

Roadmap to reducing GHG emissions



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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 reduce the absolute GHG emissions from international shipping by at least 50% by 2050 compared to 2008 levels.

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 CO₂, 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CH₄ and N₂O.

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 mechanism. Offsetting claims are only valid under a rigorous set of conditions, including that the reductions/removals involved are additional, not over-estimated, 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.

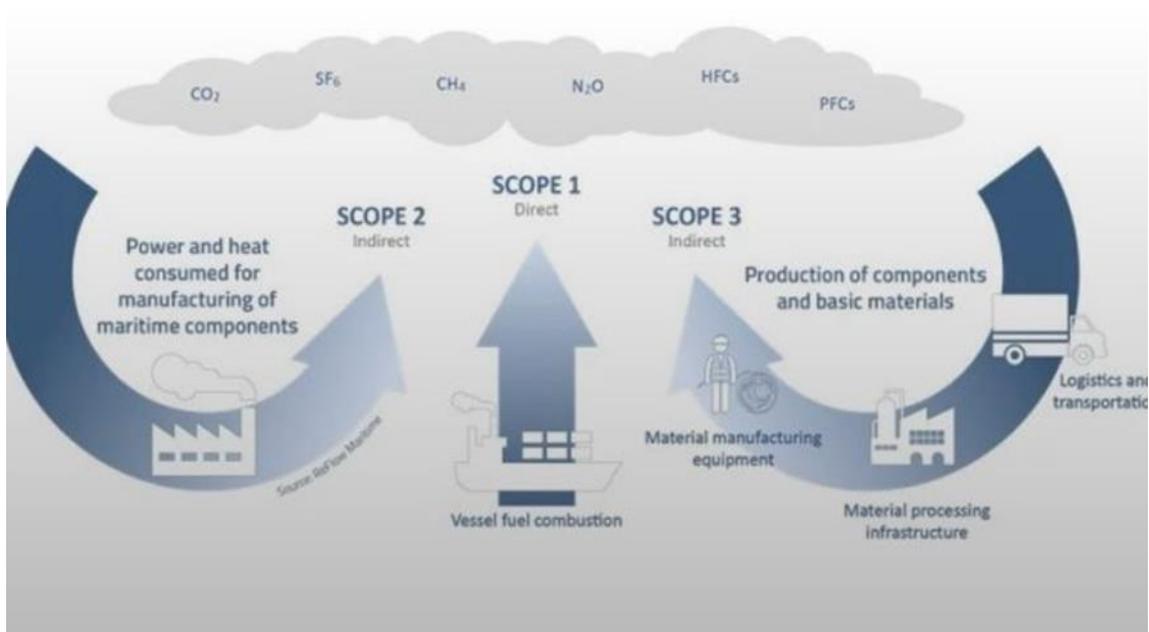
Scopes

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: [ICPP's glossary](#).

Introduction

In 2018, the global shipping sector was responsible for almost 3% of the total global anthropogenic CO₂ emissions, amounting to 1 076 million tonnes, with one-fifth of these emissions comprising black carbon.

Cruise ships account for about 0.34% of the world's commercial fleet, that in 2023 contained about 105 500 vessels. Of those 350 cruise vessels, about 60 (or c.15%) are expedition cruise ships.

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 decarbonisation required to limit this warming. Therefore, our members will prepare for further adjustments of the targets.

As part of the development of the climate commitment, AECO performed a survey amongst operating members in December 2023. The main goal of the survey was to assess the industry's practices relevant to greenhouse gas emissions. In addition, the survey was designed to highlight challenges and opportunities in transition to sustainable shipping operations that lie ahead.

The American Bureau of Shipping was tasked with estimation of the total carbon footprint of the AECO fleet to create a current baseline record of their greenhouse gas emissions. This work will be finalized in the fall of 2024.

Information presented below aims to support AECO's members in the transition period and will be updated whenever new IMO and EU guidelines/regulations are adopted.

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)

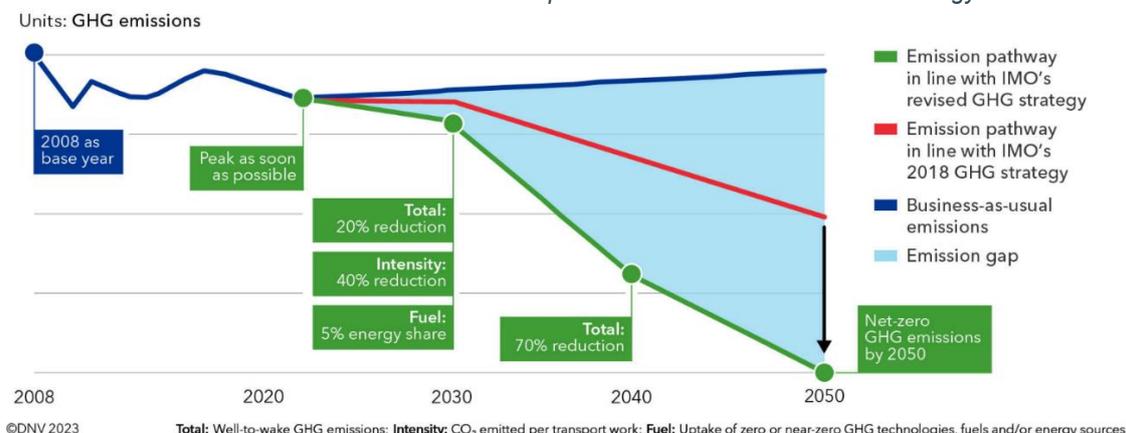
In the efforts to limit the rise of the global air temperature, IPCC reports as well as COP26 and COP28 indicate that we need to commit to interim greenhouse gas emissions reduction targets and actions leading to net zero by 2050. This means committing to achieve a balance between anthropogenic emissions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

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 CO₂ 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

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:

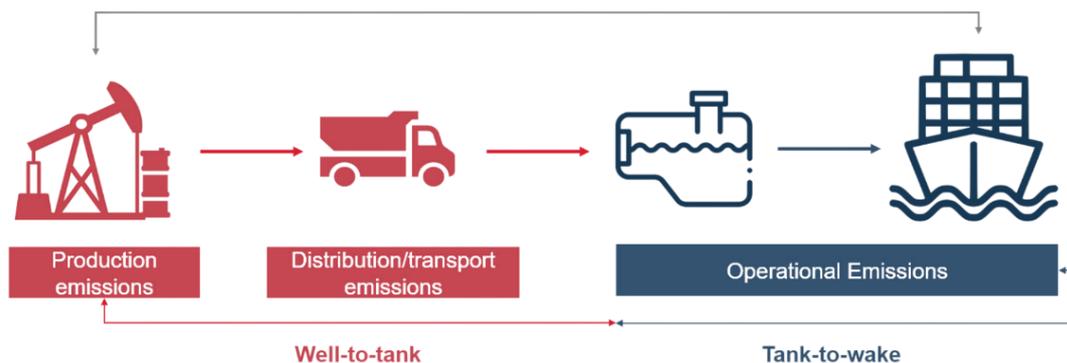
- Faster reduction of emissions allowances in the system and gradual phasing-out of free allowances for some sectors.
- Implementation of the global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) through the EU ETS.
- Increase of funding for the modernization fund and the 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 report emissions more than those covered by their purchased allowances must pay a financial penalty to the ETS system.

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. Emission factor applies from TtW.

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



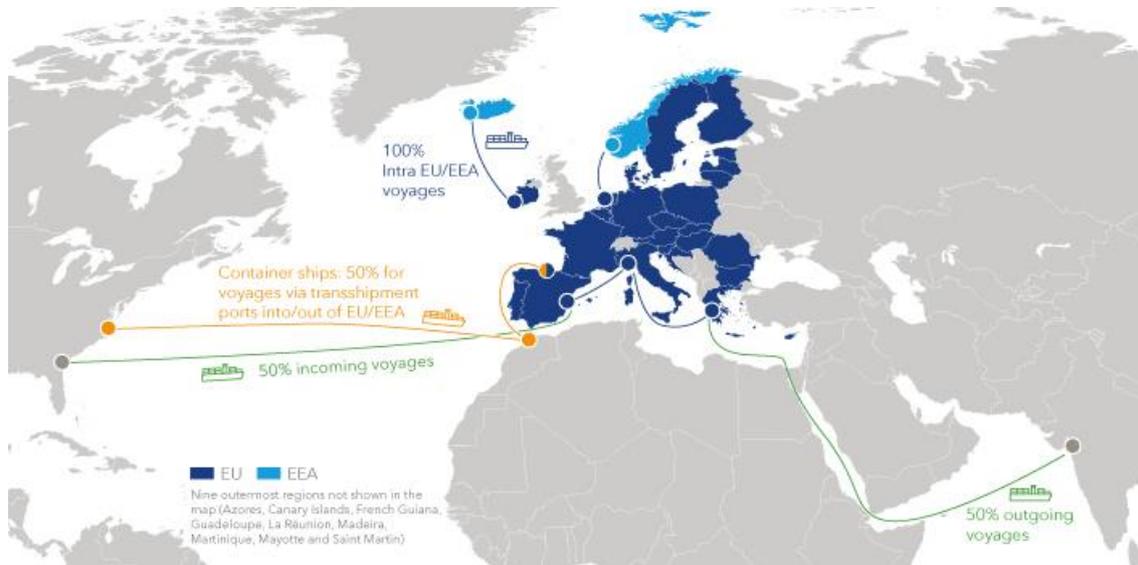
$WtW = WtT + TtW$:

- 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.

Those vessels in scope of the ETS will need to buy EU Allowances (EUA) to cover half of their GHG emissions to and from EU, Norwegian and Icelandic (EEA) ports, and all emissions for intra-EEA voyages and while at berth at EEA ports.

The system covers:

- 50% of emissions from voyages starting or ending outside of the EU (allowing the third country to decide on appropriate action for the remaining share of emissions); and
- 100% of emissions that occur between two EU ports and when ships are within EU ports.
- *U ETS operational area.*
- *U ETS operational area.*

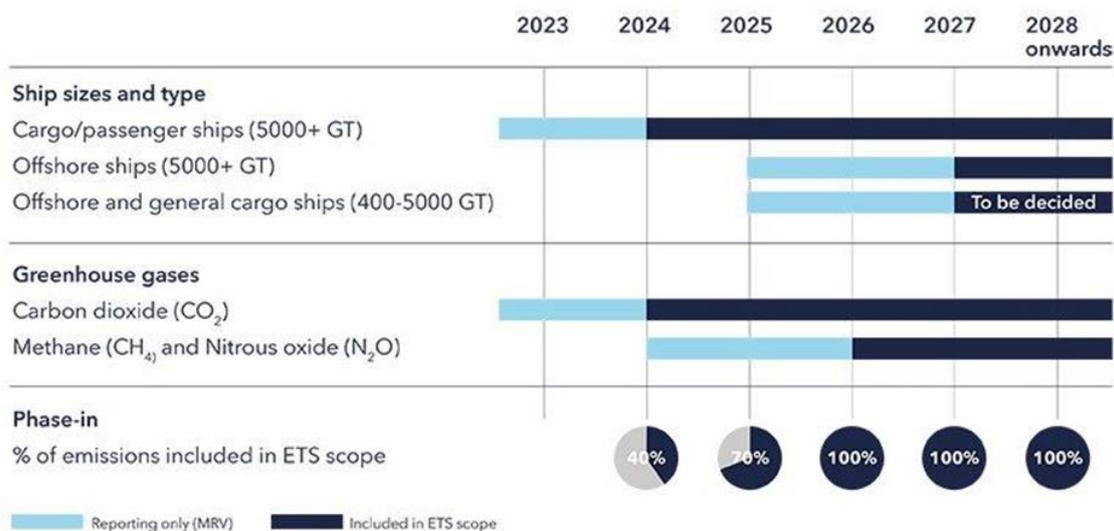
EU ETS operational area.

Obligations for shipping companies to surrender allowances will be introduced gradually:

- 40% for verified CO₂ (carbon dioxide) emissions from 2024 (submitted in September 2025 via the European Energy Exchange)
- 70% from 2025
- 100% of all emissions CO₂, CH₄ (methane), N₂O (nitrous oxide) from 2026.

Most large vessels are included within the scope of the EU ETS from the start, while other big vessels, namely offshore vessels, will be included in the Monitoring, Reporting and Verification for the EU (MRV) regulation on the monitoring, reporting and verification of CO₂ emissions from maritime transport first, and only later included in the EU ETS. Non-CO₂ emissions (CH₄ and N₂O) will be included in the MRV regulation from 2024 and in the EU ETS from 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.

From 1 January 2025, ships trading in the EU or European Economic Area (EEA), must cover their energy needs by fuels of GHG emissions (including CO₂, CH₄ and N₂O), below a threshold value. The GHG intensity will be measured on a WtW basis.

For TtW, regulation considers not only CO₂ emissions, but also CH₄ and N₂O. CH₄ and N₂O are subsequently converted into CO₂ equivalents, multiplied with Global Warming

Potential of 100 years (GWP100) which is equal to 28 for CH₄ and 265 for N₂O 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).

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.

More detailed information on the regulation, scope, banking, pooling, penalties and derogations can be found [here](#).

Updated 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 CO₂ emissions, but also N₂O and CH₄ 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 the responsibility for the operation of the ship including duties and responsibilities imposed by the ISM Code.

Tank-to-wake CO₂ emissions from cargo and passenger ships of 5,000GT and above, reported under the MRV system in 2024, will be subject to the ETS in 2025. A review of the system in 2026 will consider whether emissions should be considered on a WtW instead of TtW basis.

The emissions will be reported and verified through the existing EU MRV system, which will be revised and extended to cover necessary GHG emissions, ship types and sizes. Detailed information on preparing for EU ETS and managing responsibilities and practical aspects related to EU MRV and ETS can be found [here](#).

Marine Environmental Protection Committee 76 (MEPC76)

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.

The Carbon Intensity Indicator CII

The Carbon Intensity Indicator (CII) is a measure of how efficiently a ship transports goods or passengers and is given in grams of CO₂ 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.

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 reference year. The rates for 2027–2030 will be decided as part of the review to be concluded by 1 January 2026.

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. On the MEPC-82 in September/October 2024 CII will be revised with the aim to strengthen it and provide enforcement. The revisions should be concluded by the start of the 2026.

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

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.

Marine Environmental Protection Committee 80 and 81 (MEPC80-81)

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: CO₂, CH₄ and N₂O.

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

The GHG emissions are calculated as CO₂ equivalent (CO_{2eq}) using the Global Warming Potential over 100-year time horizon (GWP100) to convert emissions of other gasses than CO₂, as given in the fifth IPCC Report for CO₂, CH₄ and N₂O. These GWP100 values should be used for the purpose of quantifying the GHG intensity in accordance with these guidelines, as follows:

$$gCO_{2eq}(100y) = GWP_{CO_2(100y)} \times gCO_2 + GWP_{CH_4(100y)} \times gCH_4 + GWP_{N_2O(100y)} \times gN_2O$$

(CO₂ 1; CH₄ 28; N₂O 265), this would read as:

$$gCO_{2eq}(100y) = 1 \times gCO_2 + 28 \times gCH_4 + 265 \times gN_2O$$

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

$$gCO_{2eq}(20y) = GWP_{CO_2(20y)} \times gCO_2 + GWP_{CH_4(20y)} \times gCH_4 + GWP_{N_2O(20y)} \times gN_2O$$

(CO₂ 1; CH₄ 84; N₂O 264), this would read as:

$$gCO_{2eq}(20y) = 1 \times gCO_2 + 84 \times gCH_4 + 264 \times gN_2O$$

MEPC81 held in March 2024 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 for NO_x, SO_x and PM.

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 the actual TtW methodologies for actual/onboard emission factors, amongst others. Further development of the LCA framework will be discussed at ISWG-GHG 17 in September 2024.

Protecting the Arctic from Shipping Black Carbon Emissions - Resolution MEPC.342(77)

The resolution is urging shipping operating in or near the Arctic to move to distillate or other cleaner alternative fuels or methods of propulsion. Later this year, the IMO is expected to adopt two new 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
2. Guidelines on Recommendatory Back Carbon Emission Measurement, and Monitoring and Reporting.

Guidelines 1 are a part of a broader effort by the IMO's Pollution Prevention and Response (PPR) Sub-Committee to address the environmental impact of shipping in the Arctic. The goal-based measures 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.

This guideline is expected to be formally adopted during the upcoming Marine Environment Protection Committee meeting in October 2024 (MEPC 82). It includes recommendatory measures for reducing black carbon emissions. The guidelines propose the use of alternative fuels, exhaust gas cleaning systems, and engine modifications as key strategies to reduce black carbon emissions in Arctic waters.

Guidelines 2 aim to standardize the approach to managing black carbon emissions from international shipping, particularly in Arctic waters. These guidelines are expected to be approved at the MEPC 82 meeting in October 2024.

Objectives of the proposed 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 as a means 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.

Non-governmental pledges and targets that can be joined

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 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.

To learn more about the SBT guidance follow this [link](#).

Glasgow Declaration, Climate Action in Tourism

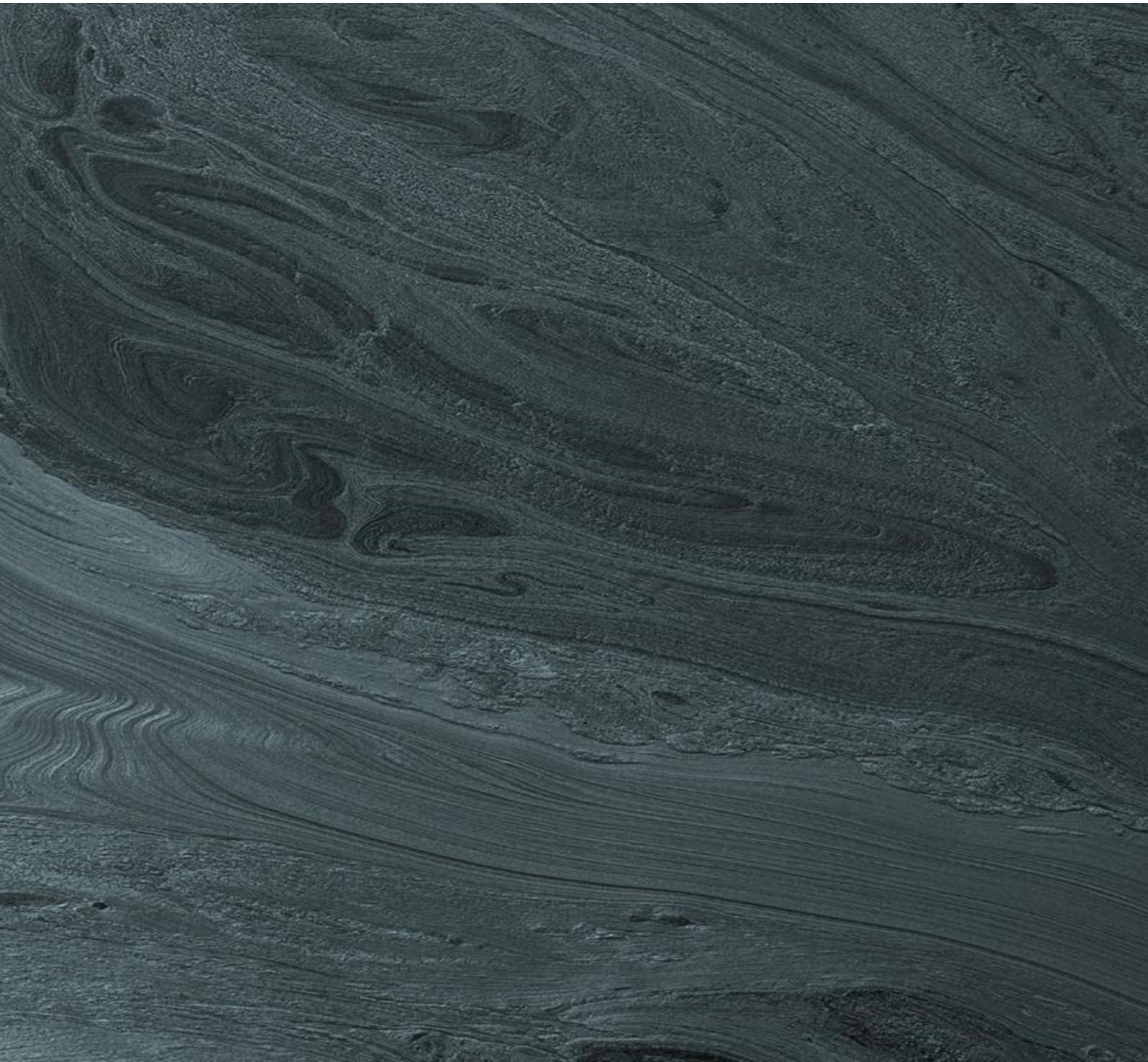
The [Glasgow Declaration](#) is a catalyst for increased urgency about the need to accelerate climate action in tourism and to secure strong actions and commitment to support the global goals to halve emissions over the next decade and reach Net Zero emissions as soon as possible before 2050.

'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.



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:

- 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

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%.

The most cost demanding measure is the introduction of alternative fuels (e.g., without carbon, with sustainable carbon, capture CO₂ 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 the emissions by up to 100%.

Flexibility on fuel selection should be considered.

The 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 be becoming more expensive. Reducing the fleet's energy demand will be crucial.

Energy efficiency measures presented in guidance from the IMO includes 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.

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 m³ 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 (Tabel 2), the most important being CO₂, NO_x, SO_x, PM and CH₄. 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*

$$\text{Emission [kg]} = \text{Fuel Consumption [mT]} \times \text{Emission Factor [kg/mT fuel]}$$

* 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 CO₂ is much smaller and is primarily based on the carbon content of the fuel. Another factor to be considered is CH₄ slip for LNG engines, which could increase carbon equivalent footprint. To measure emissions effectively and truly, one should install a continuous emissions monitoring system (CEMS)

References for calculating emissions

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

Alternative options

- Fleet and CO₂ Calculator – GreenVoyage2050
- The CO₂ calculator uses data from the Third IMO GHG Study for the year 2012 and assumes that ships use Heavy Fuel Oil with a CO₂ emissions factor of 3,114 kg CO₂ /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

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 ₂ eq/MJ)	LCV (MJ/g)	Energy Converter	Cf CO ₂ (gCO ₂ /g fuel)	Cf CH ₄ (gCH ₄ /g fuel)	Cf N ₂ O (gN ₂ O/g fuel)	Cslip /Cfuel (mass %)	ec gCO ₂ eq /g fuel	TtW GHG intensity (gCO ₂ eq /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 ₂ eq/MJ)	LCV (MJ/g)	Energy Converter	Cf CO ₂ (gCO ₂ /g fuel)	Cf CH ₄ (gCH ₄ /g fuel)	Cf N ₂ O (gN ₂ O/g fuel)	Cslip /Cfuel (mass %)	ec gCO ₂ eq /g fuel	TtW GHG intensity (gCO ₂ eq /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_gm		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 ₂ eq/MJ)	LCV (MJ/g)	Energy Converter	Cf CO ₂ (gCO ₂ /g fuel)	Cf CH ₄ (gCH ₄ /g fuel)	Cf N ₂ O (gN ₂ O/g fuel)	Cslip /Cfug (mass %)	ec gCO ₂ eq/g fuel	TtW GHG intensity (gCO ₂ eq/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 ₂ eq/MJ)	LCV (MJ/g)	Energy Converter	Cf CO ₂ (gCO ₂ /g fuel)	Cf CH ₄ (gCH ₄ /g fuel)	Cf N ₂ O (gN ₂ O/g fuel)	Cslip /Cfug (mass %)	ec gCO ₂ eq/g fuel	TtW GHG intensity (gCO ₂ eq/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_g m_1stgen	14.9	0.044	ALL ICEs							

Order	Fuel type	Fuel Pathway Code	WtT GHG intensity (gCO ₂ eq/MJ)	LCV (MJ/g)	Energy Converter	Cf CO ₂ (gCO ₂ /g fuel)	Cf CH ₄ (gCH ₄ /g fuel)	Cf N ₂ O (gN ₂ O/g fuel)	Cslip /Cfug (mass %)	ec gCO ₂ eq/g fuel	TtW GHG intensity (gCO ₂ eq/MJ)	NOTE
105	Hydrogen	H2_f_SMR_C CS_gm		0.12	ALL ICEs	0						
					Fuel cell							
121	Ammonia	NH3_rN2_fh2 _HB_gm		0.0186	ALL ICEs	0						
					Fuel cell							

