AECO Association of Arctic Expedition Cruise Operators

Version: 2
Last revised: May 2026
Scope of update: see change log

# Roadmap to Reducing GHG Emissions



# What's New?

**1.** Change Log
**2.** At-a-glance
**3.** Regulatory updates introduced to several sections
**4.** Outdated information removed from the entire document
**5.** Clarifications introduced to Definitions, Introduction, CII, BC, EU ETS, FuelEU, EU MRV and Alternative solutions aligned with sustainability and latest technology

## Change Log

**May 2026 Update**

| Section | Type of change | Reason | Summary |
|---|---|---|---|
| Front matter | Editorial | Clarity | Updated the front-matter sections to clarify the regulatory basis, the use of technical guidance, and the distinction between mandatory requirements and voluntary initiatives, without changing the substance of the Roadmap. |
| Definitions | New definition of Absolute emissions | Regulatory alignment | Updated reference to IMO targets to reflect the 2023 IMO GHG Strategy, replacing the former "50% by 2050" objective with the net-zero by or around 2050 framework |
| Introduction | Editorial | Data update Correction | Updated text to the most recent GHG emission information. Updated global cruise-fleet figures to reflect the most recent industry data, revising the estimated number of ocean-going cruise ships and their share of the global commercial fleet. Updated text to reflect completion of the ABS AECO Fleet Footprint Study and confirmation of 2023 as the baseline year. |
| EU ETS | Correction | Clarification | Clarified that EU ETS applies on a tank-to-wake (TtW) basis and added reference to updated EU ETS/MRV Maritime implementation guidance (Nov 2025) |
| EU ETS | Editorial | Clarification | Removed an unreferenced sentence about a potential 2026 review shifting ETS from TtW to WtW |
| EU ETS | New information | Clarification | Operators Takeaway section added |

| | | | |
|---|---|---|---|
| FuelEU Maritime | New information | Regulatory update | Added note that application of FuelEU Maritime is delayed for Norway and Iceland in an EEA context (treated as third-country ports until incorporation) |
| FuelEU Maritime | Update | Clarification | Added a short explanatory paragraph on FuelEU Maritime flexibility mechanisms (banking, borrowing, and pooling) to clarify available compliance options and improve operator understanding, without changing regulatory requirements or targets. Operators Takeaway section added |
| EU MRV | Correction | Clarification | Updated tense to reflect that MRV extensions to additional GHGs and ship types are already in force |
| EU MRV | New information | Regulatory update | Added 2025 scope extension |
| Other Fit for 55 measures relevant to maritime decarbonization | New information | Clarification | Information added on other measures that indirectly can have an effect on the operators. |
| Marine Environmental Protection Committee 78, 80-84 | Editorial | Clarity | Information on MEPC78, 80-84 consolidated under one main heading MEPC, and relevant subheadings: CII, HFO, LCA, ECA, BC, NZF |
| MEPC - CII | New information | Regulatory update | Updated CII reduction factors section to reflect MEPC 83 adoption of factors for 2027–2030 (MEPC.400(83)) and MEPC 84 outcomes |
| MEPC - CII | Update | Clarification | Removed outdated information to improve accuracy and reduce ambiguity for operators. Operators Takeaway section added. |
| MEPC - LCA | Editorial | Clarification | Added a forward-looking clarification on methane slip and global GWP100, noting ongoing IMO and technical discussions on WtW emissions management without pre-empting future regulatory decisions |
| MEPC - ECA | Update | Regulatory update | IMO adopted Resolution MEPC.392(82), and the amendments entered into force on 1 March 2026. |

| | | | |
|---|---|---|---|
| | | | Added the MEPC 84 adoption of the North-East Atlantic Emission Control Area |
| MEPC - BC | Update | Regulatory update | IMO adopted Resolutions MEPC.393(82) and MEPC.394(82). |
| MEPC - BC | Restructuring | Clarification | Reorganized content and Finalized the Black Carbon section, clarified voluntary/goal-based scope, and presented operator implications; Operators Takeaway section added. |
| MEPC - NZF | New information | Regulatory change | Created the Net-Zero framework section. Operators Takeaway section added. |
| Alternative solutions aligned with sustainability and latest technology | New information | Clarification | Added a non-regulatory reference to an external, publicly available industry information platform (DNV Alternative Fuels Insight) for general awareness of developments related to alternative marine fuels.<br>Operators Takeaway section added. |
| SBT | Editorial | Clarification | Added information on targets being voluntary. |
| Future Pathways | New information | Editorial | Added contextual text on green shipping corridor initiatives, IMO Digitalization Strategy, emerging alternative fuels and Life cycle GHG emissions accounting, URN in connection with GHG reduction. |
| How to reduce GHG emissions? | Editorial | Clarification | Added sub-headings to improve readability and navigation: Operational measures, Technical measures, and Fuel transition considerations.<br>Operators Takeaway section added. |
| Methods to determine GHG footprint | Editorial | Clarification | Operators Takeaway section added.<br>Added reference to new 2026 IMO guidelines for test-bed and onboard measurement of methane and nitrous oxide emissions, engine load monitoring, and continuous emissions monitoring systems. |
| Methods to determine GHG footprint | New information | Clarification | Added brief guidance on capacity-based intensity metrics to help operators interpret emissions in relation to vessel size and service capacity. |

## At-a-glance

### What this document is

A practical reference that explains how AECO members are aligning with international and regional maritime climate regulations, and how operators can reduce and track greenhouse gas (GHG) emissions over time.

### What it is based on

- The 2023 IMO revised GHG Strategy, including its net-zero ambition for international shipping.
- Binding EU maritime climate regulations (EU ETS, FuelEU Maritime, EU MRV).
- Recent IMO technical guidance and supporting technical work, including guidance adopted by the Marine Environment Protection Committee (MEPC).

### What it covers

- Current mandatory requirements and voluntary guidance relevant to expedition cruise operations.
- Near-term and longer-term options to reduce emissions, from operational efficiency to fuel transition.
- Transparent methods for measuring and reporting emissions, aligned with IMO and EU frameworks.
- Emerging future pathways, including emerging green-corridor concepts, digitalization-enabled efficiencies, new fuel options, and evolving lifecycle GHG approaches.

### What it does not do

- It does not set new regulatory requirements beyond those adopted by IMO or the EU.
- It does not mandate specific fuels or technologies.
- It does not replace compliance obligations or verification processes.

### Why it matters

Expedition cruise operations take place in climate-sensitive polar regions. This Roadmap supports informed, transparent, and credible climate action by clarifying expectations, highlighting practical pathways for emissions reduction, and distinguishing clearly between regulation, guidance, and voluntary initiatives.

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# Definitions

**Absolute emissions**
In the shipping industry, absolute GHG emissions refer to the total GHG emissions from all maritime activities, including emissions from fuel combustion by ships. The International Maritime Organization (IMO) aims **to reach net-zero GHG emissions from international shipping by or around 2050, with indicative checkpoints for reducing absolute GHG emissions** compared to 2008 levels.

Update

Absolute GHG emissions provide a comprehensive measure of the total environmental impact of a sector or activity in terms of its contribution to climate change, forming the basis for setting and tracking emission reduction goals.

**Black carbon (BC)**
Black carbon is a type of particulate matter (PM) that consists of pure carbon in several linked forms. It is produced by the incomplete combustion of fossil fuels, biofuels, and biomass. Major sources of black carbon include diesel engines, coal-fired power plants, residential wood burning, and agricultural burning. Unlike $CO_2$, which remains in the atmosphere for centuries, BC has a short atmospheric lifetime (days to weeks). However, its impact on warming is immediate and significant, making it a critical target for short-term climate mitigation strategies.

The key impacts of BC are:

- Accelerated ice and snowmelt
- Local and global climate warming and their implications
- Impact on local ecosystems
- Impact on indigenous communities through livelihood disruption and health risks
- Oceanic and atmospheric circulation changes
- Potential for increased carbon emissions

Mitigating BC emissions, particularly in and near the Arctic, is crucial for slowing Arctic warming, preserving ecosystems, and protecting vulnerable communities.

**Carbon footprint**
Carbon footprint refers to the total amount of greenhouse gas emissions, specifically $CO_2$ and other pollutants, generated by the entire life cycle of maritime activities. This includes the emissions associated with the construction, operation, and decommissioning of vessels, as well as the associated infrastructure and support activities.

**Carbon neutral**
Carbon neutral is a state where the net amount of $CO_2$ emissions released into the atmosphere is equivalent to the amount removed or offset, resulting in a net balance of

zero. Carbon neutral specifically focuses on achieving a balance in $CO_2$ emissions, and it may not explicitly address other greenhouse gases.

**Carbon removal / carbon negative**

Carbon removal or carbon negative refers to the process of capturing and removing $CO_2$ from the atmosphere, or by removing more carbon than is produced, thus reducing its overall concentration. Carbon removal initiatives in the maritime sector aim to reduce the industry's net carbon footprint by implementing strategies to capture or offset emissions. Some of the approaches include use of renewable fuels, improving energy efficiency, carbon capture and storage or using innovative technologies for alternative propulsion systems etc.

**Life Cycle Assessment framework (LCA)**

Life Cycle Assessment determines the potential environmental impacts of products, processes or services from cradle to grave, e.g., from acquisition/extraction of raw materials through processing, transport use and disposal. LCA approach provides a holistic assessment from WtW using data specific to the activity considered.

**Net Zero**

Net zero refers to the balance between the amount of greenhouse gases produced and the amount removed or offset, resulting in a net emissions level of zero. Net zero encompasses all greenhouse gases, including gases like $CH_4$ and $N_2O$.

**Offsetting**

Offsetting is reducing GHG emissions, or increasing GHG removals through external activities, to compensate for GHG emissions, such that a net contribution to global emissions is reduced. Offsetting is typically arranged through a marketplace for carbon credits or other exchange mechanisms. Offsetting claims are only valid under a rigorous set of conditions, including that the reductions/removals involved are additional, not overestimated, and exclusively claimed. Offsetting can only be used to claim net zero status to the extent it is “like for like” with any residual emissions.

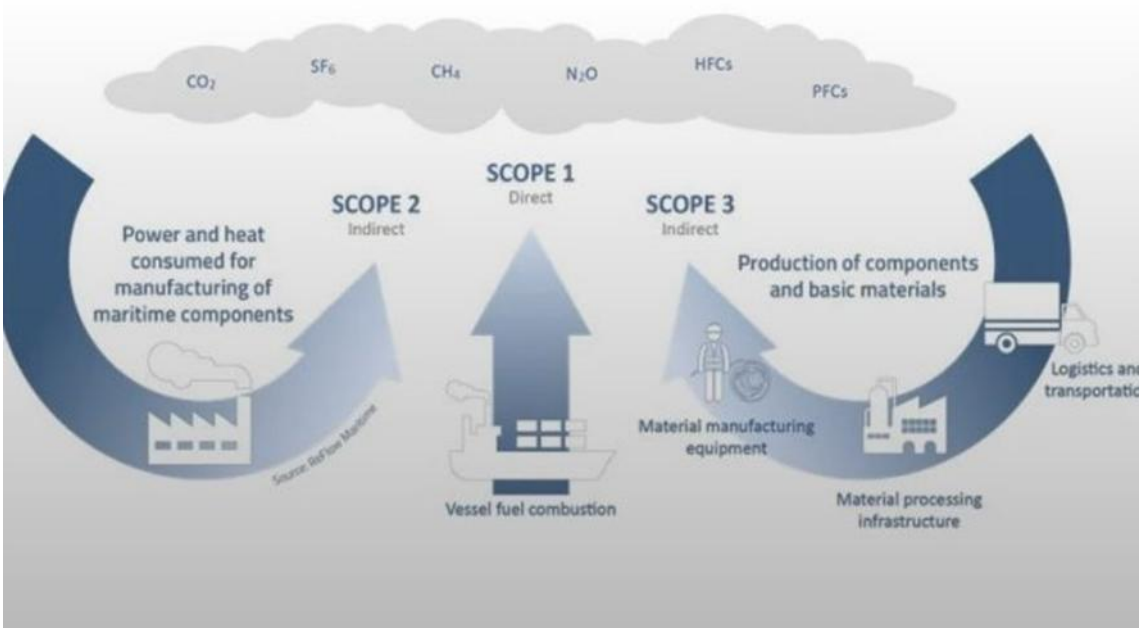
**Scopes**

The Greenhouse Gas Protocol classifies emissions sources into three scopes:

- **Scope 1** includes direct emissions that result from sources and activities controlled by the reporting entity (e.g., fuel combustion, company vehicles, process emissions and fugitive emissions like unintentional releases or leaks).
- **Scope 2** includes indirect emissions that result from the generation of electricity, heating, or cooling consumed by the reporting entity.

- **Scope 3** concerns all other indirect emissions that occur in the value chain of the reporting entity but are not included in Scope 1 or Scope 2. These emissions result from activities that are not owned or controlled by the reporting organization but are associated with its business operations. There are 15 categories of emissions defined by the GHG Protocol (include e.g. emissions from the extraction and production of purchased materials, transportation and distribution, use of sold products, and end-of-life treatment of sold products).

*Schematic presenting classification of Scopes.*




**Well-to-Wake (WtW), Well-to-Tank (WtT) and Tank-to-Wake (TtW)**
Well-to-Wake is the estimate of the energy requirements and the resulting GHG emissions in the production of a fuel and its use in a ship, based on the broader LCA methodology. The term “well” is used for fuels from all sources, because although the term is most applicable to conventional crude oil resources, it is widely used and understood.

Well-to-Tank covers the generated emissions from the extraction, cultivation, production and transportation of the fuel.

Tank-to-Wake covers the emissions generated during the combustion of the fuel.

*For more definitions go to: IPCC’s glossary*.

# Introduction

Update

The most recent **IMO-commissioned global emissions inventory**, the *Fourth IMO Greenhouse Gas Study*, estimates that in 2018, the global shipping sector accounted for about 2.9% of total global anthropogenic $CO_2$ emissions, equivalent to 1 076 million tonnes. Black carbon represented approximately one-fifth of these emissions, highlighting its significance alongside $CO_2$. This study remains, as of 2026, the latest official IMO baseline that underpins the Organization's historical emissions reference point.

Update

More recent independent studies, using updated methodologies and AIS-based vessel activity data, indicate that shipping emissions have continued to increase in absolute terms since 2018. In particular, a 2025 study by the International Council on Clean Transportation (ICCT) assessing global shipping emissions over the period 2016-2023, finds that total TtW GHG emissions increased by about 12%, despite 10.3% improvement in the fleet-wide carbon intensity over the same period.

The ICCT analysis shows that this divergence between improving carbon intensity and rising absolute emissions is driven primarily by growth in shipping activity, with global transport work increasing by approximately 21% between 2016 and 2023. The study also highlights the growing contribution of non-$CO_2$ pollutants, particularly methane and black carbon.

Significant increase in methane emissions was attributed to shift in the fuel use in shipping. Use of LNG, which replaced consumption of HFO, nearly doubled between 2016 and 2023, increasing methane emissions by more than 2.5 times in that period due to methane slip. Black carbon emissions remain a significant concern, accounting for around 8% of total TtW $CO_2$-equivalent emissions (GWP100), and approximately 23% when assessed using a 20-year global warming potential (GWP20).

Against this global backdrop, cruise ships represent a very small share of the world fleet. At the start of 2024, cruise ships accounted for only around 0.3% of the global commercial fleet, which comprised approximately 109 000 vessels. Of the ~310 ocean-going cruise ships worldwide (CLIA, 2025), around 60 vessels (approximately 15%) operate as expedition cruise ships, highlighting the limited scale of this segment within global shipping.

Even though the expedition cruise industry is relatively small in proportion to the global and conventional shipping sector, AECO members are operating in the rapidly changing Polar regions. Therefore, taking responsibility for reduction of the expedition cruise industry's emissions is vital.

AECO's members are aware of their contribution to the warming climate as well as the risks and challenges following that change. In efforts to diminish the environmental impact of the expedition cruise industry, we align with the IMO's Strategy on reduction of greenhouse gas (GHG) emissions from ships as well as other measures leading towards increased sustainability in the industry.

We understand that the IMO's Strategy on reduction of greenhouse gas emissions may not be ambitious enough to meet the global goal of limiting global warming to 1.5° above pre-industrial levels. This was agreed by most nations at the United Nations Climate Change Conferences, COP28, and with the findings of the IPCC 6th Assessment Report on the decarbonization required to limit this warming. Therefore, our members will prepare for further adjustments of the targets.

Update

As part of the development of AECO's Climate Commitment, AECO conducted a survey among operating members in December 2023 to assess existing practices related to greenhouse gas (GHG) emissions and to identify key challenges and opportunities for the transition to more sustainable shipping operations.

To strengthen this work with a robust, data-driven foundation, AECO commissioned the American Bureau of Shipping (ABS) to carry out a comprehensive Fleet Footprint Study. The study, completed in 2025, provides an estimate of vessel activity, fuel consumption, and associated GHG emissions across the AECO fleet, with 2023 selected as the baseline year. The results establish a common reference point for understanding current emissions profiles and for tracking future progress under AECO's climate work.

Information presented in this Roadmap is intended to support AECO members during the transition period and will be updated as new international regulations, guidance, and scientific knowledge become available, including developments at the International Maritime Organization (IMO) and within the European Union (EU).

The latest IPCC statement is provided to reiterate global efforts that need to be taken to reduce global warming.

The new 2023 IMO revised GHG Strategy sub-chapter provides information on targets and recommendations relevant to the cruise industry. These regulations and recommendations are the basis of AECO's commitment to reduce GHG emissions. It also includes information on the latest EU regulations for cruise vessels operating within EU and EEA waters.

These are followed by non-governmental recommendations and targets that can be joined in addition to the AECO commitment.

To help operating members start to track their emissions and their emission reduction journey, we have provided information on methods of calculation of GHG emissions. We have also provided information on how AECO operating members can reduce their GHG emissions.

Lastly, we have provided some suggestions on how to disseminate operators journey towards GHG emission reduction and more sustainable operations.

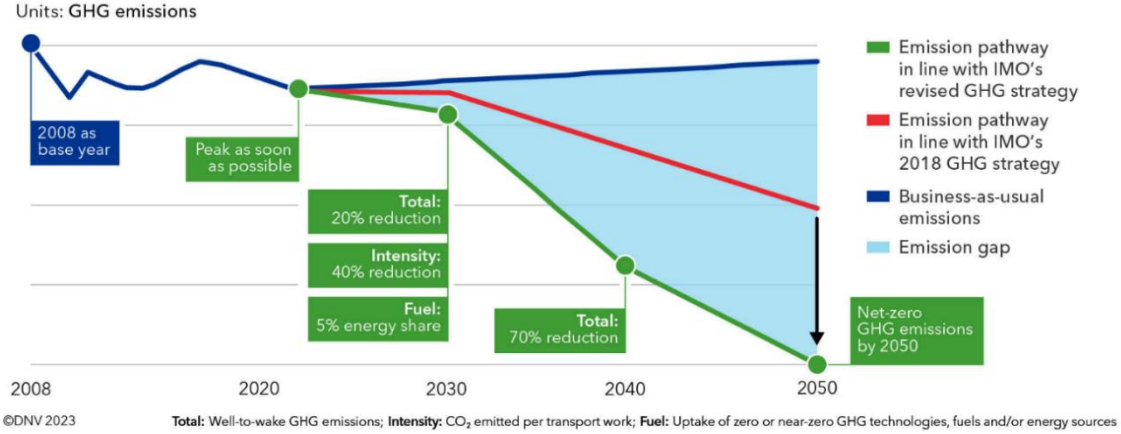
# International Recommendations & Targets

**Intergovernmental Panel on Climate Change (IPCC)**
In the efforts to limit the rise of the global air temperature, IPCC reports as well as COP26 and COP28 indicate that we need to commit to interim greenhouse gas emissions reduction targets and actions leading to net zero by 2050. This means committing to achieve a balance between anthropogenic emissions and removals of greenhouse gases.

Further, the latest IPCC report (IPCC AR6), released in April 2022, has determined that in order to keep global temperature rise below 1.5°C above pre-industrial levels by 2100 (with an overshoot and return to 1.5°C), GHG emissions should be reduced by 23% in 2030 and by 75% in 2050 relative to 2019.

**2023 IMO Revised GHG Strategy**
The 2023 IMO GHG Strategy envisages a reduction in carbon intensity of international shipping (to reduce $CO_2$ emissions per transport work), as an average across international shipping, by at least 40% by 2030 compared to 2008. The revised 2023 IMO GHG Strategy also includes a new level of ambition relating to the uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources which are to represent at least 5%, striving for 10% of the energy used by international shipping by 2030. GHG emissions from international shipping to reach net zero by or around, i.e. close to, 2050.

*Outline of ambitions and minimum indicative checkpoints on the revised IMO GHG strategy.*



The strategy also sets out indicative checkpoints for 2030 and 2040. These are, to reduce the total annual GHG emissions from international shipping by at least:

- 20%, striving for 30%, by 2030
- 70%, striving for 80%, by 2040

Update

**The 2023 IMO GHG Strategy remains overarching policy, its next review will begin in 2027**. The strategy also includes measures as part of MARPOL.

**Fit for 55 Maritime**

The Fit for 55 package aims to reform the previous EU amended Emission Trading System (EU ETS) by making it more ambitious. It includes reduction of GHG emissions by at least 55% by 2030 compared to 1990.
New provisions include:

- 2.1 Amended EU ETS scheme
- 2.2 FuelEU Maritime
- 2.3 EU MRV The Monitoring, Reporting and Verification for the EU
- 2.4 Alternative Fuels Infrastructure Regulation (AFIR)
- 2.5 Revised Renewable Energy Directive (RED III)
- 2.6 Carbon Border Adjustment Mechanism (CBAM)

The general goal of the Fit for 55 is:

- Faster reduction of emissions allowances in the system and gradual phasing-out of free allowances for some sectors.
- Implementation of the global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) through the EU ETS.
- Increase of funding for the modernization fund and the innovation fund
- Revision of the market stability reserve.
- A new self-standing emissions trading system is created for buildings, road transport and fuels for additional sectors.

*EU ETS: EU Amended Emission Trading System*

EU ETS is a carbon market based on a system of cap-and-trade of emission allowances. Companies falling under the scope can trade emission rights and must surrender purchased allowances, equivalent to their emissions each year. Those that

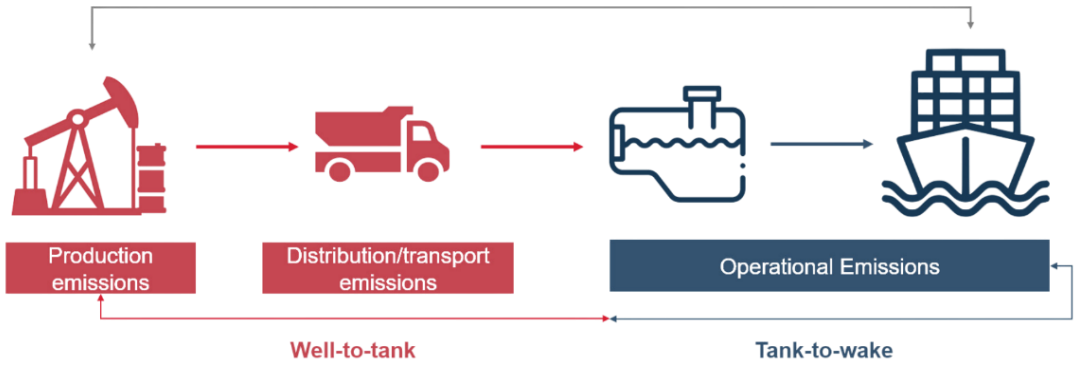
Update

report emissions more than those covered by their purchased allowances must pay a financial penalty to the ETS system.

From 2026 onwards, the phase-in reaches full coverage of GHG emissions ($CO_2$, $CH_4$ and $N_2O$). The EU ETS applies on a tank-to-wake (TtW) basis.

Emissions from shipping are included within the scope of the EU ETS as of 1 January 2024 for ships above 5000 GT that transport cargo and passengers for commercial purposes and entering EU ports regardless of the flag they fly.

*Schematic describing well-to-wake emissions (or life cycle emissions).*



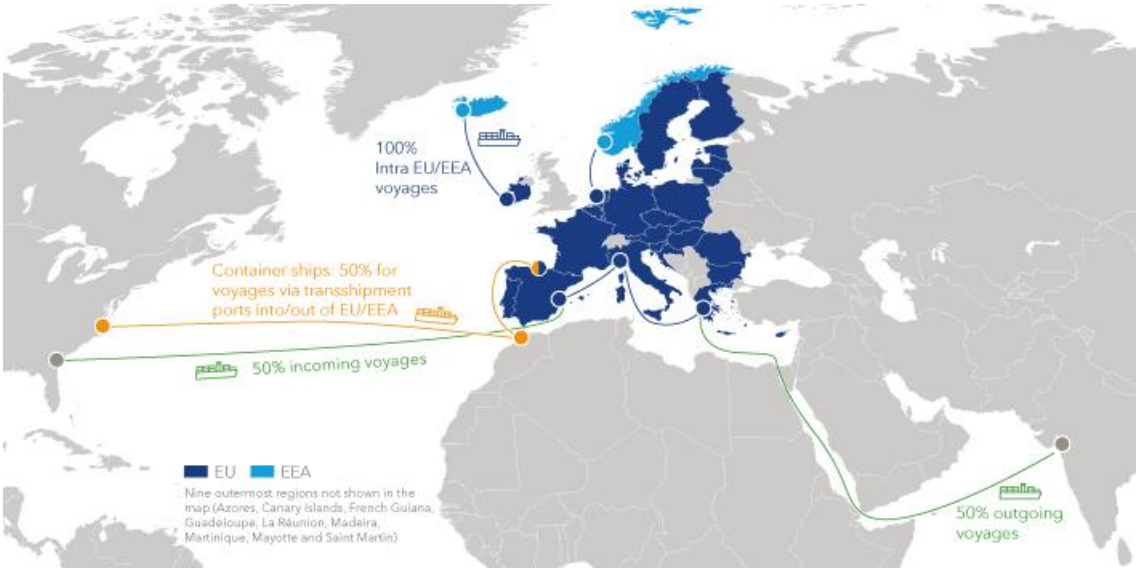

WtW=WtT + TtW:

- WtW: Estimate of the energy requirements and the resulting GHG emissions in the production of a fuel and its use in a ship, based on the broader Life Cycle Assessment (LCA) methodology. The term Well is used for fuels from all sources, because although the term is most applicable to conventional crude oil resources, it is widely used and understood.
- WtT: Covers the generated emissions from the extraction, cultivation, production and transportation of the fuel.
- TtW: Covers the emissions generated during the combustion of the fuel.

Update

Vessels in scope of the ETS are required to buy EU Allowances (EUA) in line with the geographic scope and phase-in requirements of the EU ETS for maritime transport, to cover 50% of their GHG emissions from voyages starting or ending outside of the EU, Norwegian and Icelandic (EEA) ports, and 100% of emissions from voyaged between two EU ports and when ships are within EU and EEA ports.

*EU ETS operational area.*




Obligations for shipping companies to surrender allowances were introduced gradually:

- 40% for verified $CO_2$ (carbon dioxide) emissions from 2024 (submitted in September 2025 via the European Energy Exchange)
- 70% from 2025
- 100% of all emissions $CO_2$, $CH_4$ (methane), $N_2O$ (nitrous oxide) from 2026.

Most large vessels are included within the scope of the EU ETS from the start, while other vessel categories, namely offshore vessels, will be included in the Monitoring, Reporting and Verification framework (EU MRV) first, and only later included in the EU ETS. Non-$CO_2$ emissions ($CH_4$ and $N_2O$) are included in the EU MRV framework from 2024 and become subject to EU ETS surrender obligations from 2026.

Implementation guidance for the EU ETS and MRV Maritime was updated by the European Commission in November 2025; this guidance provides clarifications but does not alter the scope or phase-in of the EU ETS for shipping.

**Key clarifications introduced:**

**1. Offshore vessels and port-of-call treatment**.

**2. Excluded stops and specific port-call cases**

Further clarification is provided on **excluded port calls**, such as stops solely for refueling, provisioning, safety, or emergency reasons. These clarifications aim to ensure uniform application of existing exclusions already embedded in the ETS Directive and MRV Regulation

**3. Change of shipping company during a voyage**

The guidance explains how responsibility for monitoring, reporting, and allowance

surrender should be allocated when a change of shipping company occurs mid-voyage (e.g. due to sale, bareboat charter changes, or management transfer). This clarification helps avoid double counting or gaps in compliance.

**4. Inactive vessels and periods of non-operation**

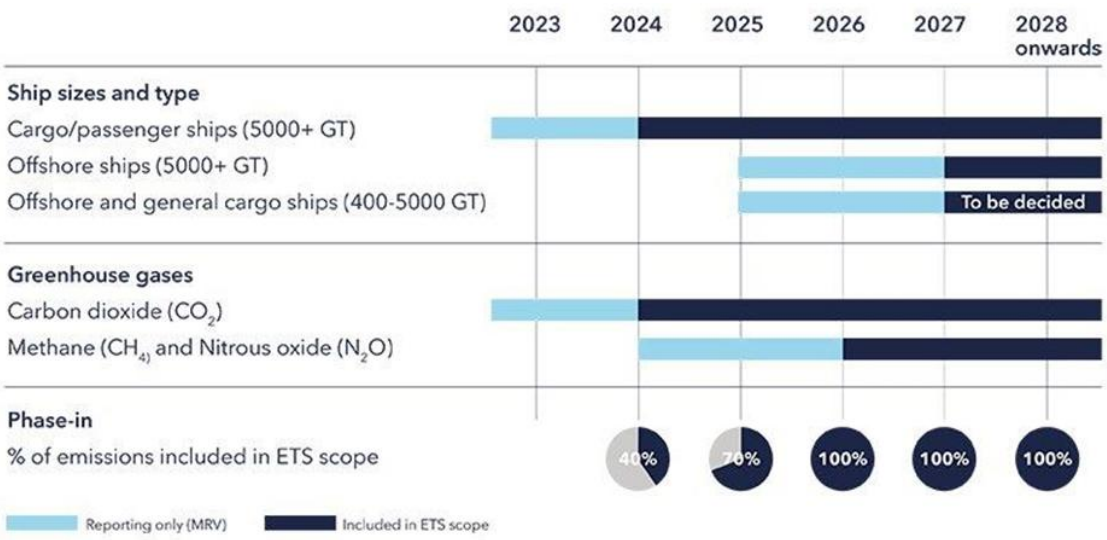
The updated guidance addresses cases of **temporary inactivity**, clarifying reporting expectations during lay-up or extended non-operational periods, in line with existing MRV principles.

**5. Alignment with biofuel and zero-rating guidance**

The Commission aligned the maritime ETS guidance with existing MRR guidance on biofuels, including circumstances under which fuels may be zero-rated for ETS purposes. This alignment supports consistency across MRV, ETS, and FuelEU implementation without changing eligibility criteria.

*The European Commission plans a review of potential ETS expansions in July 2026.*

*EU ETS introduction timeline.*




*FuelEU Maritime*

In September 2023, the European Parliament, European Commission and the European Council reached an agreement on FuelEU Maritime to be a part of the Fit for 55 package.

**The key requirements are:**

- Reduce the GHG intensity of the energy used on board.
- Use of onshore power supply (OPS) in main European ports.

- Incentivize the uptake of renewable and low-carbon fuels.
- Incentivize use of Renewable Fuels of Non-Biological Origin (RFNBOs) also known as e-fuels.

Fleets will have to meet stepped improvements in the lifecycle GHG emissions intensity of the energy they use, or face penalties. The first penalties, to be paid by June 2026, will be for those who fail to reduce GHG emissions intensity in 2025 by at least 2% compared to 2020.

From 31 August 2024, companies will need to submit the monitoring plan to the verifier according to the available standardized template.

Update

From 1 January 2025, ships trading in the EU are subject to FuelEU Maritime and must cover their energy needs by fuels of GHG emissions below a threshold value. The GHG intensity will be **measured on a WtW basis** (including $CO_2$, $CH_4$ and $N_2O$)**.**

Update

EEA note (Norway and Iceland):

Due to delays in incorporating FuelEU Maritime into the EEA Agreement, Norwegian and Icelandic ports are regarded as third-country ports in a FuelEU context from 1 January 2025 until incorporation.

For GHG accounting, regulation considers not only $CO_2$ emissions, but also $CH_4$ and $N_2O$. $CH_4$ and $N_2O$ are subsequently converted into $CO_2$ equivalents, multiplied with Global Warming Potential of 100 years (GWP100) which is equal to 28 for $CH_4$ and 265 for $N_2O$ respectively, as defined in Regulation (EU) 2020/1044.

By 31 January 2026 Companies will need to submit FuelEU report to the verifier. (according to Article 14).

Update

Flexibility mechanisms under FuelEU Maritime

The FuelEU Maritime Regulation includes flexibility mechanisms—banking, borrowing, and pooling—to support compliance with annual GHG-intensity limits. Banking allows surplus compliance to be carried forward, borrowing permits limited use of future compliance, and pooling enables the aggregated compliance performance of two or more ships (including ships operated by different companies) to be assessed collectively, provided overall compliance is achieved. These mechanisms are voluntary and do not alter the underlying reduction targets, but they offer operators flexibility in how compliance is achieved across fleets and over time.

More detailed information on the regulation, scope, banking, pooling, penalties and derogations can be found here.

Further requirements will begin in 2030, with the requirement for passenger vessels to use onshore power supply (OPS) or a zero-emission alternative when berthed at major European ports. That requirement will be extended to a wider range of ports from 2035, by which time all shipping companies will be subject to penalties if their annual GHG intensity is not 14.5% lower than it was in 2020.

Update

**Operators Takeaway**

**FuelEU compliance does not need to be achieved on a ship-by-ship basis every year. Banking, borrowing, and pooling may support cost-effective compliance and gradual fuel transition, depending on fleet composition and operating patterns. Availability of OPS in Arctic ports remains limited; operators should monitor national port-infrastructure plans when planning long-term compliance strategies.**

*EU MRV Monitoring, Reporting and Verification for the EU ~~(June 2023)~~*

Under the EU ETS each company with ships trading in the EU/EEA (ships above 5,000 GT on EU related voyages) is required to surrender emission allowances corresponding to a certain amount of its GHG emissions (TtW $CO_2$, $N_2O$ and $CH_4$ emissions, ~~but also~~ ~~as of 1 January 2024~~) emitted over a calendar year starting with 2024.

The requirements apply to the shipping company which is the shipowner or any other organization or person, such as the manager or the bareboat charterer, who has assumed responsibility for the operation of the ship including duties and responsibilities imposed by the ISM Code.

Tank-to-wake $CO_2$ emissions from cargo and passenger ships of 5,000 GT and above, reported under the MRV system in 2024, are subject to the ETS in 2025.

Update

Implementation guidance for EU ETS and MRV Maritime has been updated (latest update: November 2025), including clarifications on specific cases such as port-of-call exclusions and biofuel treatment.

Update

Accurate emissions data must be submitted for verification by an accredited verifier. Once verified, the reports must be submitted to the THETIS-MRV system. From 1 January 2025, the amended MRV Regulation also applies to additional ship types, including offshore ships and certain ships between 400 and 5,000 GT, as specified in the amended EU MRV framework. Detailed information on preparing for EU ETS and managing responsibilities and practical aspects related to EU MRV and ETS can be found here.

**Operators Takeaway**

Update

**Key 2026 change: full phase-in and inclusion of $CH_4$/$N_2O$ in ETS; FuelEU report due 31 Jan 2026; Norway/Iceland treated as third-country ports for FuelEU until EEA incorporation.**

*Other Fit for 55 measures relevant to maritime decarbonization*

Update

In addition to EU ETS and FuelEU Maritime, the EU's Fit for 55 package includes measures that indirectly affect maritime decarbonization. These include the Alternative Fuels Infrastructure Regulation (AFIR), which sets requirements for ports and Member States to deploy onshore power supply and alternative fuel infrastructure, and the revised Renewable Energy Directive (RED III), which influences the availability of renewable and low-carbon fuels. While these instruments do not impose direct compliance obligations on ships, they influence fuel availability and infrastructure over time.

**Marine Environmental Protection Committee**

MEPC 76 adopted technical and operational measures to reduce carbon intensity of international shipping, taking effect from 2023. The measures include the Energy Efficiency Existing Ship Index (EEXI), the enhanced Ship Energy Efficiency Management Plan (SEEMP) and the Carbon Intensity Indicator (CII) rating scheme.

Update

Following completion of the Phase 1 review process reported at MEPC 83, MEPC 84 commenced the second phase of the review of the CII and SEEMP frameworks. Discussion at MEPC 84 focused in particular on strengthening SEEMP as a continuous-improvement tool, including possible internal reviews, implementation logs, and stronger audit arrangements.

*The Carbon Intensity Indicator (CII)*

The Carbon Intensity Indicator is a measure of how efficiently a ship transports goods or passengers and is given in grams of $CO_2$ emitted per cargo-carrying capacity and nautical mile. The ship is then given an annual rating ranging from A to E, whereby the rating thresholds will become increasingly stringent towards 2030.

CII tackles the barriers that are stopping the uptake of available and cost-effective existing technologies and practices like wind and slower speeds.

CII reduces fuel burn, ensuring a cost-effective decarbonization of shipping.

The CII applies to all cruise ships above 5,000 GT. The yearly CII is calculated based on reported IMO DCS data and the ship is given a rating from A to E.

The reduction factor for CII was set to 7% by 2024, 9% by 2025 and 11% by 2026, with 2019 as the reference year and they currently remain as previously defined.

Update

At MEPC 83, IMO adopted amendments to the CII Reduction Factors Guidelines through Resolution MEPC.400(83), specifying the reduction factors for the years 2027–2030. These were set to: 13.625% by 2027, 16.25% by 2028, 18.875% by 2029 and 21.5% by 2030.

Following the adoption of the updated CII reduction factors, ships must ensure that SEEMP Part III (Ship Operational Carbon Intensity Plan) reflects the applicable targets and implementation planning for the relevant period, consistent with IMO requirements and flag/class processes.

MEPC 84 also continued discussion on possible refinements to the CII framework. For cruise passenger ships, a proposal to replace the current gross-ton-mile-based metric with a revised hour-based metric (cgHRS) was discussed but not agreed at this stage.

Update

**Operators Takeaway**

**CII requirements continue to tighten through 2030. Operators should monitor annual ratings, ensure SEEMP Part III reflects current targets, and prepare for possible future strengthening of SEEMP requirements. For cruise passenger ships, no revised CII metric was agreed at MEPC 84, so current compliance planning should continue on the basis of the existing framework.**

*Heavy fuel oil (HFO) in the Arctic ~~Amendments to MARPOL - prohibiting~~*

The MEPC adopted amendments to MARPOL Annex I (addition of a new regulation 43A) to introduce a prohibition on the use and carriage for use as fuel of HFO by ships in Arctic waters on and after 1 July 2024.

The prohibition will cover the use and carriage for use as fuel of oils having a density at 15°C higher than 900 kg/m3 or a kinematic viscosity at 50°C higher than 180 mm2/s.

Ships engaged in securing the safety of ships, or in search and rescue operations, and ships dedicated to oil spill preparedness and response would be exempted. Ships which meet certain construction standards regarding oil fuel tank protection would need to comply on and after 1 July 2029.

*Life Cycle Assessment (LCA)*

MEPC80 adopted the ‘Guidelines on Life Cycle GHG Intensity of Marine Fuels’ (LCA Guidelines) which set up methods for calculating WtW and TtW GHG emissions for all fuels and other energy carriers (e.g. electricity for shore power). The guidelines will be under review in the light of experience gained with their implementation.

Life Cycle Assessment (LCA) – WtW Scope

The scope of the guidelines addresses GHG intensity and sustainability aspects used for ship propulsion and power generation onboard. The sustainability part defines a Fuel Lifecycle Label (FLL) that collects and conveys the information relevant for the LCA. Preliminary default emissions factors for various fuels and fuel pathways are provided in the appendix. Note that these factors will be further reviewed in the future taking into account emerging and evolving technologies.

The relevant GHGs included in the LCA: $CO_2$, $CH_4$ and $N_2O$.

Not included: $SO_x$, CO, PM, black carbon and volatile organic compounds.

Update

Future IMO LCA refinements may include methane-slip mitigation considerations, which are relevant for LNG-capable vessels.

The GHG emissions are calculated as $CO_2$ equivalent ($CO_{2eq}$) using the Global Warming Potential over 100-year time horizon (GWP100) to convert emissions of other gases than $CO_2$, as given in the fifth IPCC Report for $CO_2$, $CH_4$ and $N_2O$. These GWP100 values should be used for the purpose of quantifying the GHG intensity in accordance with these guidelines, as follows:

$$gCO_{2eq}(100y) = GWP_{CO2(100y)} \times gCO_2 + GWP_{CH4(100y)} \times gCH_4 + GWP_{N2O(100y)} \times gN_2O$$

($CO_2$ 1; $CH_4$ 28; $N_2O$ 265), this would read as:

$$g_{CO2eq(100y)} = 1 \times gCO_2 + 28 \times gCH_4 + 265 \times gN_2O$$

Update

Current IMO and EU frameworks apply a 100-year global warming potential (GWP100) for the conversion of methane ($CH_4$) to $CO_2$-equivalents. Ongoing discussions at the IMO and among technical bodies increasingly emphasize the importance of managing methane slip and well-to-wake emissions performance, and future guidance may further refine how methane emissions are addressed.

A calculation using a Global Warming Potential over a 20-year horizon (GWP20) may be provided as information for comparative purposes, as follows:

$$gCO_{2eq}(20y) = GWPCO_2(20y) \times gCO_2 + GWPCH_4(20y) \times gCH_4 + GWP_{N2O}\ (20y) \times gN_2O$$

($CO_2$ 1; $CH_4$ 84; $N_2O$ 264), this would read as:

$$g_{CO2eq(20y)} = 1 \times gCO_2 + 84 \times gCH_4 + 264 \times gN_2O$$

Update

MEPC81 adopted amendments to the LCA Guidelines (2024 LCA Guidelines) including quantification of parameters related to biofuel production, the evaluation of GHG intensity of electricity, and methodologies for actual tank-to-wake emission factors. Work on the LCA framework continued at MEPC 84. The framework remains under technical development and will continue to evolve through future intersessional work and MEPC sessions.

*Emission Control Areas (ECA)*

MEPC81 progressed the development of GHG reduction measures to achieve the ambitions of the GHG Strategy, and approved proposals to designate the Canadian Arctic and the Norwegian Sea as Emission Control Areas **(ECAs)** for $NO_x$, $SO_x$ and PM. At MEPC 82 (October 2024), IMO adopted Resolution MEPC.392(82), and the amendments entered into force on 1 March 2026.

Update

At MEPC 84 (April/May 2026), IMO adopted an additional ECA for the North-East Atlantic, covering the exclusive economic zones and territorial seas of Greenland, Iceland, the Faroe Islands, Ireland, the mainlands of the United Kingdom, France, Spain, and Portugal. The amendments will enter into force on 1 September 2027, and the ECA requirements will take effect in 2028. Within ECAs, ships must use fuel with a Sulphur content of no more than 0.10%, and new ships operating in the designated area will also be subject to $NO_x$ Tier III requirements in line with the agreed implementation dates. Stricter emissions limits will also include particulate matter (PM).

**For expedition cruise operators, this new North-East Atlantic ECA is particularly relevant to voyages involving Greenland, Iceland, and North Atlantic positioning routes**.

*Black Carbon Emissions (BC) in the Arctic*

Update

Reducing black carbon emissions from shipping is considered an important near-term measure for limiting Arctic warming and complements longer-term efforts to reduce overall greenhouse gas emissions from international shipping.

Resolution MEPC.342(77) urges ships operating in or near the Arctic to reduce black carbon emissions, including by moving to distillate or other cleaner alternative fuels or methods of propulsion.

At MEPC 82 (October 2024) the IMO adopted two recommendatory (voluntary) sets of Guidelines relating to this resolution:

1. Guidelines on Best Practice on Recommendatory Goal-based Control Measures to Reduce the Impact on the Arctic of Black Carbon Emissions from International Shipping (Resolution MEPC.393(82))

Update

2. Guidelines on Recommendatory Black Carbon Emission Measurement, and Monitoring and Reporting (Resolution MEPC.394(82)).

The goal-based control measures developed under the IMO's Pollution Prevention and Response (PPR) Sub-Committee address the environmental impact of shipping in the Arctic. They are designed to be flexible, allowing ship operators to choose the most appropriate technologies and practices for their specific circumstances, while still meeting the overall objective of minimizing black carbon emissions in this sensitive

region. Suggested measures include the use of cleaner fuels, exhaust gas treatment systems, and engine or operational adjustments.

The measurement, monitoring and reporting guidelines aim to support a more consistent and transparent understanding of black carbon emissions from ships operating in or near the Arctic. Operators are encouraged to develop a black carbon management plan, including voluntary reduction targets for specific ships, engines, or fleets.

Guidelines 2 aim to standardize the approach to managing black carbon emissions from international shipping, particularly in Arctic waters.

Update

These Guidelines (MEPC.394(82)) apply to marine diesel engines with a power output of more than 130 kW or other methods of propulsion. These can include an exhaust gas treatment system or the use of other cleaner alternative fuels, on board any ship operating in or near the Arctic. Guidelines recommend measuring BC emissions at least once during a seven-day period while operating in or near the Arctic, using ISO 8178 methods. Results should be recorded, and voluntary annual reports on the BC management plan can be shared with Administrations**.**

Objectives of the recommendatory guidelines are to:

- Reduce Environmental Impact: By establishing clear measurement, monitoring, and reporting protocols, the guidelines seek to minimize the impact of black carbon emissions on the Arctic environment.
- Support Policy Development: The collected data will inform future policy decisions and contribute to global efforts to mitigate climate change.

**Black Carbon emissions and fuel types**
Although HFO is considered the largest contributor to high BC concentrations, other fuels are not free from BC emissions.

**Liquefied Natural Gas (LNG):** LNG is considered a cleaner alternative to HFO and has been widely promoted to reduce black carbon emissions. Research suggests that LNG reduces particulate emissions by up to 85% compared to HFO. However, LNG's methane slip (unburnt methane) can have a potent greenhouse gas effect, which is a consideration for its overall environmental impact.

**Marine Gas Oil (MGO):** MGO, a distillate fuel with lower sulfur content than HFO, also results in lower black carbon emissions. Regulations such as the International Maritime Organization’s (IMO) sulfur cap have increased the use of MGO, indirectly leading to reduced black carbon emissions due to its lower particulate formation.

**Biofuels:** Marine biofuels, including biodiesel and other renewable sources, are being explored as alternatives. These fuels can potentially reduce black carbon emissions, but their impact depends on the feedstock used and the specific combustion characteristics. Some biofuels have shown promise in reducing particulate matter, but there are concerns about their lifecycle emissions and potential impacts on engine performance and fuel stability.

**Hydrogen and ammonia:** These are emerging as future fuels for shipping, with the potential to reduce or eliminate black carbon emissions altogether. Both are considered

zero-emission fuels when used in fuel cells or with combustion technologies that do not produce black carbon. The use of hydrogen and ammonia is still in the experimental phase, and research is ongoing to address challenges related to storage, infrastructure, and engine adaptation.

**Operators Takeaway**

Update

**IMO black carbon guidance for Arctic operations is recommendatory and goal-based. Operators are encouraged to consider fuel choices, operational measures, and voluntary monitoring to reduce black carbon emissions when operating in or near the Arctic.**

*The Net-Zero Framework - Integration with IMO NZF and EU Regulations*

Update

In April 2025 (MEPC 83), IMO approved draft amendments to MARPOL Annex VI intended to establish the IMO Net-Zero Framework (NZF). The draft package included a well-to-wake GHG-intensity metric and two main regulatory elements:

- a Goal-Based Marine Fuel Standard, often described as a Global Fuel Standard) and
- an economic element (a global Pricing Mechanism).

However, the Framework was not adopted at the extraordinary session in October 2025, and MEPC 84 in April–May 2026 did not resolve the remaining differences.

Instead, MEPC 84 agreed to continue work through two intersessional meetings in September and November 2026 ahead of MEPC 85 (30 November–3 December 2026). The resumed extraordinary MEPC session is scheduled for 4 December 2026, subject to discussion at MEPC 85. As a result, the IMO Net-Zero Framework is not yet in force, and no final implementation timeline should be assumed at this stage.

At the same time, MEPC 84 continued technical work that is expected to support any future NZF, including draft guidance on calculation of attained GHG fuel intensity (GFI), draft amendments to verification guidelines, recognition of sustainable fuel certification schemes, Fuel Lifecycle Label approaches, and guidance on wind propulsion energy accounting.

In parallel, the IMO has adopted the 2024 Lifecycle GHG Guidelines (LCA Guidelines), which define how WtW emissions must be calculated, and are intended to serve as the technical basis for NZF's WtW fuel-intensity requirements. The NZF's compliance system, including how a ship's annual GHG Fuel Intensity (GFI) would be determined, relies on the methodology, emission factors, and verification framework contained in

the LCA Guidelines. Although the Guidelines are currently non-mandatory, they will become operational only once incorporated into the future MARPOL amendments that implement the NZF. Further revisions to the LCA Guidelines, supporting future NZF enforcement, are scheduled for MEPC 84 (2026) and MEPC 87 (2028).

**Operators Takeaway**

**The IMO Net-Zero Framework is not yet in force. Operators should monitor developments closely through MEPC 85 and the resumed extraordinary session in December 2026, while continuing to comply with current IMO and EU requirements. In parallel, long-term fuel decisions should increasingly take account of likely future well-to-wake accounting, fuel certification expectations, and the treatment of non-$CO_2$ emissions.**

# Non-governmental pledges and targets that can be joined

Update

In addition to regulatory frameworks, several voluntary initiatives may be relevant for operators.

*CLIA*

In line with IMO, CLIA announced a global cruise industry commitment to reduce the rate of carbon emissions across the industry fleet by 40% by 2030 compared to 2008 levels. Further, CLIA ocean-going cruise lines are pursuing net carbon neutral cruising by 2050 across the global fleet. More information about CLIA's policy can be found here.

*Science Based Targets (SBT)*

Through the Science Based Target Setting Guidance for the Maritime Transport Sector, the SBTi outlines how much and how quickly a maritime transport company needs to cut emissions to be in line with limiting global warming to 1.5°C. It provides detailed information on how maritime companies should set targets and account for greenhouse gas emissions, considering the barriers and opportunities of the sector.

To get on track with the UMAS Transition Strategy Report, the sector must cut its emissions by 45% by 2030 and reach net-zero by 2040. The SBTi, with support from WWF, Smart Freight Centre (SFC) and UMAS, developed the Science Based Target Setting Guidance and Tool for the Maritime Transport Sector.

The Guidance is designed for companies that own and operate ocean-going vessels and those setting targets for supply chain emissions associated with maritime trade.

Update

These targets represent a voluntary, science-aligned pathway that goes beyond current IMO requirements.

To learn more about the SBT guidance follow this link.

*Glasgow Declaration, Climate Action in Tourism*

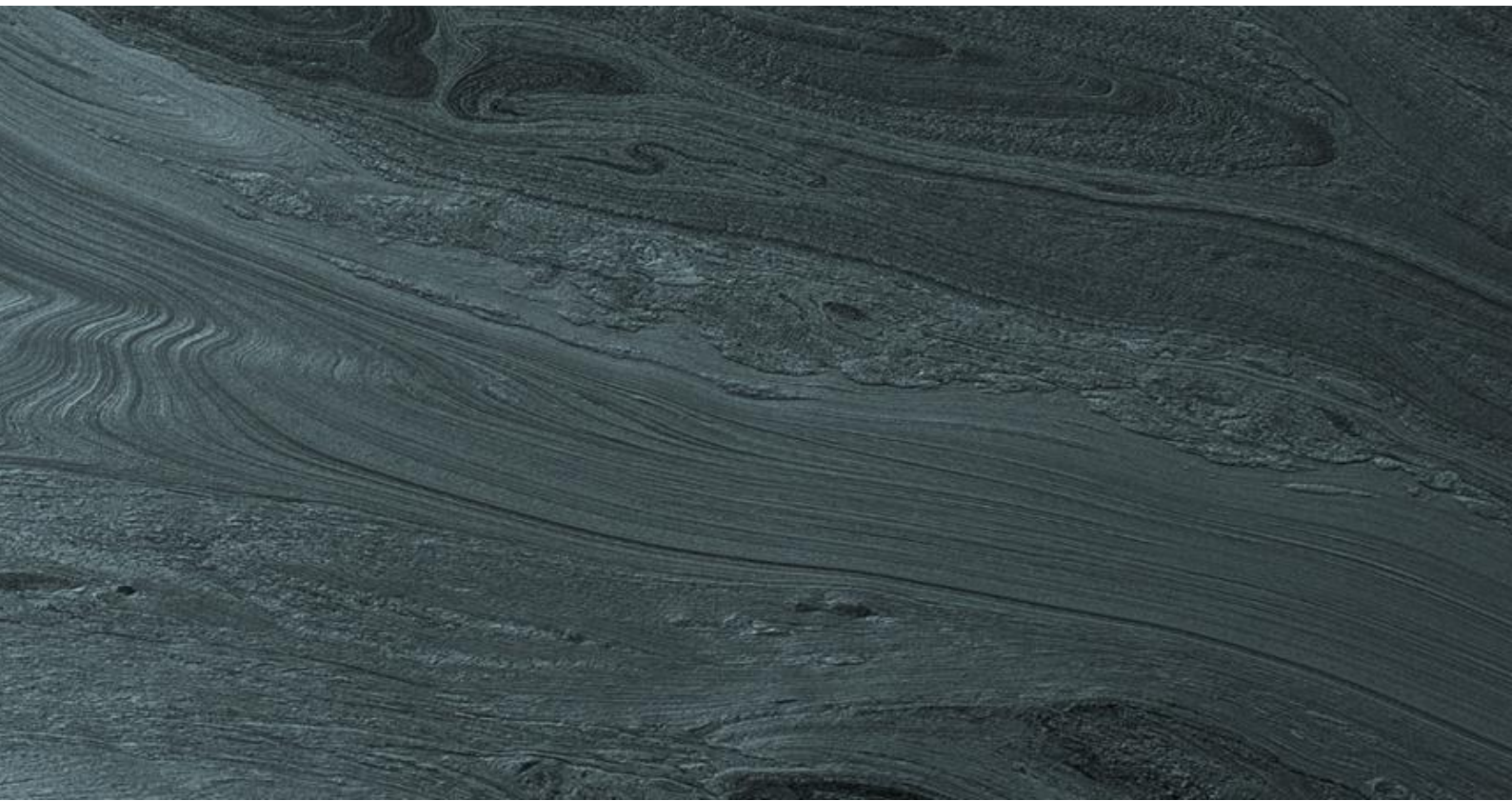
The Glasgow Declaration is a catalyst for increased urgency about the need to accelerate climate action in tourism and to secure strong actions and commitment to support the global goals to halve emissions over the next decade and reach Net Zero emissions as soon as possible before 2050.

*'We declare our shared commitment to unite all stakeholders in transforming tourism to deliver effective climate action. We support the global commitment to halve emissions by 2030 and reach Net Zero as soon as possible before 2050. We will consistently align our actions with the latest scientific recommendations, so as to ensure our approach remains consistent with a rise of no more than 1.5°C above pre-industrial levels by 2100."*

*Race to Net Zero*

Race to Zero is a global campaign rallying non-state actors – including companies, cities, regions, financial, educational, and healthcare institutions – to take rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer, net zero world.

All members must meet robust science-aligned criteria, which was clarified and strengthened through an extensive consultation process in June 2022. Partner initiatives are responsible for helping to bring members to the starting line to credibly race to zero emissions.



Update

# Future Pathways

**Arctic green shipping corridors**

In parallel with regulatory developments, several Arctic and Nordic initiatives are examining the potential for green or low-impact shipping corridors in Arctic and sub-Arctic waters. These initiatives typically aim to combine emissions reduction with enhanced safety, environmental protection, and consideration of local and Indigenous community impacts.

Current initiatives, led by Arctic States, Nordic governments, international organizations, and non-governmental stakeholders, focus on identifying priority routes, improving safety and environmental performance, and exploring the feasibility of zero- or near-zero-emission shipping in the region. To date, most Arctic corridor initiatives remain at the planning or pilot stage, with full implementation constrained by fuel availability, infrastructure readiness, and the need for coordinated governance across Arctic jurisdictions.

These emerging Arctic initiatives are consistent with the broader international concept of green shipping corridors articulated under the Clydebank Declaration, which promotes the development of zero-emission maritime routes through voluntary, multi-stakeholder collaboration. While the Clydebank Declaration is a government-level initiative, many Arctic and Nordic shipping operators, including AECO members, operate within jurisdictions that are signatories to the Declaration and may therefore be indirectly influenced by national green-corridor policies emerging under this framework.

**Digitalization-enabled emissions reduction (IMO Maritime Digitalization Strategy)**

Digitalization in the maritime sector is evolving from standalone tools to more integrated ship-to-shore systems that can support voyage planning, energy management, and increasingly automated emissions reporting. Industry assessments indicate a shift toward interoperable systems, reliable connectivity, and evidence-based performance, replacing fragmented applications with architectures that enable ships to use data more effectively to reduce fuel consumption and associated GHG emissions.

In parallel, the IMO is developing a cross-cutting Maritime Digitalization Strategy that harnesses emerging technologies to enhance efficiency, safety and sustainability in the shipping industry. Although these developments remain at an early stage (estimated adoption by the IMO Assembly by the end of 2027), they signal a future in which

digitalized data flows and harmonized standards may shape how emissions are monitored, analyzed, and reduced.

For Arctic expedition operators, integrated digital systems could help optimize speed and routing, improve situational awareness in remote regions, and streamline compliance-related data handling, each contributing to lower fuel use and more efficient GHG reporting. The Arctic's challenging connectivity environment means that future solutions designed to prioritize mission-critical data, support bandwidth-efficient reporting, and combine inputs from navigation, weather, and vessel-performance systems may be particularly relevant for safe, efficient, and lower-emission operations in polar regions. While full integration is still emerging, this direction of travel highlights how digitalization may gradually enhance operational planning, safety, and data-driven emissions management in remote areas.

**Emerging alternative fuels (ammonia, hydrogen, e-fuels, synthetic fuels)**
International work continues to assess the long-term viability of low- and zero-emission fuels such as ammonia, hydrogen, synthetic e-fuels, and advanced biofuels. The European Maritime Safety Agency (EMSA) has commissioned a comprehensive series of technical studies examining these fuels from a 360-degree perspective, covering safety hazards, storage requirements, fuel availability, lifecycle GHG performance, scalability, and regulatory gaps. The multi-year program began in 2021 and is planned for completion by late 2026.

To date, EMSA's reports on ammonia and hydrogen identify both as potential long-term options for shipping but also highlight significant short-term barriers. These include ammonia's toxicity, handling risks, and stringent storage requirements, as well as hydrogen's cryogenic storage needs, equipment failure modes, and vessel-specific risk profiles. EMSA notes that large-scale deployment will require new safety protocols, ship-design adaptations, and supporting regulatory frameworks before these fuels can be introduced at scale.

Complementing EMSA's regulatory-focused assessments, the Global Centre for Maritime Decarbonization (GCMD) is conducting real-world pilots and operational trials to test alternative fuel readiness and infrastructure demands. Its initiatives include route-based pilots on drop-in biofuels, operational risk assessments for ammonia handling, and coalition projects that translate pilot results into emerging technical guidance and standards. These efforts are generating practical data on bunkering

conditions, hardware requirements, safety procedures, and engine-performance implications.

For Arctic expedition cruise operators, findings from EMSA and GCMD indicate that these emerging fuels are not operationally viable in the near-term, due to energy-density limitations, large onboard storage needs, extensive safety controls, and the lack of supporting infrastructure in remote regions. Ammonia and hydrogen in particular pose toxicity, safety, or cryogenic-handling challenges incompatible with small passenger vessels operating far from emergency response capacity.

Over time, advances in vessel design, port infrastructure, and global supply chains, as well as the development of more robust lifecycle GHG accounting frameworks, may clarify which fuels could become practical options for future operations. For now, however, these fuels represent long-term transition pathways rather than near-term solutions for AECO members.

**Lifecycle (well-to-wake) emissions accounting evolution**

Work at the IMO, in the EU, and across technical research platforms continues to strengthen the shift toward well-to-wake (WtW) lifecycle accounting. FuelEU Maritime already applies a WtW GHG-intensity metric, and MEPC 84 further advanced technical work relevant to future IMO fuel-intensity regulation, including GFI calculation guidance, fuel certification approaches, Fuel Lifecycle Label development, and continued refinement of default lifecycle emission factors and methodological boundaries. As these frameworks mature, lifecycle accounting is likely to play a growing role in fuel comparison, reporting practices, and long-term fleet planning.

**IMO Approach to Underwater Radiated Noise alongside GHG reduction**

Underwater radiated noise (URN) from shipping is recognized as a significant environmental pressure, with documented adverse impacts on marine life. The IMO addresses URN through non-mandatory, recommendatory guidelines (MEPC.1/Circ.906/Rev.1). These guidelines apply to both new and existing ships and are intended to support awareness, voluntary uptake, and the development of practical measures to reduce noise, rather than establish binding limits at this stage. **The guidelines emphasize that URN reduction should be considered alongside other objectives such as energy efficiency, safety, and operational performance**.

The URN management planning includes:

- establishing a baseline noise profile (predicted or measured),
- defining URN reduction targets, and

- implementing and monitoring a combination of design, technical, operational, and maintenance measures.

This approach is intended to be flexible and tailored to individual vessels and operational contexts.

# How to reduce GHG emissions?

AECO recognizes the difficulties our members face in their efforts to reduce GHG emissions, and to transition to a smaller environmental footprint. The work that will have to be undertaken to achieve those goals is complicated and requires time.

In the immediate future when green fuel availability is still restricted, an effort towards increasing efficiency should be made to reduce the uptake of conventional fuel. When biofuels become more available, uptake of those fuels should be prioritized alongside already developed fuel-efficient operations.

Whenever possible, alternative solutions that minimize GHG emissions should also be applied to decrease environmental footprint and provide more sustainable model of operations.

The latest Maritime Energy Transition Summit held to prepare the industry for the upcoming changes and led by the DNV in February 2024, recommend below actions and offered suggestions on how to decarbonize:

- Reduction of energy consumption should start now.
- There is no golden solution to decarbonization. All decarbonization options should be considered.
- Focus should be given to fuel flexibility.
- Long-term fuel strategy should be considered.
- Cooperation within the sector is key.
- Wind solutions have the potential to become the key propulsion support or system.
- New technologies require new training.

All available and relevant fuel options should be evaluated:

*Operational measures*

- Introducing operational measures (like those listed below), could be the least expensive ones, but will require focus and digital tools. It has the potential to reduce the emissions by 3-15%:
    - In optimizing machinery and system operations:

        - Aux engine loads, aux systems, main engine tuning, steam plant optimization, turbocharger optimization, managing engines preheating systems, stopping the generators when anchoring overnight

    - In optimizing hydrodynamic and propulsion efficiency:
        - using autopilot, propeller polishing, hull cleaning, trim/draught, combinator opti., dynamic positioning

    - In commercial and logistical measures:
        - optimizing voyage, weather routing, utilizing capacity and fleet, optimizing speed, using main engine at medium speed only - if possible, optimizing port calls, managing itineraries for optimized fuel consumption

*Technical measures*

Implementing technical measures (like those listed below), is more costly and may add complexity and increase the need for competence. It has the potential to reduce emissions by 5-30%.

- In machinery and systems:
    - use of autotuning, waste heat recovery, variable engine speed, (Aux) exhaust gas boilers, variable frequency drivers, PTO/PTI and De-rating.

- In propulsion efficiency and enhancement:
    - using ducts, fins, high efficiency rudder and propeller design/retrofit.

- In hydrodynamic efficiency enhancement:
    - using air lubrication, hull paint, hull form, bulbous bow and deadweight increase.

- In alternative energy sources:
    - Using shore power, onboard CCS, WAPS, batteries, fuel cells and lighting.

- In energy-saving and operation-monitoring solutions:
    - Decision support, remote monitoring and performance management.

Introducing commercial and logistical measures will have a business impact. It has the potential to reduce emissions by 0-20%.

*Fuel transition considerations*

The most cost demanding measure is the introduction of alternative fuels (e.g., without carbon, with sustainable carbon, capture $CO_2$ from combustion, biofuels methanol, ammonia, or nuclear). In this case, availability and price will drive the fuel selection. Using alternative fuels has the potential to reduce emissions by up to 100%.

Flexibility on fuel selection should be considered.

Fuel selection should also take account of non-$CO_2$ emissions, especially methane slip and nitrous oxide where relevant, as well as the likely need for stronger lifecycle documentation and recognized certification under emerging IMO and EU frameworks. MEPC 84 adopted new guidelines for the measurement of methane and nitrous oxide emissions from marine engines, signaling increasing regulatory attention to these emissions in fuel comparisons and future compliance systems.

The latest Maritime Energy Transition Summit concluded with a suggestion that the best strategy is to:

> Implement all available and relevant fuel saving options from the start (technical, operational and logistics) and gradually increase the use of biofuel or carbon neutral fuel.

Applying energy efficiency measures gradually will be less cost efficient, as the reduced fuel expenses are also deferred.

Relying solely on biofuel or carbon neutral fuel will be the most expensive option, as these fuels will become more expensive. Reducing the fleet's energy demand will be crucial.

Energy efficiency measures presented in guidance from the IMO include the formulation of the Ship Energy Efficiency Management Plan (SEEMP), a ship-specific plan for vessel operators

Sustainable Aviation Measures and reducing GHG from aviation.

This is the biggest challenge in terms of internal flights. Examples include sustainable aviation fuel, energy efficient aircraft, flight paths whilst there is growth in sustainable aviation options.

Reduction of fuel use for the generation of electricity in deep field camps and on vessels, exploring lower carbon fuel sources, alternative fuel sources where fuel is used for the generation of electricity.

Renewable mobile power energy generation for camps for example: solar and wind.

Update

***Operators Takeaway***

**Emissions reductions can be achieved through a combination of operational efficiency, targeted technical investments, and long-term fuel transition planning. The most effective pathway will vary by vessel type, operating area, and regulatory context.**

# Methods to determine GHG footprint

**In-House**
It is recommended to perform regular greenhouse gas emission calculations within scope 1,2 and 3, for operations in the Arctic. These can be done either in-house following official guidelines or through an external company specializing in the calculation of emissions.

**Step 1**
Determine fuel consumption in metric tons

For most companies operating vessels, fuel type and consumption can be taken from daily progress reports or bunker fuel notes.

Calculate mass based on volume:

In case only the volume of fuel is known to you, weight can be determined by multiplying the volume times the density of the fuel type. For example, 1 $m^3$ of MDO = 0.89 metric tons of MDO.

Average density of different fuel types used in calculations of emissions

| Fuel | Average density ($mT/m^3$) | Source |
|---|---|---|
| HFO | 0.92-1.01 | ISO 8217 |
| MDO | 0.89 | ISO 8217 |
| LNG | 0.45 | MEPC.281(70) |

**Step 2**
Determine emission factors

Each type of fuel has associated emissions (Table 2), the most important being $CO_2$, $NO_X$, $SO_X$, PM and $CH_4$. The table below shows the emissions in kilograms when 1 metric ton of fuel is burned (source: IMO Greenhouse Gas Study 2020 table 53). With fuel consumption and emission factors known, you can now calculate emissions. *The averages of IMO GHG Study 2020 have been taken [kg/mT]

Emission factors for different types of fuel pollutants. Source: IMO

| Fuel | Pollutant | Emission Factor* |
|---|---|---|
| HFO | $CO_2$ | 3114 |
| | $NO_X$ | 77.26 |
| | $SO_X$ | 47.73 |
| | PM | 7.25 |
| | $CH_4$ | 0.05 |
| MDO | $CO_2$ | 3206 |
| | $NO_X$ | 54.88 |
| | $SO_X$ | 2.15 |
| | PM | 0.95 |
| | $CH_4$ | 0.05 |
| LNG | $CO_2$ | 2750 |
| | $NO_X$ | 8.28 |
| | $SO_X$ | 0.03 |
| | PM | 0.11 |
| | $CH_4$ | 8.27 |

**Step 3**

*Calculate emissions*

*Emission [kg] = Fuel Consumption [mT] x Emission Factor [kg/mT fuel]*

* It should be noted that these emission factors are (in some cases) heavily influenced by engine settings. In the case of $NO_X$ for example, the amount of emissions can vary significantly. The variation for $CO_2$ is much smaller and is primarily based on the carbon content of the fuel. Another factor to be considered is $CH_4$ slip for LNG engines, which can materially increase the overall $CO_2$-equivalent footprint. MEPC 84 adopted new 2026 Guidelines for test-bed and onboard measurements of methane ($CH_4$) and/or nitrous oxide ($N_2O$) emissions from marine diesel engines, together with guidelines for engine load monitoring (ELM) and continuous emission monitoring systems (CEMS). Where operators wish to improve understanding of actual non-$CO_2$ emissions performance, these tools may support more robust measurement and future-proof data collection.

Update

**References for calculating emissions**

- IMO - Fourth IMO Greenhouse Gas Study 2020
- IMO – MEPC.281(70)
- ISO 8217 – Fuel standard for marine fuels

Update

**Capacity-based interpretation of emissions intensity (conceptual guidance)**

In addition to calculating total emissions, operators may find it useful to track capacity-based intensity indicators that relate emissions to the size and functional capability of a vessel. These indicators, such as metrics expressing emissions per gross ton of vessel capacity per nautical mile, complement distance-based measures by showing how efficiently a ship uses its overall operational footprint.

For cruise and expedition vessels hotel loads, auxiliary demand, and passenger-service space make traditional cargo-based metrics less meaningful. Capacity-based measures such as cgDIST or cgHRS can help operators understand efficiency trends across different vessel types, identify the drivers of higher auxiliary loads, and benchmark vessel performance more accurately over time.

While not required for compliance, these metrics can support more informed operational and investment decisions.

**Alternative options**

- Fleet and $CO_2$ Calculator – GreenVoyage2050
- The $CO_2$ calculator uses data from the Third IMO GHG Study for the year 2012 and assumes that ships use Heavy Fuel Oil with a $CO_2$ emissions factor of 3,114 kg $CO_2$ /ton fuel.

**Alternative solutions aligned with sustainability and latest technology**

- Cetasol- Intelligent Maritime Sustainability, iHelm analytical platform with AI modelling as well as virtual fuel reader

- Alternative Fuels Insight (AFI) - DNV's Alternative Fuels Insight (AFI) is an open platform that provides an overview of the global uptake of alternative fuels and technologies in the maritime sector, including information on vessels, fuel pathways, and bunkering infrastructure. AFI aggregates publicly available and industry-reported data and is intended as a reference tool to support strategic awareness and understanding of developments related to alternative marine fuels. The platform does not set regulatory requirements and is not a substitute for compliance with IMO or EU regulations.

Update

Update

***Operators Takeaway***

**There is no single pathway to decarbonization. Operators are encouraged to consider fuel flexibility, operational efficiency, and emerging technologies considering vessel type, trading area, and regulatory outlook.**

# Recommended targets for reduction of emissions

Recommended targets on reduction of the GHG emissions for AECO operating members is presented in the Commitment to Reduce GHG emissions.

AECO's mission is to carry out expedition cruises with the utmost consideration for the natural environment.

AECO's operating members are committed to working towards GHG emission reductions in line with the IMO's GHG Strategy and its future amendments. In addition, AECO operating members intend to follow any local regulatory strategies that may come into force.

AECO's operating members commit to calculating and tracking their GHG emissions, in line with IMO guidelines. This also applies to AECO vessels below 5000 GT, who are not currently required to do so. The calculation methods are listed in AECO's Roadmap to reducing GHG emissions.

**AECO's operating members commit to continuous efforts to reduce their absolute emissions within the Tank-to-Wake scope, and work towards Well-to-Wake scope.**

# Outreach

- Share our pledge (your web, passenger information, marketing material, social media, press release, etc.)
- Share your climate strategy journey
- Continue to work towards sustainability, reduction of your environmental footprint and implementation of environmentally friendly practices
- Educate passengers and the public on your efforts to combat climate change
- Distribute available AECO climate change materials.
- Encourage passengers to offset the rest of their emissions. Some examples of free carbon calculators:
    - United Nations Climate Neutral Now
    - Carbon Footprint.com

# Appendix:

MEPC 80/17/Add.1 Annex 14 Initial default emission factors per fuel pathway code

| Order | Fuel type | Fuel Pathway Code | WtT GHG intensity ($gCO_2eq$/MJ) | LCV (MJ/g) | Energy Converter | Cf $CO_2$ ($gCO_2$/g fuel) | Cf $CH_4$ ($gCH_4$/g fuel) | Cf $N_2O$ ($gN_2O$/g fuel) | Cslip /Cfug (mass %) | ec gCO2eq /g fuel | TtW GHG intensity ($gCO_2eq$/MJ) | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Heavy Fuel Oil (ISO 8217 Grades RME, RMG and RMK, 0.10 < S ≤ 0.50%) | HFO(VLSFO)_f_SR_gm | 16.8 | 0.0402 | ALL ICEs | 3.114 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| 2 | Heavy Fuel Oil (ISO 8217 Grades RME, RMG and RMK exceeding 0.50% S) | HFO(HSHFO)_f_SR_gm | 14.9 | 0.0402 | ALL ICEs | 3.114 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| 3 | Light Fuel Oil (ISO 8217 Grades RMA, RMB and RMD maximum 0.10% S) | LFO(ULSFO)_f_SR_gm | | 0.0412 | ALL ICEs | 3.151 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| **4** | **Light Fuel Oil (ISO 8217 Grades RMA, RMB and RMD, 0.10 < S ≤ 0.50%)** | **LFO(VLSFO)_f_SR_gm** | | **0.0412** | **ALL ICEs** | **3.151** | **0.00005** | **0.00018** | | | | **Resolution MEPC.364(79) Fourth IMO GHG study** |

| Order | Fuel type | Fuel Pathway Code | WtT GHG intensity ($gCO_2eq$/MJ) | LCV (MJ/g) | Energy Converter | Cf $CO_2$ ($gCO_2$/g fuel) | Cf $CH_4$ ($gCH_4$/g fuel) | Cf $N_2O$ ($gN_2O$/g fuel) | Cslip /Cfug (mass %) | ec $gCO_2eq$/g fuel | TtW GHG intensity ($gCO_2eq$/MJ) | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Marine Diesel/Gas Oil (ISO 8217 Grades DMX, DMA, DMZ and DMB maximum 0.10 % S) | MDO/MGO(ULSFO)_f_SR_gm | 17.7 | 0.0427 | ALL ICEs | 3.206 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| 6 | Marine Diesel/Gas Oil (ISO 8217 Grades DMX, DMA, DMZ and DMB, 0.10 < S ≤ 0.50%) | MDO/MGO(VLSFO)_f_SR_g m | | 0.0427 | ALL ICEs | 3.206 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| 11 | Liquefied Petroleum Gas (Propane) | LPG(Propane)_f_SR_gm | | 0.0463 | ALL ICEs | 3.000 | 0.00005 | 0.00018 | | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| **21** | **Liquefied Petroleum Gas (Butane)** | **LPG(Butane)_f_SR_gm** | | **0.0457** | **ALL ICEs** | **3.030** | **0.00005** | **0.00018** | | | | **Resolution MEPC.364(79) Fourth IMO GHG study** |

| Order | Fuel type | Fuel Pathway Code | WtT GHG intensity ($gCO_2eq/MJ$) | LCV (MJ/g) | Energy Converter | Cf $CO_2$ ($gCO_2/g$ fuel) | Cf $CH_4$ ($gCH_4/g$ fuel) | Cf $N_2O$ ($gN_2O/g$ fuel) | Cslip /Cfug (mass %) | ec $gCO_2eq/g$ fuel | TtW GHG intensity ($gCO_2eq/MJ$) | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | Liquefied Natural Gas (Methane) | LNG_f_SLP_gm | | 0.0480 | LNG Otto (dual fuel medium speed) | 2.750 | 0 | 0.00011 | 3.5/- | | | Resolution MEPC.364(79) Fourth IMO GHG study |
| | | | | | LNG Otto (dual fuel slow speed) | | | | 1.7/- | | | |
| | | | | | LNG Diesel (dual fuel slow speed) | | | | 0.15/- | | | |
| | | | | | LBSI (Lean-Burn Spark-Ignited) | | | | 2.6/- | | | |
| | | | | | **Steam Turbines and boilers** | | | | **0.01/-** | | | |

| Order | Fuel type | Fuel Pathway Code | WtT GHG intensity ($gCO_2eq/MJ$) | LCV (MJ/g) | Energy Converter | Cf $CO_2$ ($gCO_2/g$ fuel) | Cf $CH_4$ ($gCH_4/g$ fuel) | Cf $N_2O$ ($gN_2O/g$ fuel) | Cslip /Cfug (mass %) | ec $gCO_2eq/g$ fuel | TtW GHG intensity ($gCO_2eq/MJ$) | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | Liquefied Natural Gas (Methane) | LNG_b_AD_g m | | | LNG Otto (dual fuel medium speed) | 2.750 | | | | | | |
| | | | | | LNG Otto (dual fuel slow speed) | | | | | | | |
| | | | | | LNG Diesel (dual fuel slow speed) | | | | | | | |
| | | | | | LBSI (Lean-Burn Spark-Ignited) | | | | | | | |
| | | | | | Steam Turbines and boilers | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | Diesel (FAME) | FAME_b_TRE_gm_2ndgen | 20.8 | 0.0372 | ALL ICEs | | | | | | | |
| 77 | Renewable Diesel (HVO) | HVO_b_HD_gm_1stgen | 14.9 | 0.044 | ALL ICEs | | | | | | | |

| Order | Fuel type | Fuel Pathway Code | WtT GHG intensity ($gCO_2eq/MJ$) | LCV (MJ/g) | Energy Converter | Cf $CO_2$ ($gCO_2/g$ fuel) | Cf $CH_4$ ($gCH_4/g$ fuel) | Cf $N_2O$ ($gN_2O/g$ fuel) | Cslip /Cfug (mass %) | ec $gCO_2eq/g$ fuel | TtW GHG intensity ($gCO_2eq/MJ$) | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 105 | Hydrogen | H2_f_SMR_CCS_gm | | 0.12 | ALL ICEs | 0 | | | | | | |
| | | | | | Fuel cell | | | | | | | |
| 121 | Ammonia | NH3_rN2_fH2_HB_gm | | 0.0186 | ALL ICEs | 0 | | | | | | |
| | | | | | Fuel cell | | | | | | | |