after leaving Mediterranean costal States that are EU Member States. This would increase fuel consumption due to the deviation and lead to carbon leakage. In addition, there is a need to evaluate the distance travelled by vessels on the last leg before visiting a port in a Mediterranean coastal State that is an EU Member State and on the first leg after leaving a port in a Mediterranean coastal State that is an EU Member State.

- Shipping lines could switch to smaller vessels below 5,000 GT as they are not covered under the EU ETS. This could result in considerable carbon leakage and revenue leakage in the Mediterranean region. Hence, these should also be monitored accordingly.
- It is recommended to explore prioritising the inclusion of ships between 400 GT and 5,000 GT as they could be used for transporting containers.
- A system could be developed to map the movement of cargo from origin to destination using technologies such as blockchain to identify carbon leakage.
- Foreign Direct Investment (FDI) in Mediterranean coastal States that are not EU Member States should be monitored, as it could potentially be for shifting industries from Mediterranean coastal States that are EU Member States to Mediterranean coastal States that are not EU Member States. This could give some indication of possible carbon leakage, but the same would need to be investigated further.

8.3.6 Recommendations related to other issues

Recommendations on the other topics are listed below:

- Shipping companies are charging their customers heavily to cover the cost of EUAs and initiatives could be taken to better manage the market to prevent such practices.
- Low-income households generally try to purchase low-priced items that are associated with high-carbon emissions, which will increase carbon leakage. In addition, these households also depend a lot on fossil-based fuels for heating, cooking, etc. From a social equity perspective, policies and measures that effectively support the most vulnerable households are thus necessary.

- EUA cost is market-driven and depends on demand and supply. This creates uncertainty for shipowners and financial institutes in carrying out a financial evaluation of any proposed measures to reduce emissions. It is recommended to take some measures to develop some official long-term forecasts for EUA prices, on a non-liability basis, in base, high and low case scenarios. The same could be revised regularly, as required.
- Once all Mediterranean coastal States are on a common platform with required incentives in place to motivate them to adopt decarbonisation, a conducive ecosystem comprising policymakers, regulators, ports, shipowners/managers, charterers, ship agents, shipbuilders, fuel producers, educational/training and research institutes, amongst others, will be required for a common step forward towards decarbonisation.
- There should be a detailed evaluation of the impact and proposed corrective measures. The corrective measures should not result in any other issues.
- REMPEC could play an important role to build consensus amongst the Mediterranean coastal States on various issues.

9 Roadmap and action plan to address the challenges of implementing the EU ETS

Mediterranean coastal States can collectively work towards a more sustainable and environment-friendly shipping industry by leveraging opportunities for regional cooperation, investment in cleaner technologies, and development of green infrastructure, in addition to enhanced monitoring and reporting, capacity-building, and international collaboration.

The recommended roadmap and action plan to address the challenges of implementing the EU ETS are presented in the table below.

Table 9.1 Recommended roadmap and action plan to address the challenges of implementing the EU ETS

Timeline	Area	Recommended action	Responsibility
Short term	Legal	CPs should engage with Mediterranean coastal States that are not EU Member States about taking initiatives to align their local emission regulations with the EU ETS as far as possible.	CPs
	Technical	Port authorities should play an active role in supporting and facilitating the development of green corridors and the JIT system.	CPs
	Revenue leakage	CPs should explore the possibility of changing the two criteria (300 nautical miles and 65% transhipment volumes) of neighbouring container transhipment ports whenever required, and not restrict it to every two years.	CPs
	Revenue leakage	CPs should issue a circular stating that they are monitoring transhipment volumes to identify shifts in trade routes for avoiding the EU ETS costs. CPs should reserve the right to declare certain ports for transhipment under the EU ETS, even if they do not meet the two criteria.	CPs
	Carbon leakage	CPs should issue a circular warning shipping lines of any misuse of the EU ETS provisions that may cause carbon leakage; if such misuse is proven, CPs could publicly name the shipping line, potentially damaging its reputation.	CPs
	Carbon leakage	CPs should explore the possibility of expediting the implementation of the EU ETS2 for road transportation.	CPs

	Carbon leakage	CPs should consider prioritising the inclusion of ships between 400 GT and 5,000 GT in the EU ETS, which could potentially be used to transport containers as feeder vessels.	CPs
	Carbon leakage	CPs should be urged to play an active role within IMO to finalise and implement the MBM plan as a priority since it could significantly address carbon leakage and revenue leakage globally.	CPs
	Others	CPs should take initiatives to help prevent shipping companies from charging their customers higher-than-reasonable amounts to cover the EU ETS costs.	CPs
Mid-term (till 2030)	Administrative	CPs should introduce a mechanism for enforcing the “polluter pays” principle.	CPs
	Administrative	CPs should ensure that administrating authorities have sufficient resources to carry out their roles and responsibilities.	CPs
	Technical	CPs should encourage stakeholders in the Mediterranean region to come together and create a decarbonisation fund, which could be exclusively used for decarbonisation of shipping in the region as it involves massive investment.	CPs
	Carbon leakage	CPs should develop a system for identifying carbon leakage by mapping the movement of cargo from its origin to its destination.	CPs
	Carbon leakage	CPs should propose to IMO that initiatives like CBAM need to be explained at a global level to make all stakeholders aware of its benefits and thereby encourage the development of a global measure.	CPs
Long term (beyond 2030)	Technical	CPs should continue pursuing the development and provision of low-/zero-carbon fuels to enable the shipping sector to decarbonise in line with targets set by the IMO and the EU.	CPs
	Technical	CPs should encourage and facilitate the adoption of other possible new/innovative emission reduction mechanisms that may emerge in the future.	CPs
Ongoing	Administrative	CPs should educate the various stakeholders and train the required staff about EU ETS and decarbonisation.	CPs

	Technical	CPs should carry out a capacity-building exercise for shipyards to accelerate the decarbonisation of vessels. This could be a study carried out by a neutral third-party facilitator.	CPs
	Technical	CPs could consider involving a neutral third party to encourage and facilitate bringing the buyers and suppliers of green fuels together on their behalf so that companies can transition to low-/zero-carbon shipping.	CPs
	Revenue leakage	CPs should regularly review changes to shipping line routing as well as transhipment volumes of ports in Mediterranean coastal State that are EU Member States to evaluate revenue leakage.	CPs
	Carbon leakage	CPs should closely monitor capacity expansion of ports in Mediterranean coastal States that are not EU Member States.	CPs
	Carbon leakage	CPs should regularly review changes to shipping line routing to evaluate evasive action (as well as the distance travelled by vessels) by calling additional ports on the last leg before visiting a Mediterranean coastal State that is an EU Member State and/or on the first leg after leaving a Mediterranean coastal State that is an EU Member State.	CPs

References

1. Argus Media analysis platform
   Commodity prices, forecasts, news & market analysis | Argus Media
2. Atlas Marine Systems (2023)-Benefits of a shore power system
   https://atlasmarinesystems.com/blog/benefits-shore-power
3. Becker Mewis Duct-product article
   https://becker-marine-systems.com/products
4. Brunvoll Controllable pitch propeller product guide
   https://www.brunvoll.no/products/controllable-pitch-propellers
5. ClassNK (2024) FAQs on FuelEU Maritime 2nd edition
   FuelEU_faq_2_e.pdf (classnk.com)
6. "Commission Delegated Regulation (EU) 2023/2904 of 25 October 2023 amending Delegated Regulation (EU) 2019/1122 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards the functioning of the Union Registry"
   https://eur-lex.europa.eu/eli/reg_del/2023/2904/oj
7. "Commission Implementing Regulation (EU) 2023/2297 of 26 October 2023 identifying neighbouring container transhipment ports pursuant to Directive 2003/87/EC of the European Parliament and of the Council"
   https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302297
8. "Commission Implementing Regulation (EU) 2023/2599 of 22 November 2023 laying down rules for the application of Directive 2003/87/EC of the European Parliament and of the Council as regards the administration of shipping companies by administering authorities in respect of a shipping company"
   https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302599
9. Damen Marine component "Advantages of rudder bulb" product guide
   https://www.damenmc.com/advantages-of-a-rudder-bulb/
10. Directive 2003/87/EC of the European parliament and of the council for GHG emission allowance
    CL2003L0087EN0150010.0001_cp 1..2 (europa.eu)
11. "Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system"
    https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L0959&qid=1724838397869
12. Directorate-General for Climate Action, European Commission
    https://climate.ec.europa.eu/index_en
13. Global Maritime Forum Annual Progress Report (2023) on Green Shipping Corridors
    https://cms.globalmaritimeforum.org/wp-content/uploads/2023/11/Global-Maritime-Forum_Annual-Progress-Report-on-Green-Shipping-Corridors_2023.pdf

14. Global Maritime Forum (2020) Report titled 'The scale of investment needed to decarbonize shipping'
https://globalmaritimeforum.org/insight/the-scale-of-investment-needed-to-decarbonize-international-shipping/
15. GloFouling Partnerships Project Ccoordination Unit, International Maritime Organization data on biofouling
https://www.imo.org/en/OurWork/PartnershipsProjects/Pages/GloFouling-Project.aspx
16. ICCT (2020) working paper 'Limiting Engine Power to reduce CO_2 from Existing Ships'
https://theicct.org/sites/default/files/publications/Limiting_engine_power_02112020_0.pdf
17. ICS (2021) Paper 'A zero emission blueprint for shipping'
https://www.ics-shipping.org/wp-content/uploads/2021/11/A-zero-emission-blueprint-for-shipping.pdf
18. Identec Solutions (2023) 'The Green Port Concept'
https://www.identecsolutions.com/news/the-green-port-concept
19. International Maritime Organization MEPC. 1/Circ.885/Rev. 1 Revised procedure for assessing impacts on states of candidate measures (2023)
https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/MEPC.1-Circ.885-Rev.1.pdf
20. Market–Based Measures writeup by IMO
Market-Based Measures (imo.org)
21. McKinsey & Company (2021) Article 'Green Corridors-A lane for zero carbon shipping'
https://www.mckinsey.com/capabilities/sustainability/our-insights/green-corridors-a-lane-for-zero-carbon-shipping
22. MDPI (2021) Article 'Challenges for Zero Emissions Ship'
https://www.mdpi.com/2077-1312/9/10/1042#:~:text=Table%202.-,Emissions%20from%20shipping.,the%20auxiliary%20systems%20and%20consumables.
23. "MEPC.1-Circ.885-Rev.1" circular (2023)
MEPC.1-Circ.885-Rev.1.pdf (imo.org)
24. Mid- and long-term GHG reduction measures writeup by IMO
Mid- and long-term GHG reduction measures (imo.org)
25. MOL Techno-Trade Asia Pte. Ltd. PBCF service portal
https://www.motech.co.jp/en/business-en/environment-en/
26. Nakashima Propeller Co. Ltd. ECO-Cap product lineup portal
https://www.nakashima.co.jp/eng/product/eco_cap.html
27. Nautilus Shipping (2024) Article 'Zero Carbon Emission Ships'
https://www.nautilusshipping.com/zero-carbon-emission-ships
28. Official Journal of the European Commission on Regulation (EU) 2023/1805 of the European Parliament and of the council on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC
https://eur-lex.europa.eu/eli/reg/2023/1805/oj
29. "Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of greenhouse gas emissions from maritime transport, and amending Directive 2009/16/EC"

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02015R0757-20240101

30. Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC

    Regulation (EU) 2023/… of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC (europa.eu)

31. ScienceDirect (2022) Article 'A Review of Low & Zero Carbon Fuel Technologies ; Achieving Ship Carbon Reduction Targets'

    https://www.sciencedirect.com/science/article/abs/pii/S2213138822008104

32. Six hydrogen production deals concluded in Tunisia (2024)

    Six hydrogen production deals concluded in Tunisia - Offshore Energy (offshore-energy.biz)

33. Turkey (Türkiye) moves to close EU loophole with its own emissions trading scheme (2024)

    Turkey moves to close EU loophole with its own emissions trading scheme - The Loadstar

34. UCL Energy Institute (2019) paper on carbon emissions reduction by 2050

    New infographics from our Shipping Team highlight how carbon emissions could be cut by 2050 | UCL Energy Institute - UCL – University College London

35. Wartsila Marine gate rudder product guide

    https://www.wartsila.com/marine/products/propulsors-and-gears/energy-saving-technology/gate-rudder-tm

36. Wood Mackenzie (2023) writeup on "how the CBAM will change the world".

    horizons-september-2023-whitepaper .pdf (woodmac.com)

PREPARED FOR:
REMPEC

BY:

Drewry Maritime Advisors

Drewry Maritime Services (Asia) Pte. Ltd.
#17-01 Springleaf Tower, No 3 Anson Road
Singapore 079909

Tel: +65 6220 9890
Fax: +65 6220 9890
E-mail: krishna@drewry.co.uk

The primary source of market insight, analysis and advice trusted by a global audience of maritime and shipping industry stakeholders

UK	India	Singapore	China
15-17 Christopher Street London EC2A 2BS United Kingdom	4th Floor, Tower C, Pioneer Urban Square, Sector 62 Golf Course Extension Road Gurgaon India, 122102	#17-01 Springleaf Tower No 3 Anson Road Singapore 079909	D01, 10th Floor, Shinmay Union Square Building B 506 Shangcheng Road Pudong District, Shanghai China, 200120
T +44 20 7538 0191	T +91 124 497 4979	T +65 6220 9890	T +86 (0) 21 6182 6759