AUGUST 2026

SINGAPORE SHIPPING ASSOCIATION

FAQ ON BUNKERING OF BIOFUELS FOR OCEAN-GOING VESSELS IN THE PORT OF SINGAPORE

PREAMBLE

The Biofuels FAQ was updated in 2026 and issued by the Singapore Shipping Association (SSA) has been necessitated by the growing importance & use of marine biofuels as an alternative fuel of choice given its practical compatibility as a drop-in fuel with existing ships' engines & operations.

This complements Singapore's role as the world's largest multi-fuel bunkering hub and where sales of biofuel blends have grown rapidly to 1.36 million tonnes in 2025.

The Singapore Shipping Association (SSA) issued the first version of this Biofuel FAQ in August 2022, at a time when the trialing and use of biofuels was gaining momentum. A second edition was issued in 2024 to further elaborate on the technical and regulatory developments.

ABOUT THIS DOCUMENT

This document is for informational purposes only and is by no means exhaustive. The main intention is to provide technical, commercial, testing and regulatory guidance to the shipping industry with regard to the bunkering and use of biofuels on board ships.

Every attempt has been made to ensure that all the information provided in this document is accurate. SSA is however not liable for the accuracy, content, completeness, legality or reliability of the information.

The focus of this document is on FAME-based liquid biofuels and blends as this type of biofuel is expected to become most widely adopted by the shipping industry. Other non-FAME-based biofuels have also been addressed where relevant.

The Singapore Biofuel Standard TR 140:2025 (Specifications for Marine Biofuels) has been referenced throughout this document. A copy can be obtained at Singapore Standards.

Readers are strongly advised to consult their suppliers, equipment manufacturers, classification societies, service providers and other stakeholders for confirmation or more information.

This FAQ provides practical guidance on the bunkering and onboard use of marine biofuels. It covers:

1. Technical and operational considerations, including engine compatibility, fuel additives, storage and handling, fuel stability, operational best practices, and Class requirements.
2. IMO and European Union regulatory requirements, including guidance on DCS, CII, SEEMP, EU MRV, EU ETS, FuelEU Maritime, sustainability certification and reporting obligations.
3. Fuel quality standards and testing methods, with reference to TR 140:2025 (Specifications for Marine Biofuels), ISO 8217:2024, recommended testing protocols, and quality assurance requirements.
4. Commercial considerations, including biofuel supply and availability, market outlook, pricing, sustainability documentation, government incentives, and the commercial supply chain for biofuels in Singapore.

ABOUT THIS DOCUMENT

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The Marine Fuel Committee set up the Working Group to prepare a revised Biofuels FAQ document. The Working Group consists of the following experts who contributed in their individual capacity:

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3. Yow Sushan, Betaorix	BP Singapore Pte. Limited
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8. Casey Phua	Wilhelmsen Ships Service (S) Pte. Ltd.

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- Argus Media Singapore Group Pte Ltd (Mahua Mitra)
- DNV Singapore Pte. Ltd.
- Global Centre for Maritime Decarbonization (Dr Prapisala Thepsithar)
- Lloyd's Register of Shipping Singapore Pte. Ltd.
- NTU-MESD (Dr Liu Ming)
- Veritas Petroleum Services (Asia) Pte. Ltd.

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FAQ 1: WHAT ARE BIOFUELS?

Bio-derived fuels and blends of bio-derived fuels with petroleum products are included within the range of potential alternative energy sources being considered by the marine industry since they are renewable and can result in reduced greenhouse gases (GHGs) and Sulphur emissions (SOx).

Biofuels are commonly classified based on the feedstocks and production pathways as follows:

1.First generation biofuels are produced from feedstock that is used for the food industry, such as food crops, sugar/starch and vegetable oils using conventional processing (transesterification) technologies. These biofuels, also known as FAME (Fatty Acid Methyl Ester) can be derived from crops, rapeseed, palm, soyabean and sunflowers, using the transesterification method.

2.Second generation biofuels are typically produced from waste, residues and non-food crop feedstocks, such as used cooking oil (UCO), using esterification (FAME), hydrocracking or hydrogenation processes. While HVO/HEFA (Hydrogenated Vegetable Oil/Hydro-processed Esters and Fatty Acids) based biofuels have a similar range of feedstocks as FAME, they go through different production processes.

3.The feedstocks of third generation biofuels are specially designed engineered crops such as farmed algae.

4.Fourth Generation biofuels use genetically modified (GM) algae as feedstock to enhance production.

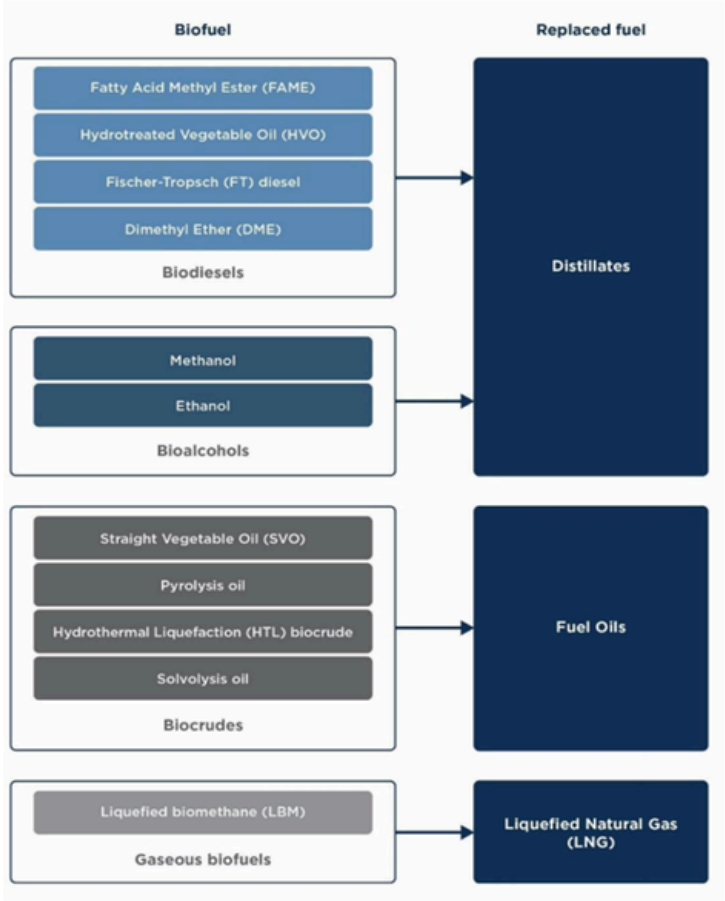
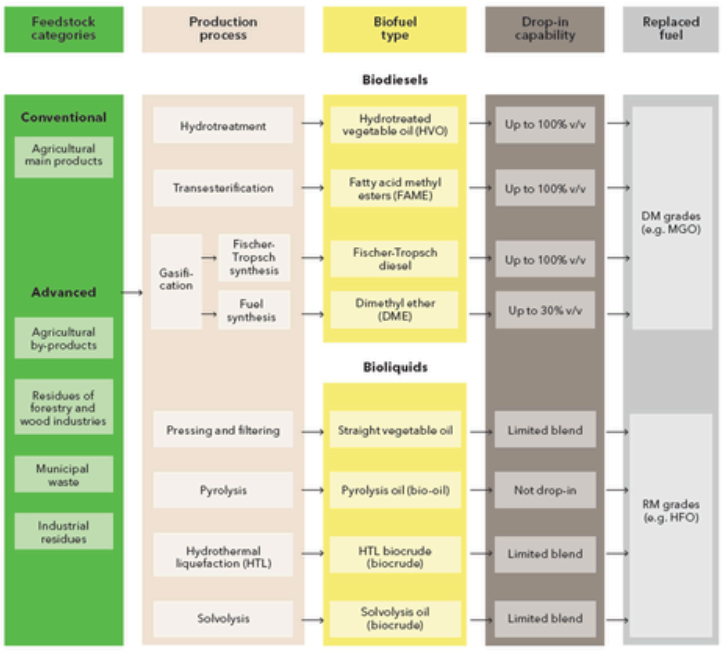


Figure 1. Overview of biofuels, production pathways and biomass-feedstock groups

Source: EMSA – Update on Potential of Biofuels in Shipping

Production of biofuels from several feedstocks using different process, resulting in different types of liquid biofuels with differing qualities.



Source: DNV Whitepaper – Biofuels in Shipping

TECHNICAL

FAQ 2: WHAT ARE THE PRIMARY BENEFITS OF BIOFUELS?

The use of biofuels (including biofuel blends) can provide the following benefits to ship owners, operators and managers:

a. Biofuels are generally considered a "drop-in" alternative fuel because they are typically compatible with existing technology and can be used in internal combustion engines and boilers without significant technical modifications and capital expenditures.

b. Biofuels have properties that are close to the existing fossil marine fuel oils and most have a flashpoint above 60°C.

c. Biofuels can comply with the sulphur requirements of the International Maritime Organization (IMO).

d. Biofuels have a well-to-wake GHG emission reduction potential and can help to comply with the increasingly stringent environmental requirements set by the IMO and the European Union (EU).

e. On board trials with biofuels usage have shown good operating results so far.

f. Biofuels offer lower SO_x, PM (particulate matter) and lifecycle CO_2 emissions.

g. Biofuels are biodegradable, thereby reducing environmental contamination risks, especially with B100 FAME. The biodegradability decreases for blended biofuels such as B20.

FAQ 3: WHAT ARE THE TYPICAL TECHNICAL AND OPERATIONAL CHALLENGES ASSOCIATED WITH THE USE OF BIOFUEL?

The following operational and technical challenges (non-exhaustive) require due attention from operators and crew:

a. Storage issues due to degradation and sludge formation if the biofuel is not used within a specific timeframe.

b. Low ambient temperatures may result in wax formation in the tanks containing biofuel. Operators should take note when sailing from areas with warmer climate to colder areas and ensure that the tanks have adequate heating capacity.

c. Exposure to water and a high oxygen content in biofuels increases the risk of microbial growth.

d. Potential compatibility issues when mixing with fossil fuels or other biofuels. It is generally advised to clean the fuel storage tank thoroughly before bunkering biofuels.

e. Auto-oxidation of biofuels can amplify its corrosive characteristics and affect engine and equipment components. Corrosion can generally be prevented by selecting materials such as aluminium or stainless steel.

f. Certain types of engines may require a different lubrication oil when using biofuels.

g. It is recommended that all TR 140:2025 (Specifications for Marine Biofuels) fuel quality parameters are met.

h. Possible degeneration of rubber sealings, gaskets and hoses. It is important to verify that these components in the fuel system are endurable and can be used together with the biofuel.

TECHNICAL

FAQ 3: WHAT ARE THE TYPICAL TECHNICAL AND OPERATIONAL CHALLENGES ASSOCIATED WITH THE USE OF BIOFUEL?

i. Filter clogging: Biodiesel has shown to have a solvent property, so when switching from diesel to biofuel, it is expected that deposits in the fuel system will be flushed, thus clogging the fuel filters. It is recommended to flush the system and/or to monitor filters during this period.

Engine makers need to be consulted prior to biofuel use in order to verify what type of blends can be used with the specific type of the engine. Shipowners and operators are urged to obtain a confirmation letter from the engine makers, their dealer or supplier, explicitly providing specification of biofuels, which may be used in those engines.

Crew familiarisation and adequate training in the use of biofuels is paramount. Operators have to consider modifying their standard operating procedures.

Please refer to Annex D of TR 140:2025 (Specification for Marine Biofuel) for additional guidance on the use of marine biofuels.

The Global Centre for Maritime Decarbonisation (GCMD) has also conducted a research study (Project LOTUS Report: Project-LOTUS-Report_FINAL.pdf) and the summary of their findings are as follows (next page):

Table 2: Perception of potential impact of biodiesel on engine systems and potential mitigation measures

	Biodiesel characteristics	Potential impact to engines, fuel supply system and operations	Precautions, potential mitigation measures and note
1.0	Degradation of biodiesel		
1.1	Biodiesel degrades over time due to its susceptibility to oxidation of carbon double bonds in fatty acids.		To avoid degradation, - the fuel should be consumed as quickly as possible. - antioxidant can be added to retard degradation. Note: The rate of oxidation varies depending on the number and position of double bonds. It is difficult to predict since the reaction also depends on usage environment.
1.2	Species formed during oxidation process include		
	- peroxides and hydroperoxides -> higher corrosivity[a]	Corrosion	
	- acids, e.g., formic acid, acetic acid -> higher corrosivity	Corrosion	
	- aldehyde, ketone, lactone -> carcinogenic	Human health hazard	
	- alcohol -> lower flashpoint	Fire hazard	
	- viscous and insoluble materials -> higher viscosity	Heating and clogging	
2.0	Solvency of biodiesel		
2.1	Biodiesel is more polar compared to marine fuel. There is a concern over materials compatibility.		To avoid the impact of biodiesel solvency, - all parts and components should be checked for compatibility and routinely inspected during use. - the fuel supply system should be cleaned routinely to remove deposits to prevent fuel oil filter clogging.
2.2	Biodiesel can interact with - some metals in the fuel oil tank - elastomers, rubbers and plastics in the fuel supply system[b]	Materials incompatibility	
2.3	Given its acidity, biodiesel can inadvertently dislodge deposits in the fuel supply system.	Clogging	
3.0	Cold flow properties		
3.1	Biodiesel has poorer cold flow properties compared to conventional marine fuels. There is a concern over fuel fluidity and solidification at low temperatures.	Clogging, resulting in interruption of engine operations	To avoid these problems, - fuel oil heating may be necessary for high pour point fuels (10 ºC above pour point). - fuel obtained should have sufficiently low pour point for the usage environment. To note: - Saturated fatty acids and long-chain fatty acids that are greater than C20 in biodiesel results in a high pour point.
4.0	Hygroscopic nature of biodiesel		
4.1	Biodiesel can absorb moisture from its surroundings.		To minimise the impact of hygroscopic nature of biodiesel, - proper heating and avoiding condensation can help restrict water absorption. - fuel oil tanks should be drained of water regularly.
4.2	Moisture in biodiesel can enhance hydrolytic oxidation leading to degradation.	Refer to 1.2	
4.3	Microbial attack[c] can take place where water comes in contact with biodiesel and can form:		

	• microbial sludge	Clogging[6]	• additives can be added to mitigate the microbial growth.
	• acidic metabolic products from microbial growth	Pitting	
5.0	Other		
5.1	Biodiesel and its blends have • lower viscosity compared to residual marine fuel • lower net calorific value compared to conventional marine fuels	Leakage[6] Inability to deliver peak load	Check/ adjust fuel system, fuel oil pump capacity and fuel injection system to accommodate for viscosity and net calorific value differences.

TECHNICAL

FAQ 4: WHAT IS THE ROLE OF FUEL ADDITIVES WHEN USING BIOFUELS?

Biofuels are hygroscopic, meaning they can absorb water from the environment. The absorbed water can promote microbial growth and corrosion in the fuel system.

Water ingress may occur due to leaking heating coils and venting or structural malfunction may result in complications in processing the filtration and separation of biofuel on board. Condensation from a humid tank's headspace can also contribute to gradual water buildup.

Fuel additives can help in demulsifying water from the fuel by facilitating its removal through filtration and separation processes, which will help protect the fuel system from water-related issues.

Bacteria and fungi can thrive in the presence of water and organic matter, leading to sludge formation and fuel system blockages. Bio-distillate fuels have a higher susceptibility to microbial growth due to their chemical composition and viscosity characteristics.

Biocide additives have properties that inhibit microbial growth, maintaining cleanliness of the fuel system.

Antioxidant additives can help to prolong the biofuel storage period by interrupting the oxidation chain reaction, thereby reducing the formation of peroxides, acids, gums and insoluble sediments. However, it should be noted that oxidation is irreversible; once occurred, antioxidants cannot restore the fuel to its original condition. Antioxidant additives can only slow further deterioration.

The use and efficacy of additives, biocides, corrosion inhibitors, etc. should be evaluated between supplier and end user.

FAQ 5: WHAT ARE THE STORAGE CONCERNS OF BIOFUEL ON BOARD SHIPS?

Due to its lower viscosity and higher polarity, residual biofuel blends can dissolve sludge and sediments in the tank. This can lead to filter clogging and purification issues. Therefore, if there is a presence of sludge or sediment in the tank, it is recommended to clean the tank before bunkering new biofuel.

It is recommended to keep the biofuels at approximately 10 ºC above the Pour Point reported in the Certificate of Quality (CoQ) which is provided by the supplier and to prevent temperature swings. In case the temperature has dropped below the pour point of the fuel, it is recommended to heat the fuel to ensure that all waxes are dissolved again. It should be noted that the pour point test may not be the most accurate indicator of waxing in which case Wax Appearance Temperature or other test means needs to be deployed. Refer to TR 140:2025 Annex J – Cold Flow (Specification of marine biofuel) for more details.

During long storage periods, it is recommended to periodically send samples for analysis to check the fuel quality especially to determine if the stability of the fuel is degrading or not.

A general recommendation is to use the biofuel within 3 months.

Improper handling, prolonged storage or contamination will affect the stability of biofuels. Most often, degradation is caused by hydrolysis (in case of water ingress) and oxidation.

Should there be any signs of degradation, owners/operators are encouraged to also consult their classification societies (Class) or testing laboratories for mitigative actions. If the degradation is mild, and bunkers can still be used with some mitigative actions onboard, such as increasing filtration temperature, reducing flow rates, in-line blending with fresh bunkers, shock treatment, etc.

FAQ 5: WHAT ARE THE STORAGE CONCERNS OF BIOFUEL ON BOARD SHIPS?

A study published by NTU-MESD, suggested that the following key parameters can be used to monitor the stability of the product.

(a)Oxidation stability – the most direct indicator of whether the biodiesel has undergone degradation.
(b)FAME content – decreases as esters break down during oxidation. A measurable reduction in FAME content from nominal blend specification may indicate oxidative degradation of esters or dilution/contamination of the biodiesel component.
(c)Acid value – increases due to the formation of free fatty acids (FFAs) from ester degradation.
(d)Water content – increases due to moisture absorption which can accelerate oxidation processes.

The key storage concern for biofuels onboard ships is that their quality may change over time if they are kept too long or not properly managed. In GCMD's pilot, B24 (FAME + VLSFO) was intentionally stored in an onboard fuel tank for six months to assess its stability under actual onboard conditions. Although acid value increased over time, it remained within ISO 8217 limits under the conditions tested, indicating that the fuel remained fit for use.

These findings suggest that the blend can be stored and handled safely onboard, while reinforcing a practical rule of thumb for shipboard storage: fresh in, fresh out, supported by good storage management and routine quality monitoring. (https://gcformd.org/gcmds-project-lotus-confirms-long-term-operational-feasibility-of-b24-biofuel-blend-in-vessels/) .

TECHNICAL

FAQ 6: WHAT ARE THE OPERATIONAL GUIDELINES/BEST PRACTICE FOR THE USE BIOFUEL FROM THE ENGINE MAKERS

Guidance from the various engine makers who are SSA members can be found in the following embedded documents:

Everllence

Wartsila

Yanmar

RR MTU

Please be informed to obtain the relevant and necessary guidance from your respective engine makers.

TECHNICAL

FAQ 7: DOES A B30 BIOFUEL BLEND CONTAIN 30% FAME?

No, the number following the "B" indicates the volume percentage of the bio-content but does not necessarily equate to the actual FAME percentage. The FAME percentage depends on the bio-component used in the blend.

For instance, in an EN 14214 compliant B100 FAME product, the FAME content is at a minimum of 96.5% (mass percentage). Therefore, for a B30 VLSFO/FAME blend, the FAME percentage will be 28.95%. Refer to TR 140:2025 Annex E (Reproducibility and Repeatability of FAME Content Test Method)

For additional details refer to the paragraph in section 6.2.1.1 in the CIMAC guideline "Marine Fuels Containing FAME".

FAQ 8: WHAT ARE THE CLASS REQUIREMENTS FOR THE USE OF BIOFUEL?

Ship owners and operators need to confirm the suitability of the internal combustion engines, the installed fuel system equipment (treatment plant, filters, purifiers, etc.) and other fuel burning equipment (such as boilers) for use with the specified biofuel(s) with the respective OEMs or suppliers, typically through documentation, service letters, biofuel specifications, 'Letters of No Objection' or similar communications.

Class and fuel consultants can assist with all aspects of the required assessments for use of biofuels, including fuel analyses, implementation plans, risk assessment, etc. and preparation of the necessary supporting documents.

Where owners or operators are unable to obtain the OEM or supplier's confirmation on suitability, Class will assess applications based on the installed arrangements and proposed modifications, as applicable.

Class can facilitate the application to and communications with Flag Administration on statutory matters in their capacity as a recognised organisations (ROs).

The following documentation, as applicable, is to be submitted to Class:

- Details and particulars of the ship(s) on which the biofuel(s) will be used, including intended internal combustion engines and machinery;
- Specifications, MSDS and analyses of the proposed range of biofuel(s) or blends;
- Details and particulars of any proposed modifications to fuel storage arrangements, fuel systems and equipment, internal combustion engines; boilers, gas turbines and associated machinery;
- Arrangement of the fuel service tanks;
- Fuel system material and coating specifications;
- Copies of any OEM biofuel specifications, agreements and communications with the OEMs;
- Details of the ship implementation plan and associated assessments;
- Information on the MARPOL compliance aspects detailed under Ch 2, 2 Environment; and
- Documentation detailing any planned long-term testing and monitoring.

TECHNICAL

FAQ 8: WHAT ARE THE CLASS REQUIREMENTS FOR THE USE OF BIOFUEL?

Process Map for operators:

Approval for the use of biofuel (blend) from Flag Administration, Class and/or OEM.
↓
Risk Assessment and Ship Implementation Plan.
↓
The biofuel blend should meet ISO 8217:2024 specs and the biofuel components should meet EN 14214/ASTM D6751 or Paraffinic Fuels EN 15241 (like HVO).
↓
Supplier to provide Proof of Sustainability (PoS).
↓
Fuel analysis to be carried out by recognised laboratory.
↓
Monitor the fuel condition and performance during operations.

TECHNICAL

FAQ 9: ARE FAME-BASED BIOFUELS STABLE ACROSS THE SUPPLY CHAIN?

The Global Centre for Maritime Decarbonisation (GCMD) has conducted end-to-end supply chain trials which indicated no significant degradation of FAME, arising from autoxidation, hydrolytic oxidation or microbial contamination under standard commercial operating conditions.

FAME-based biofuels are known to be sensitive to environmental factors such as oxygen, water, trace metals and microbial contamination, which can lead to degradation through autoxidation, hydrolysis and microbial activity. In other words, fuel quality may deteriorate over time if it is not properly handled.

In Global Centre for Maritime Decarbonisation (GCMD) pilot, quality of neat FAME and FAME blends with VLSFO and HSFO were monitored over five months under commercial operating conditions, from production and storage through blending, bunkering and onboard delivery. Across the samples tested, key indicators including acid value, viscosity, calorific value and microbial contamination showed no upward trend or step-change. The results demonstrate that fuel quality was maintained throughout the monitoring period, giving confidence that today's supply chain can handle FAME and its blends without introducing critical quality concerns.

The findings offer encouraging evidence for FAME use in the marine fuels supply chain. GCMD's trial has provided pertinent data to understand the behaviour of FAME as it was handled, transported, blended, and stored across commercial supply chains over a span of five months.

The findings also complement existing results from laboratory-based studies in highlighting the importance of the environmental conditions under which testing is carried out.

Given the potential for higher adoption of biofuels, the shipping industry will need to continue to build up a crucial database to develop best practices to guide the development of biofuels use.

The full report by the GCMD (June 2024), "Tracking the Propensity of Biofuels Degradation Across the Maritime Supply Chain" is available on this webpage: https://www.gcformd.org/our-publications/?page=2&report-id=6380

FAQ 10: CAN TRADITIONAL BUNKER TANKERS BE USED FOR BIOFUELS OR BIOFUEL BLENDS IN THE NEAR FUTURE?

As per MEPC.1/Circ.917 dated 12 May 2025, conventional bunker ships may carry fuel blends with up to 30% biofuel by volume (often referenced as ≤B30), together with MARPOL Annex I cargoes (i.e., petroleum fuel oils).

Any biofuel blends in excess of B30 will need to be carried in IMO Type 2 (chemical) tankers.

Also, please refer to MPA's circular dated 6 March 2025 "CARRIAGE OF BLENDS OF BIOFUELS AND MARPOL ANNEX I CARGOES BY CONVENTIONAL BUNKER TANKERS IN THE PORT OF SINGAPORE": https://www.mpa.gov.sg/media-centre/details/port-marine-circular-no.-04-of-2025-carriage-of-blends-of-biofuels-and-marpol-annex-i-cargoes-by-conventional-bunker-tankers-in-the-port-of-singapore

The carriage of energy-rich fuels (which includes HVO) and the carriage of blends of energy-rich fuels and biofuels meeting Annex 12 of MEPC.2/Circular shall comply with MARPOL Annex I and adhere to Section 5 and 6 of MEPC.1/Circ.879 respectively. In addition, there should be an official document indicating the proper product name of the cargo to be carried as recorded in Annex 12 of MEPC.2/Circ.

This implies that a conventional oil bunker tanker can carry energy-rich fuels but – in the context of HVO – only pure (100%) HVO and blends with more than 75% HVO. Please note that Oil Discharge Monitoring Equipment should be installed in compliance with regulation 31 of MARPOL Annex I and, if the energy-rich fuel contains ethyl alcohol also a deck firefighting system needs to be installed meeting the requirements of SOLAS chapter II-2 (regulations 1.6.1 and 1.6.2).

Still, it is recommended to apply to MPA with a ship-specific enquiry prior to carrying HVO or HVO blends on conventional bunker tankers.

FAQ 11: WHAT ARE THE STATUTORY NOX REGULATIONS FOR BIOFUELS AND BIOFUEL BLENDS?

The use of biofuel blends in marine engines is subject to the NO_x emission limits that apply to fossil fuels.

Prior to bunkering and using biofuels on board, shipowners and operators are strongly recommended to seek the advice from their Flag States to ensure compliance with MARPOL Annex VI Regulation 18.3.2.2.

The Unified Interpretation (UI) of MARPOL Annex VI (MEPC.1/Circ.795/Rev.98) now considers fuel blends which contain 30% biofuel or less as "petroleum derived" and should therefore meet the requirements of Regulation 18.3.1. Assessment of the NO_x impact is thus not required.

Fuel blends with more than 30% biofuel content must meet the requirements of Regulation 18.3.2. The UI stipulates that these blends do not require any assessment of the NO_x impact providing that the engine's critical components or settings remain within those stated in the engine's approved Technical File.

Owners or operators of Singapore registered ships who wish to conduct biofuel trials that could potentially affect the NO_x emissions are advised to approach MPA for exemption via the classification society/recognised organisation of the ship.

FAQ 12: WHAT ARE IMO'S INTERIM GUIDELINES FOR THE USE BIOFUELS IN RELATION TO IMO'S DATA COLLECTION SYSTEM(DCS)

Pending the development of IMO's LCA (Life Cycle Assessment) Guidelines, MEPC.1/Circ.905 provides interim guidance on the use of biofuels under Regulation 26 (SEEMP), 27 (DCS) and 28 (CII) of MARPOL Annex VI.

Emission conversion factors (Cf) quantify the relation between fuel consumption (measured in grammes) and the emissions (also measured in grammes) based on the carbon content in the respective fuels. Default emission conversion factors are specific in Appendix 2 of Resolution MEPC.391(81).

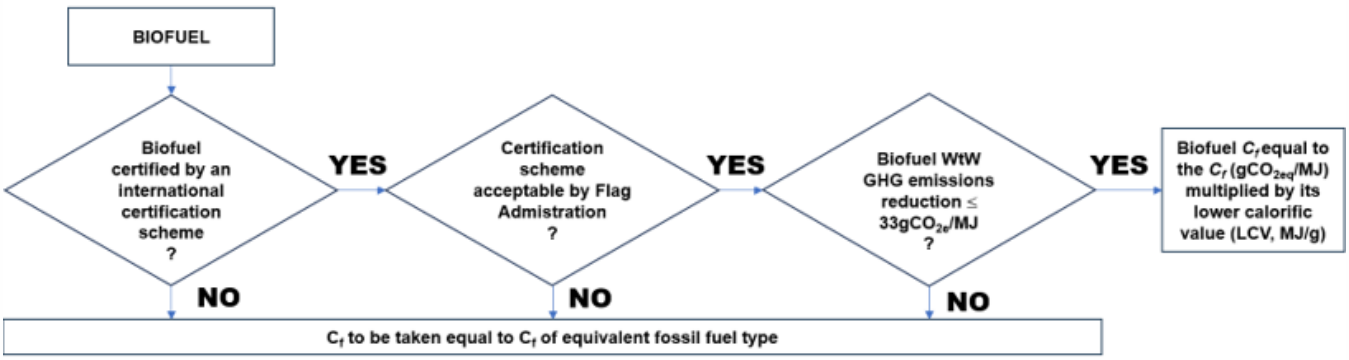
The terms "emission conversion factor", "conversion factor", "emission factor", and "carbon factor" are often used interchangeably.

The interim guidance applies to biofuels that have been certified by an international certification scheme, meeting that scheme's sustainability criteria and in addition require a well-to-wake GHG emissions reduction of at least 65% compared to the well-to-wake emissions of fossil MGO of 94 gCO_2eq/MJ (in other words: achieving an emission intensity not exceeding 33 g CO_2 eq/MJ).

- The Conversion Factor Cf may be taken as the well-to-wake GHG emissions of the biofuel (as stated in the certificate) multiplied by its lower calorific value.
- The Conversion Factor Cf cannot be less than zero.
- For blends, the Conversion Factor Cf should be based on the weighted average of the Cf for the respective amounts of fuels (by energy).

REGULATIONS

FAQ 12: WHAT ARE IMO'S INTERIM GUIDELINES FOR THE USE BIOFUELS IN RELATION TO IMO'S DATA COLLECTION SYSTEM(DCS)



A Proof of Sustainability (PoS) or similar documentation from a recognised certification scheme is to be provided with the Bunker Delivery Note (BDN) to facilitate the verification.

Example 125 tonnes B30 biofuel blend

1	2	3	4	5	6	7	8
	WtW GHG Intensity	LCV ¶	Mass	Energy ‡	Energy %	C_F	Weighted C_F (by energy)
	[gCO_{2e}/MJ]	[MJ/g]	[kg]	[MJ]	[%]	[gCO_2/gfuel]	[gCO_2/gfuel]
FAME *	23 †	0.0372	37,500	1,395,000	28.4	0.856 §	0.284 × 0.856
HFO	n/a	0.0402	87,500	3,517,500	71.6	3.114 ¶	0.716 × 3.114
Fuel blend			125,000	4,912,500			**2.473** #

* Certified by an international scheme and emission intensity not exceeding 33 gCO2e/MJ.
† Value as documented in the Proof of Sustainability.
‡ Energy value in MJ: Row 3 × Row 4 × 1,000
§ Cr value of the FAME content: Row 2 × Row 3
¶ Respective default LCV and Cr values as per Appendix of MEPC.391(81) of the LCA Guidelines
# Weighted Cr by energy: (28.4 / 100) × 0.856 + (71.6 / 100) × 3.114 = 2.473

Data collected and reported under IMO DCS is used to calculate the ship's Attained Carbon Intensity Indicator (CII).

The lower weighted fuel conversion factor achieved through the use of certified sustainable biofuels and biofuel blends will be reflected in better CII ratings.

FAQ 12: WHAT ARE IMO'S INTERIM GUIDELINES FOR THE USE BIOFUELS IN RELATION TO IMO'S DATA COLLECTION SYSTEM(DCS)

In April 2026, MEPC approved the revised interim Guidance (MEPC.1/Circ.905) which replaces the energy-weighted average method for determining the C_f of biofuel blends with a mass-weighted average approach, and to clarify that a biofuel blend should be treated as an equivalent fossil fuel type when the biogenic component is not certified. The revised interim Guidance (MEPC.1/Circ.905/Rev.1) will be applicable from 1 January 2027 to align with the beginning of the next DCS data collection period.

For B100 and HVO, the Conversion Factor C_f may be taken as the well-to-wake GHG emissions of the biofuel (as stated in the certificate) multiplied by its lower calorific value.

A Proof of Sustainability (PoS) or similar documentation from a recognised certification scheme is to be provided with the Bunker Delivery Note (BDN) to facilitate the verification.

Data collected and reported under IMO DCS is used to calculate the ship's Attained Carbon Intensity Indicator (CII).

The lower weighted fuel conversion factor achieved through the use of certified sustainable biofuels and biofuel blends will be reflected in better CII ratings.

Example 125 t B30 biofuel blend (MEPC.1/Circ.905/Rev.1)

1	2	3	4	5	6	7
	WtW GHG Intensity	LCV ¶	Mass	Mass %	C_F	Weighted C_F (by mass)
	[gCO_{2e}/MJ]	[MJ/g]	[kg]	[%]	[gCO_2/gfuel]	[gCO_2/gfuel]
FAME *	23 †	0.0372	37,500	30	0.856 §	0.30 × 0.856
HFO	n/a	0.0402	87,500	70	3.114 ¶	0.70 × 3.114
Fuel blend			125,000			**2.437#**

* Certified by an international scheme and emission intensity not exceeding 33 gCO2e/MJ.
† Value as documented in the Proof of Sustainability.
§ C_F value of the FAME content: Row 2 × Row 3
¶ Respective default LCV and C_F values as per Appendix of MEPC.391(81) of the LCA Guidelines
# Weighted C_F by mass (30 / 100) × 0.856 + (70 / 100) × 3.114 = 2.437

FAQ 13: WHAT ARE THE IMO'S APPROVED SUSTAINABILITY CERTIFICATION SCHEMES?

What are the IMO's approved sustainability certification schemes?

IMO refers in circular MEPC.1/Circ.905 to the following International Civil Aviation Organisation's (ICAO) CORSIA-approved Sustainability Certification Schemes:
- International Sustainability and Carbon Certification (ISCC) and
- Roundtable on Sustainable Biomaterials (RSB).

MEPC.1/Circ.905/Rev.1 supersedes MEPC.1/Circ.905 from 1January 2027, however the approved sustainability certification schemes remain unchanged.

FAQ 14: DO SEEMP PART II AND/OR PART III REQUIRE TO BE UPDATED WHEN A SHIP STARTS USING BIOFUEL?

Pending finalisation of the LCA Guidelines, biofuels or biofuel blends with an emission factor that is different from the equivalent fossil fuel, the following guidance applies:
oSEEMP Part II is to be updated when a vessel intends to start using biofuels or biofuel blends. Biofuels or biofuel blends have to be listed under "other" fuel types and the method of estimation of the conversion factor needs to be documented.

SEEMP Part III is to be updated when a vessel intends to start using biofuels or biofuel blends if:

1. The calculation methodology of the emission factor in the current SEEMP Part III is not suitable for biofuels (i.e. in accordance with MEPC.1/Circ.905), or

2. The use of biofuel or biofuel blend is intended as a measure in the 3-year implementation plan or part of the Plan of Corrective Actions

MEPC.1/Circ.905/Rev.1 supersedes MEPC.1/Circ.905 from 1 January 2027, based on which the IMO's SEEMP Part III will be updated.

FAQ 15: HOW SHOULD BIOFUEL BE REPORTED UNDER IMO DCS?

Pending finalisation of the LCA Guidelines, biofuels or biofuel blends with an emission conversion factor that is different from the equivalent fossil fuel, biofuel or biofuel blends are to be reported:

1. With a user-defined name under the "Other" fuels category and
2. With the conversion factor calculated according to MEPC.1/Circ.905.

There is no consensus yet on the reporting of biofuels that have a conversion factor that matches the conversion factor of their fossil equivalents.

MEPC.1/Circ.905/Rev.1 supersedes MEPC.1/Circ.905 from 1January 2027, based on which the IMO's DCS will be changed.

FAQ 16: ARE BIOFUELS CONSIDERED IN THE EEDI AND EEXI CALCULATIONS?

No. MARPOL Annex VI currently does not provide specific guidance or values of conversion factors for biofuels or biofuel blends in the Energy Efficiency Design Index (EEDI) and Energy Efficiency Existing Ship Index (EEXI) calculations. It is therefore not possible at the design stage to establish the technical carbon footprint of ships that are designed or intended to operate on biofuels (or other low-carbon or carbon-neutral fuels).

REGULATIONS

FAQ 17: WHAT HAS CHANGED TO EU MRV (MONITORING, REPORTING AND VERIFICATION)?

Under EU ETS (Emissions Trading Scheme), emissions are monitored, reported and verified through the EU MRV system.

The two key documents for EU ETS and FuelEU verification are: (i) Bunker Delivery Note - BDN and (ii) Proof of Sustainability - PoS, as issued by the certified fuel supplier to demonstrate compliance with GHG/sustainability certification rules.

In 2024 and 2025, only CO_2 emissions are within the scope of EU ETS however from 2024, methane (CH_4) and nitrous oxide (N_2O) emissions will already have to be included in the annual reporting of the total aggregated of greenhouse gas emissions. Only from 2026 onwards, the CH_4 and N_2O emissions will be included in the scope of EU ETS.

- 40% of reported 2024 CO_2 emissions at company level to be surrendered in 2025.
- 70% of reported 2025 CO_2 emissions at company level to be surrendered in 2026.
- 100% of reported 2026 CO_2 , N_2O and CH_4 emissions at company level to be surrendered in 2027.

Amendments have been introduced to EU MRV to align the MRV system with the additional reporting requirements that have come into effect with the inclusion of shipping into EU ETS.

For Fuel EU Maritime, from 1 January 2025, shipping companies, operating ships of over 5,000 GT calling at EU ports are required to meet stepped reductions in the GHG intensity of energy used onboard as shown in the table below (pg. 30), with an additional requirement to have zero at-berth emissions (for container and passenger ships) coming into effect from 2030.

Under Fuel EU Maritime, each ship should indicate the chosen method used to monitor and report the amount, type and emission factor of energy used on board, with the full years' data to be verified by 30 March of the following year.

REGULATIONS

FAQ 17: WHAT HAS CHANGED TO EU MRV (MONITORING, REPORTING AND VERIFICATION)?

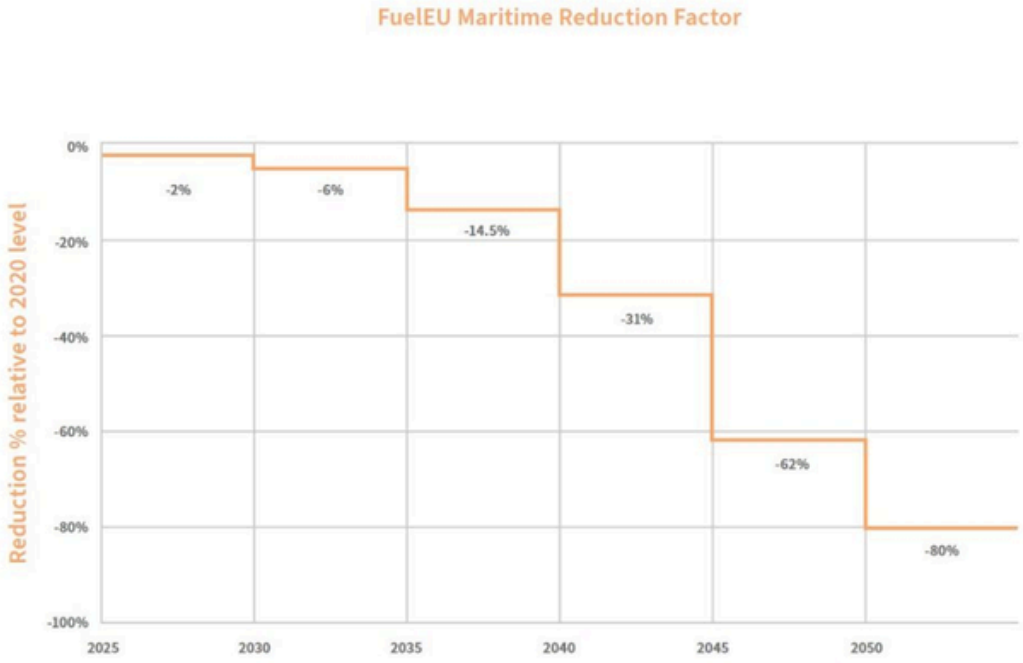
Key FuelEU Maritime Requirements

- Applies to ships >5,000 GT transporting cargo or passengers calling at EU/EEA ports, regardless of flag.
- Introduces annual well-to-wake GHG intensity limits (gCO_2eq/MJ) for energy used onboard.
- Required GHG-intensity reductions vs 2020 baseline:
  - 2% from 2025–2029
  - 6% from 2030–2034
  - 14.5% in 2035
  - 31% in 2040
  - 62% in 2045
  - 80% in 2050

- Emissions include CO_2, CH_4, and N_2O, calculated on a well-to-wake lifecycle basis.

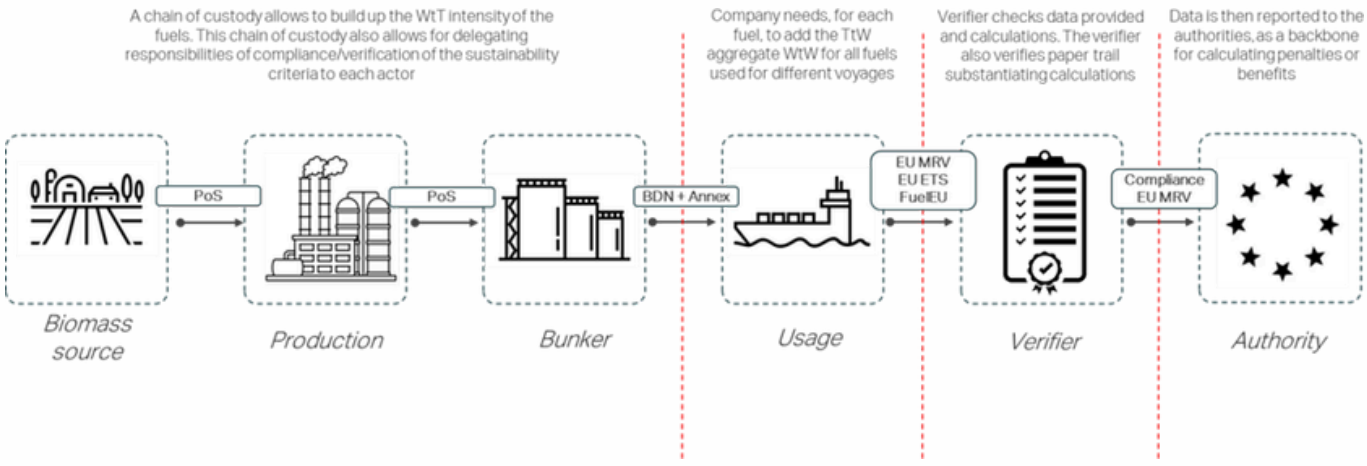
REGULATIONS

FAQ 17: WHAT HAS CHANGED TO EU MRV (MONITORING, REPORTING AND VERIFICATION)?



Above: Reduction in GHG intensity of energy used on board from 2020 levels (%).

Source: LR Fuel for Thought: Nuclear



Source: INTERCARGO - Boundary of Renewable and LCF compliance chain for FuelEU and EU ETS

REGULATIONS

FAQ 18: WHAT CO2 EMISSION FACTOR (EFCO2) APPLIES TO BIOFUEL BLENDS IN THE CONTEXT OF EU ETS?

Similar to the emission conversion factor (Cf) under IMO DCS, EU MRV uses emission factors "EF" to convert fuel consumption (mass) into emissions.

The terms "emission conversion factor", "conversion factor", "emission factor", and "carbon factor" are often used interchangeably. However, due care should be observed as the default factors and the calculation method differ between IMO and the EU regulations.

For biofuels that meet the greenhouse gas savings criteria as defined in the Renewable Energy Directive (RED III), the EF_{CO_2} of the biomass fraction of the blend shall be zero (0).

The EF_{CO_2} of biofuel blends is to be calculated as the weighted average (by mass) of the EF_{CO_2} of the respective fossil and biomass components.

It should also be noted that the emission factor for EU ETS and FuelEU Maritime is different as one looks at TtW (gCO2e/t) and the other at WtW (gCO2e/MJ) as an intensity.

Example: 125 tonnes B30 biofuel blend

1	2	3	4	5
	Mass	Mass %	EF	Weighted EF (by mass)
	[kg]	[%]	[gCO_2/gfuel]	[gCO_2/gfuel]
FAME *	37,500	30	0 *	0.30 × 0
HFO	87,500	70	3.114 ‡	0.70 × 3.114
Fuel blend	125,000			**2.180** †

* Compliant with Article 29 of RED II.
† Weighted C_F by mass: (30.0 / 100) × 0 + (70 / 100) × 3.114 = 2.180
‡ EFCO2 as per EU Regulation 2023/2776.

REGULATIONS

FAQ 19: DOES THE MRV MONITORING PLAN NEED TO BE UPDATED IN CASE A SHIP IS USING BIOFUELS?

Yes. Biofuels and biofuel blends should be recorded in the fuel type table using default names “Bio-diesel” for FAME biofuel, “HVO” for Hydrotreated Vegetable Oil and “Other biofuel” for fuels that do not fall under the two specific categories. Companies are required to specify the biofuel component.

Fuel blends should not be specified separately each time a new blend percentage is to be used. In addition to the fuel type table, companies should specify which emission sources would potentially use the biofuel as well as declare the method to determine the density of fuel.

MEPC.1/Circ.905/Rev.1 supersedes MEPC.1/Circ.905 from 1 January 2027, based on which the IMO’s DCS will be changed.

REGULATIONS

FAQ 20: WHAT ARE THE EU APPROVED SUSTAINABILITY CERTIFICATION SCHEMES?

The EU Commission has formally recognised 18 voluntary and national certification schemes.

Austrian Agricultural Certification Scheme (AACS)
Better Biomass
Biomass Biofuels voluntary scheme (2BSvs)
Bonsucro EU
CertifHy
International Sustainability and Carbon Certification (ISCC EU)
KZR INiG system
Programme for the Endorsement of Forest Certification (PEFC)
REDcert
Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme (Red Tractor)
Round Table on Responsible Soy EU RED (RTRS EU RED)
Roundtable on Sustainable Biomaterials (RSB)
Scottish Quality Farm Assured Combinable Crops (SQC)
Sustainable Biomass Program (SBP)
Trade Assurance Scheme for Combinable Crops (TASCC)
Universal Feed Assurance Scheme (UFAS)
U.S. Soy Sustainability Assurance Protocol – Renewable Energy Directive (SSAP-RED)

The full and most up-to-date list of recognised certification schemes (and applications under consideration) are available on EU Website.

The ISCC and RSB schemes are most commonly used in the shipping industry.

FAQ 21: WHAT IS THE MAIN DIFFERENCE BETWEEN FUELEU MARITIME REGULATION AND EU ETS DIRECTIVE?

EU ETS only considers emissions on a Tank-to-Wake (TtW) basis, i.e. the greenhouse gasses emitted on board the ship; in first instance only CO_2 but from 2026 onwards also CH_4 and N_2O emissions.

FuelEU Maritime on the other hand aims to gradually reduce the greenhouse gas intensity of the energy used on board ships on a full lifecycle basis, also referred to as Well-to-Wake (WtW). This includes CO_2, CH_4 and N_2O emission during extraction, cultivation, production, transportation, storage and combustion on board. In other words, "Well-to-Tank" (WtT) plus "Tank-to-Wake" emissions are taken into account.

The FuelEU Maritime regulation sets limits on the GHG intensity of ships to incentivise the uptake of zero and low carbon fuels. FuelEU Maritime is not a cap-and-trade system, nor a tax or levy. It aims to create a level playing field between cheaper fossil fuels and the more expensive low-carbon or zero-carbon alternative fuels by imposing penalties on ships that exceed the required GHG intensity limits.

FAQ 22: DO ALL BIOFUELS MEET THE FUELEU MARITIME CRITERIA?

No. Under FuelEU Maritime, biofuels need to meet GHG emissions saving criterion of the RED III directive in order to be eligible for a reduction in GHG intensity. This criterion requires a minimum 65% reduction of GHG emissions compared to the reference value of 94 gCO_2e/MJ.

Biofuels that do not meet these criteria or that are produced from food and feed crops, will need to be considered with a WtW GHG intensity identical to their fossil equivalent.

REGULATIONS

FAQ 23: HOW IS THE YEARLY AVERAGE GREENHOUSE GAS INTENSITY CALCULATED UNDER FUELEU MARITIME?

The yearly average GHG intensity [g CO_2eq/MJ] is the life cycle (WtT + TtW) emission of CO_2, CH_4 and N_2O produced by the ship in a reporting year, divided by the energy used by the ship in that year.

The yearly average GHG Intensity is calculated on EU geographical scope.

The calculation details are provided in Annex I of the FuelEU Maritime regulation and are largely based on default values defined by the EU, however Tank-to-Wake CH_4 and N_2O emissions can be based on actual values, providing these are certified by means of laboratory testing.

FAQ 24: HOW DO BIOFUELS AFFECT THE YEARLY AVERAGE GREENHOUSE GAS INTENSITY VALUE UNDER FUELEU MARITIME?

The carbon in biofuels is absorbed by plants through photosynthesis during the growth stage. When biofuels are used to produce energy, the carbon is released during combustion and returns to the atmosphere.

The emissions during combustion of the biofuel can therefore be deducted from the WtT term of the calculation to avoid double counting.

Specific reference is made to the following term in the GHG calculation:

$$WtT_{Biofuel} = E - \frac{C_F}{LCV}$$

whereby E is the emissions saving term stated in the PoS.

STANDARDS & TESTING METHODS

FAQ 25: WHAT ARE THE CHANGES TO CIRC.905 DUE TO MEPC 84?

The main change to MEPC.1/Circ.905 from MEPC 84 relates to the calculation of the carbon conversion factor (Cf) for biofuel blends used in IMO DCS and CII reporting.

From 1 January 2027, the carbon factor (Cf) for biofuel blends should be based on the weighted average of the Cf for the respective amount of fuels by mass instead of energy.

The biofuel blend should be treated as an equivalent fossil fuel type when the biogenic component is not certified.

FAQ 26: WHAT ARE THE POTENTIAL QUALITY ISSUES WITH BIOFUELS?

a. Energy Content:
Heating value of biofuels can be lower than common petroleum-based fuel oils. This will depend on the FAME content. Lower calorific value can be a challenge for the mechanically controlled engines as they are unable to adjust the intended injection timing at a given engine load. It is recommended to measure the heating value using a bomb calorimeter.

Lower calorific value will in practice:
1.Impact the need of fuel in terms of quantity required to fulfil a certain voyage (more fuel for same voyage)
2.Due to lesser heat being released, engine fuel pumps may reach maximum capacity at lower engine load compared to fossil fuel usage.

Both are more noticeable with use of B100 biofuel.

b. Corrosion:
Acid degradation products of FAME are suspected of causing damage to fuel pumps, injectors, and piston rings, leading to an acid number limit in marine fuel specifications. This needs further evaluation over time to establish the impact on ship structure and equipment.

c. Degradation:
The presence of water can increase the risk of microbial contamination, accelerating the formation of biofilms and microbial colonies which can damage fuel system components.

d. Cold Flow:
Fuel gelling occurs when molecules aggregate and form crystals at low temperatures, causing the fuel to become cloudy. With further cooling, these crystals become larger, increasing fuel viscosity and forming a gel followed by a solid. Gelling complications arise during fuel bunkering and delivery, limiting its use in cold conditions.

FAQ 26: WHAT ARE THE POTENTIAL QUALITY ISSUES WITH BIOFUELS?

e. Oxidation Stability:
Higher oxygen content in biofuels as compared to conventional fuels can also lead to lower oxidation stability, where it is more prone to degrade over time.

f. Microbial contamination
Increased potential for microbial contamination risk. Microbes can degrade biofuel which may cause excessive sludge, resulting in blocked filters and/or purifier, and acid formation which may cause increased wear on fuel pumps.

g. Material compatibility
The solvent nature of FAME may affect some materials used in the ship machinery. Particular attention is required for joints, seals and gaskets. The table below shows recommended materials for use with biofuels.

Material	Recommended	Not Recommended
Metals	Carbon steel Stainless steel Aluminium	Brass Bronze Copper Lead Tin Zinc
Elastomers	Fluorocarbon Nylon Teflon® Viton®	Nitrite rubber Neoprene Chloroprene Natural rubber Hypalon Styrene-Butadiene rubber Butadiene rubber
Polymers	Carbon filled acetal	Polyethylene Polypropylene Polyurethane Polyvinylchloride
Others	Fibreglass	

Source: CONCAWE

FAQ 26: WHAT ARE THE POTENTIAL QUALITY ISSUES WITH BIOFUELS?

h. Viscosity
Depending on the characteristics, may have lower or higher viscosity compared to conventional bunker fuel. Low viscosity can cause leakage in the fuel system and high viscosity can cause challenges in fuel atomisation and combustion. Please ensure that the Auto viscosity controller is working properly.

i. Solvent property
High residue in the bunker tank can be dislodged, which can cause filter and/or purifier blockage. It is recommended to clean the bunker tank before using it to store biofuels.

For further guidance, please refer to Annex D of TR 140:2025 "Technical reference – Specification for marine biofuel" and Annex A of ISO 8217: 2024 "Specifications of marine fuel".

STANDARDS & TESTING METHODS

FAQ 27: WHAT TESTS ARE TO BE UNDERTAKEN?

The ISO Standard 8217:2024, "Specifications of Marine Fuels", is the most recent technical specification for marine fuels by all industry participants: owners, operators, fuel suppliers and Original Equipment Manufacturers (OEM)s.

Biodiesel blends (up to 100% FAME content) in both distillate marine fuels and residual marine fuels can be evaluated using the typical testing parameters listed in ISO 8217:2024, with the additional testing parameters as summarised below to provide further evaluation of the quality of the biodiesel blends with respect to potential handling, storage, and operational issues:

Table 1: Distillate marine biofuel

Note: This table is applied complimentarily to the requirements of ISO 8217:2024. Refer to other test parameters and requirements, as provided in ISO 8217:2024.

Additional Test	Biodiesel Blends in Distillate Marine Fuels	Remarks:
Total Bacteria Count & Total Yeast & Mould	IP385	To measure risk of microbial growth.
Copper Corrosion	ATSM D130	To measure corrosiveness effect (specifically for higher FAME content in bunker).
Steel Corrosion	ASTM D665 – Procedure A	
Chemical species analysis (such as fatty acids, glycerides and glycerine)	GCMS technique	To determine presence of chemical species such as fatty acids, glycerides, glycerine, methanol and iodine.

Source: Annex H (TR 140:2025), Technical Reference – Specification for marine biofuel

FAQ 27: WHAT TESTS TO BE UNDERTAKEN?

Table 2: Residual marine biofuel

Note: This table is applied complimentarily to the requirements of ISO8217:2024. Refer to other test parameters and requirements, as provided in ISO 8217:2024.

Additional Test	**Biodiesel Blend in Residual Marine Fuel**	**Remarks:**
Copper Corrosion	ASTM D130	To measure corrosiveness effect (specifically for higher FAME content in the bunker).
Steel corrosion	ASTM D665- Procedure A	
Chemical Species Analysis (such as fatty acids; glycerides and glycerine)	GCMS Techniques	To determine presence of chemical species such as fatty acids, glycerides, glycerine, methanol & iodine.
Fuel combustion analysis (CCAI-Calculated Carbon Aromaticity Index)	IP 541	To measure ignition and combustion properties.

Source: Annex H (TR 140:2025), Technical reference – Specification for marine biofuel

FAQ 27: WHAT TESTS TO BE UNDERTAKEN?

In addition to the above suggestions, it is also recommended to evaluate the iodine value of the biocomponent, which measures the level of unsaturation. Unsaturation in biofuels refers to the presence of double bonds in the fatty acid chains of the biofuel molecules and here is how unsaturation impacts the stability of biofuels:
Unsaturation in biofuels impacts stability by:

1. Increasing Oxidation: More prone to oxidation, leading to quicker degradation and rancidity.
2. Affecting Cold Flow: Improves cold flow properties but can crystallize at low temperatures.
3. Causing Polymerization: Can form gums and sediments that clog filters and injectors.
4. Reducing Storage Stability: More susceptible to degradation during storage, forming sediments and varnish.

Classification societies and testing laboratories have done extensive trials with biofuels and can recommend their list of tests. Owner/Operators are encouraged to also consult their classification societies or testing laboratories for such advisory. Importantly, reference should also be made to "TR 140:2025 "Specification for marine biofuel".

CIMAC WG7 (Working Group 7 "Fuels") has published the following guidelines in conjunction with the release of ISO 8217:2024.
1.Marine-fuels containing FAME; A guideline for shipowners & operators
2.ISO 8217:2024 - FAQ

FAQ 28: IS EN14214 BIODIESEL SPEC A MUST FOR ALL BIOFUEL BLENDS? THERE ARE MANY FEEDSTOCKS USED FOR BIOFUEL BLENDS, HOW DO WE KNOW IF THEY ARE SUITABLE?

EN 14214 biodiesel specification is a widely recognized standard within the European Union for biodiesel quality (FAME). It ensures that the biodiesel meets certain criteria for physical and chemical properties, which are essential for consistent performance and compatibility with diesel engines. Hence, for general applicability and consistency, the ISO 8217 committee adopted EN 14214, apart from cold filter plugging point (CFPP) and sulphur requirement, for the 2024 version's bio-residual marine fuels (RF) grades.
For general adoptability and consistency, the ISO 8217 committee adopted EN 14214 (except for cloud point, cold filter plugging point and sulphur content) or ASTM D7651 (except for sulphur content) as a blend component in both distillate (DF grade) and residual fuel (RF grade).

As such, this entails a common misconception that EN 14214 is the only bio-component accepted for biofuels. It is not necessarily a must for all biofuel blends at this current market. Many reports already cited that current FAME production is not expected to cope with the marine industry demand in the near future, especially when there is a competition with the aviation sector for the use of the same feedstock for the production of Sustainable Aviation Fuel (SAF).

There are existing examples and track records of suppliers supplying non-FAME products with some receiving positive feedback from shipowners. These products include (but are not limited to) HVOs, "off-spec" FAME, Upgraded Pyrolysis Oil, Bio Heating Oil and Cashew Nutshell Liquid (CNSL).

Any non-FAME product should be tested before use (as listed below), mutually agreed by buyer and seller and with approval from the vessel's Flag state and Classification Society.

a. Review and assess documentation
b. Analysis of the product
c. Pre-trial suitability assessment
d. Oversight of sea trial data collection and review
e. Final assessment for sea trial performance
f. Medium to long term assessment for machinery endurance

FAQ 28: IS EN14214 BIODIESEL SPEC A MUST FOR ALL BIOFUEL BLENDS?THERE ARE MANY FEEDSTOCKS USED FOR BIOFUEL BLENDS, HOW DO WE KNOW IF THEY ARE SUITABLE?

Renewable diesel (HVO) used for blending should – after blending – meet the specification requirements of EN 15940 or ISO 8217:2024.

In general, suppliers do not provide test reports for the FAME component unless specifically requested or stated in the commercial agreement. Any offers based on the ISO 8217:2024 specification imply that the supplier – by default – has complied with the requirement that the FAME component used for the blend meets the EN 14214 standard (except for sulphur content, cloud point, and CFPP) or the ASTM D6751 standard (except for sulphur). This means that if any quality dispute arises, suppliers will then be obliged to provide proof of compliance.

For further guidance, please refer to Annex C of TR 140:2025 “Technical reference – Specification for marine biofuel” and Annex A of ISO 8217: 2024 “Specifications of marine fuel”.

STANDARDS & TESTING METHODS

FAQ 29:WHERE TO FIND MPA'S GUIDANCE ON BIOFUEL BUNKERING WITHIN THE PORT OF SINGAPORE?

MPA has developed a framework to allow licensed bunker suppliers to supply biofuel within the Port of Singapore to vessels provided that the conditions of the framework are adhered to:
Biofuel Bunkering | Maritime & Port Authority of Singapore (MPA)

Further to the bunker contamination incident in February 2022, MPA has issued the following Port Marine Circular:
https://www.mpa.gov.sg/media-centre/details/port-marine-circular-no.-03-of-2024-adoption-of-testing-enhancements-for-marine-fuel-intended-to-be-delivered-as-bunkers-in-the-port-of-singapore

Also, please refer to MPA's port marine circular dated 6 March 2025 "CARRIAGE OF BLENDS OF BIOFUELS AND MARPOL ANNEX I CARGOES BY CONVENTIONAL BUNKER TANKERS IN THE PORT OF SINGAPORE"
https://www.mpa.gov.sg/media-centre/details/port-marine-circular-no.-04-of-2025-carriage-of-blends-of-biofuels-and-marpol-annex-i-cargoes-by-conventional-bunker-tankers-in-the-port-of-singapore

In this context it should be noted that no COC (Chlorinated Organic Compounds) test is required for FAME-based B100 biofuel that complies with the specifications of EN 14214/ASTM D6751 as it is categorised as distillate (i.e. DF grades) under ISO 8217:2024 Section 9.1.

A COC test is required for a B100 with non-FAME component or FAME that does not meet EN 14214/ ASTM D6751 standards (except for sulphur content, cloud point and cold filter plugging point) and when the supplier has categorised the B100 biofuel as RF grade.

FAQ 30: WHICH COMPANIES ARE SUPPLYING BIOFUELS IN SINGAPORE?

The following companies (in alphabetical order) are commercially and operationally ready to supply biofuels in the Port of Singapore. Details are correct as per 20.08.2024.

Company	Contact Details
BP Singapore Pte Ltd	masaki.low@sel.bp.com Nicolas.robbins@bp.com
Cathay Marine Fuel Oil Trading Pte Ltd	sales@cathaymaritime.com.sg
Chevron Singapore Pte Ltd	gmpsgb@chevron.com
Consort Bunkers Pte Ltd	bunkers@consortbunkers.com.sg
Equatorial Marine Fuel Management Services Pte. Ltd.	jenny_liaw@emf.com.sg
Fratelli Cosulich Bunkers (S) Pte. Ltd.	bunker@cosulich.com.sg
Global Energy Trading Pte Ltd	sales@genergytrading.com
Hong Lam Fuels Pte. Ltd.	chartering-snp@honglam.com.sg han@honglam.com.sg
Kenoil Marine Services Pte Ltd	general@kenoil.com
Maersk Oil Trading Singapore Pte. Ltd.	kenny.yeo@maersk.com
Minerva Bunkering Pte Ltd	singapore@minervabunkers.com
Pegasus Maritime (S) Pte Ltd	admin@pegasus-m.com

Company	Contact Details
PetroChina International (Singapore) Pte. Ltd.	ops-fueloil@petrochina.com.sg
Shell Eastern Trading (Pte) Ltd	vincent.v.tan@shell.com
SK Energy International Pte. Ltd.	asiabunker@sk.com
TFG Marine Pte. Ltd.	singapore.sales@tfgmarine.com
Vitol Bunkers (S) Pte. Ltd.	rbb@vitol.com

COMMERCIAL

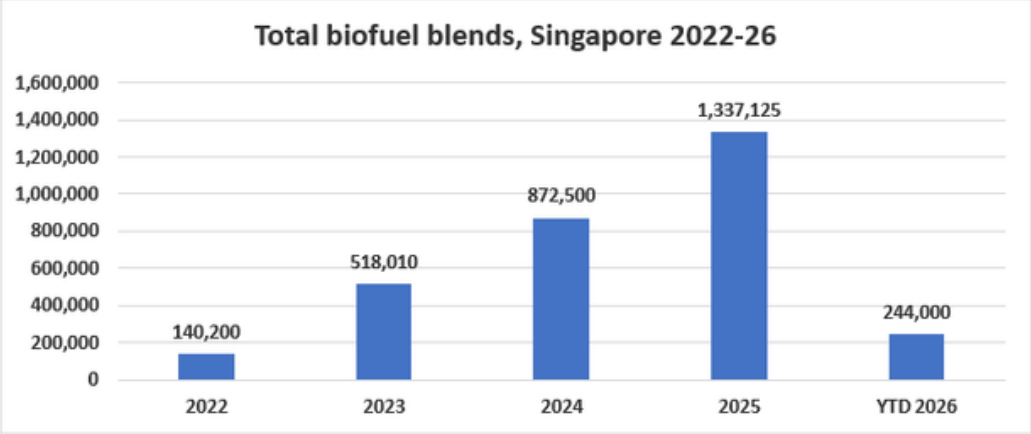
FAQ 31: WHAT IS THE OUTLOOK FOR BIOFUEL FUEL DEMAND AND AVAILABILITY?

It is estimated that total biodiesel demand in the Asia-Pacific region rose to about 19 million tonnes in 2025, according to Argus Consulting data, driven primarily by higher national blending mandates. Marine biodiesel remained a relatively small but growing segment, accounting for around 2% of regional biodiesel consumption in 2024–25, down from about 3–3.5% in 2023.

Global availability of feedstock Used Cooking Oil (UCO) stood at 11-12 million tonnes in 2025, up from 10 million tonnes in 2023. Higher collection rates coupled with increased consumption of vegetable oils resulted in this increase in UCO availability.

Close to half of these volumes were used to produce around 5 million tonnes of Used Cooking Oil Methyl Ester (UCOME), while more than 6 million tonnes of UCO were used to produce sustainable aviation fuel (SAF) and hydrotreated vegetable oil (HVO) in 2025.

More than half of UCOME produced globally, or about 370,000t of estimated volumes, were sold for use as marine biodiesel. Singapore imports the majority of its UCOME volumes from China, to be blended with different fuel oil grades into commonly known blends such as B24 and B30. UCOME can also be sold as B100 to ship-owners.



Source: Maritime & Port Authority of Singapore (MPA)

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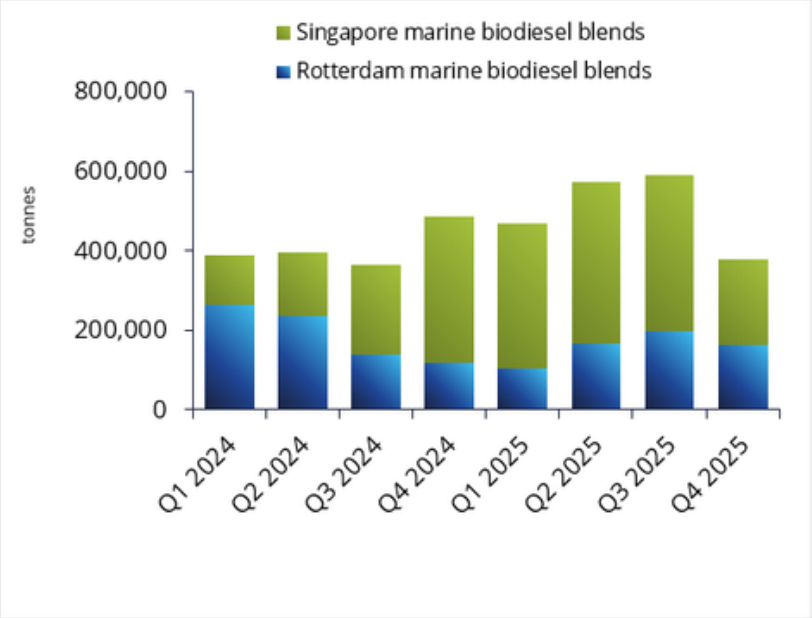
FAQ 31: WHAT IS THE OUTLOOK FOR BIOFUEL FUEL DEMAND AND AVAILABILITY?

Biodiesel is seen as the first fuel option among alternative marine fuels, given the drop-in nature of the fuel and limited or no cost of retrofitting vessels. In 2024-25, more ship-owners chose biofuels, which led to a sharp growth in volumes at key ports, while a proliferation in blends using UCOME as a blendstock was also observed globally. It was adopted not only in key hubs like Singapore and Rotterdam, but also in ports like Fujairah, Guangzhou, among others.

Global trends have also shifted as the port of Rotterdam showed signs of slower growth in 2025 for bunkering biofuels because of tighter advanced biodiesel supply and higher costs. Despite this, Rotterdam remained a key centre for EU-compliant marine biodiesel bunkering in 2025, selling around 635,000t.

Asia-Pacific emerged as the largest bunkering region for biofuels in 2025, as the port of Singapore's biofuel blends consumption rose by 53pc year-on-year to 1.33 million tonnes, outstripping Rotterdam's consumption. This increase was slightly lower but still strong compared with 2024, when the port recorded a year-on-year jump of 68pc in its biofuel bunkering consumption to 872,500t.



Source: Port data, Rotterdam and Singapore

FAQ 31: WHAT IS THE OUTLOOK FOR BIOFUEL FUEL DEMAND AND AVAILABILITY?

China's key hubs like Guangzhou and Zhoushan were poised for growth, with policy changes and higher volumes in 2024-25, but bottlenecks with blending policies persist. Zhoushan launched its first marine biofuel blending operation on 13 March 2026, becoming the first mainland Chinese port to locally blend biofuels.

Bio-bunker fuel sales totalled about 63,700t in the first quarter of 2026, with Ningbo-Zhoushan accounting for roughly 24,000t, the largest share among Chinese ports. This was a jump compared with the 37,300t estimated bunkered in all Chinese ports in 2025.

Biomethanol bunkering activity in Asia increased in 2024–25 but remained limited and highly sporadic, with demand largely confined to pilot operations and tender-driven supply. Uptake was led by liner operators such as Maersk, Evergreen and COSCO, with bunkering concentrated at Chinese ports including Shanghai, Tianjin and Shenzhen.

Singapore emerged as a secondary supply point, with bunker suppliers participating in regional tenders but facing cost disadvantages compared with Chinese ports, limiting volumes mainly to initial trials. Despite new Chinese biomethanol capacity and expanding port infrastructure, biomethanol uptake continued to lag compared with UCOME blends, constrained by higher costs, limited vessel availability and regulatory uncertainty, positioning it as a medium-term transition fuel rather than a near-term compliance option.

Looking ahead, the most important factor for growth in biofuels adoption is policymaking by the European Union (EU) and the International Maritime Organization (IMO).

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FuelEU Maritime has emerged as the primary near-term driver of marine biodiesel demand, with the regulation coming into force from January 2025. FuelEU requires ships calling at EU ports to progressively reduce the greenhouse gas (GHG) intensity of the energy they use on a well-to-wake basis. FuelEU has shifted bunker procurement from price-only optimisation toward compliance-driven sourcing, with shipowners increasingly willing to absorb higher bio-blend costs to avoid penalties or pooling complexity.

This has supported sustained premiums for bio-blends over conventional fuels like very-low sulphur fuel oil (VLSFO), even during periods of weaker overall bunkering demand. At the same time, there has been increased competition for certified UCOME and advanced fatty acid methyl ester (FAME) feedstocks, as maritime demand has begun to overlap with road transport and aviation markets for biofuels, thus tightening supply and increasing price volatility.

By contrast, the IMO's net-zero framework (NZF), which was deferred in October 2025, has had a more limited impact on near-term demand. Shipowners have largely treated the IMO process as a longer-term directional signal, rather than a trigger for immediate fuel switching.

Taken together, bio-bunker demand today is being shaped far more by EU regulations than by global IMO policies. FuelEU has created a tangible, enforceable compliance need that has directly lifted bio-blend bunkering at key hubs, while the IMO process continues to influence expectations around future fuel pathways without yet translating into firm, global bio-bunker demand.

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FAQ 32: HOW ARE BIOFUELS PRICED COMPARED TO VLSFO?

Marine biodiesel pricing in Asia over 2024–25 was characterised by firmness despite uneven demand, reflecting its increasingly compliance-driven nature rather than underlying bunkering activity. B24 and B30 prices in Singapore and south China move largely in line with crude and VLSFO cargo markets, underscoring the dominance of an energy-led pricing structure rather than biofuel-specific fundamentals. During periods of higher crude prices in mid- and late-2024, biofuel blend prices rose even as spot bunkering activity remained thin, highlighting limited price elasticity on the downside.

Premiums for blends over VLSFO remained structurally elevated at low to mid $200/t over cargo prices throughout 2024–25, particularly in Singapore, as buyers were mainly shipowners exposed to EU compliance requirements. Purchasing decisions were driven by regulatory exposure rather than arbitrage, allowing suppliers to preserve delivered premiums even when overall bunker demand softened. Price corrections were typically expressed through narrower premiums rather than outright price declines.

Throughout 2024–25, Chinese UCOME values remained broadly range-bound, with sellers anchoring offers to European netbacks and feedstock costs. Weak spot liquidity limited upside, but the absence of sustained selling pressure capped downside, preventing significant falls in marine biodiesel prices even during demand lulls. This reinforced a market structure in which biofuel blend prices were supported more by cost floors and compliance positioning than by consumption growth.

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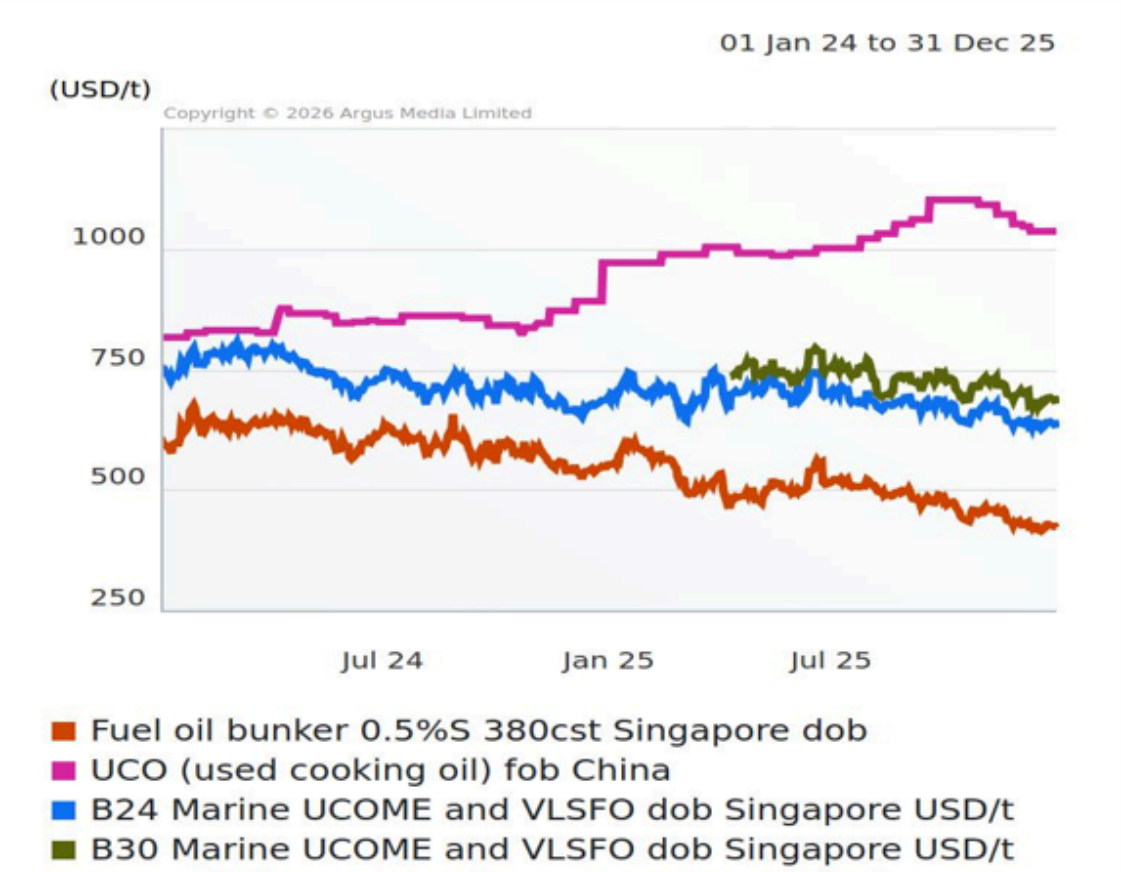
FAQ 32: HOW ARE BIOFUELS PRICED COMPARED TO VLSFO?



Source: Argus Media

FAQ 33: ARE THERE ANY INCENTIVES IN SINGAPORE FOR OPERATORS TO BUNKER AND USE BIOFUELS?

The Maritime Singapore Green Initiative (MSGI) seeks to reduce the environmental impact of shipping and related activities and to promote clean and green shipping in Singapore. In 2011, the Maritime and Port Authority of Singapore (MPA) pledged to invest up to S$100 million over 5 years in the MSGI. Enhancements to the MSGI were made in 2013, 2019 and 2022, to further encourage companies to adopt environmentally friendly shipping practices.

In Singapore, MPA in 2024 updated various green initiatives and incentives under the Maritime Singapore Green Initiative (MSGI) to encourage early adoption of zero and near-zero emission technologies and fuels:
I.Green Ship Programme (GSP)
II.Green Port Infrastructure Programme (GPIP)
III.Green Craft Programme (GCP)
IV.Green Energy and Technology Programme (GETP)
V.Green Awareness Programme (GAP)

These are voluntary programmes designed to recognise and provide incentives to companies that adopt clean and green shipping practices and port operations. The initiative underscores Singapore's commitment as a responsible flag and port state to clean and green shipping.

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FAQ 33: ARE THERE ANY INCENTIVES IN SINGAPORE FOR OPERATORS TO BUNKER AND USE BIOFUELS?

Green Ship Programme (GSP)

From 1 January 2025 until 31 December 2027, MPA will provide up to 100% port dues concession to ocean-going vessels calling at the Port of Singapore which:

- Use of zero-emission fuel/technology (e.g. hydrogen, full electrification, hybrid of hydrogen fuel cell and electrification etc.);
- Use of zero-carbon fuel (e.g. ammonia with pilot fuel capped at 25% with ammonia slip/NO_x/N_2O addressed, B100 biofuel, green methanol etc.);
- Use of low-carbon content fuels with CF value ≤ 1.375 (e.g. methanol), or using LNG in engine with methane slip addressed to max 1%, or biofuels B50 and above up to B99; or
- Use of low carbon content fuels with 1.375 < CF value ≤ 2.750, e.g. LNG (in engine without methane slip addressed), or biofuels B24 and above up to B49.

Please refer to the Shipping Circular No. 12 of 2024 and Port Marine Circular No. 13 of 2024 for more information on the GSP.

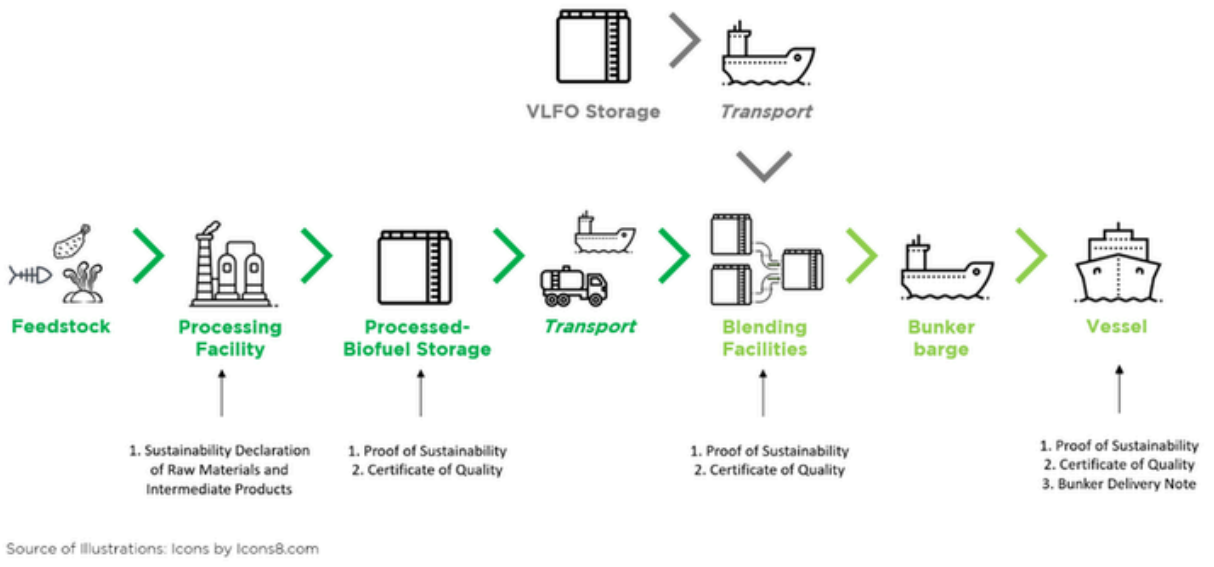
Green Energy and Technology Programme (GETP)

The GETP aims to encourage Singapore-based maritime companies to develop and/or conduct pilot trials for green technologies that can help vessels meet the 2023 IMO Strategy on Reduction of GHG Emissions from Ships targets.

For more information on the MPA's green initiatives listed above, please refer to MPA's website:https://www.mpa.gov.sg/maritime-singapore/sustainability/maritime-singapore-green-initiative

COMMERCIAL

FAQ 34: WHAT IS THE TYPICAL COMMERCIAL FLOW OF BIOFUELS?



Source of illustrations: Icons by Icons8.com

Above is a typical commercial flow for biofuel. The quantity allocation for the Proof of Sustainability (PoS) is usually determined by the delivered quantity stated in the Bunker Delivery Note (BDN). Unlike a BDN, which is issued immediately upon delivery, the PoS cannot be issued right away. This is because it involves the calculation of the biofuel quantity allocation by the supplier. Due to the involvement of various operations and counterparties throughout the supply chain, there is a lead time for issuing the PoS to the end customer.

Several factors impact this lead time, including internal compliance checks, accountability trails, approval processes, and the involvement of additional traders or brokers in the supply chain. Depending on how suppliers blend their biofuels, it is possible for a single delivery to receive multiple PoS. For example, UCOME may be blended from two different origins or have different GHG emission values, resulting in more than one PoS for the same delivery.

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FAQ 34: WHAT IS THE TYPICAL COMMERCIAL FLOW OF BIOFUELS?

The typical lead time for issuance of the PoS to the end user is approximately 30 days after the date of delivery and this is based on a new batch of feedstock. Subsequent deliveries from the same batch will be faster.

Under ISCC's GHG methodology, transport between two ISCC-certified operators is also included whether or not the logistic provider is certified. Only the final transport to receiver is excluded.

If after blending and PoS being issued, and the product is again transported via truck, vessel to another storage facility prior to delivery to final receiver - then, a new PoS needs to be issued if transported to the other storage facility.

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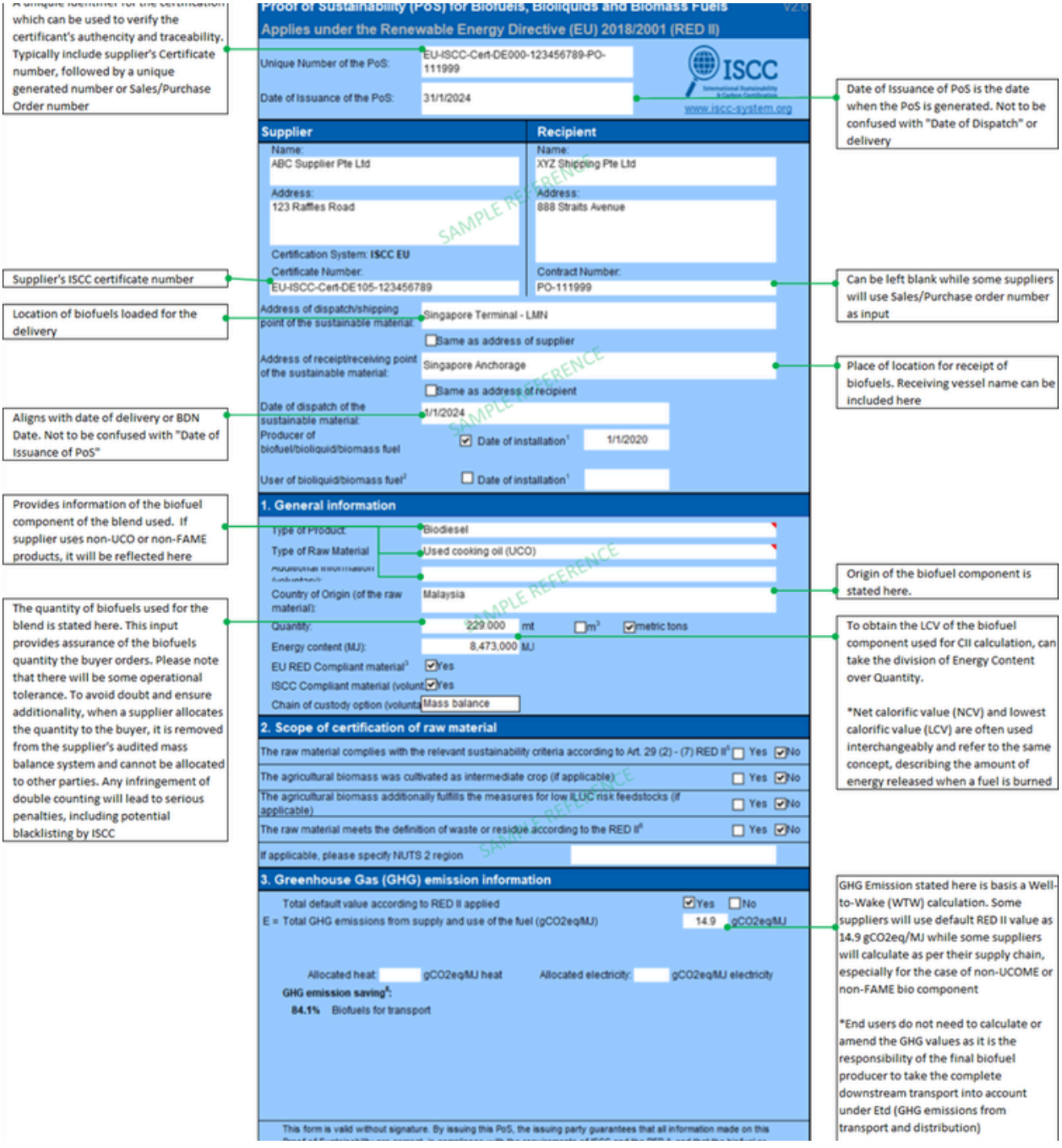
FAQ 35: WHAT INFORMATION IS TYPICALLY INCLUDED IN THE PROOF OF SUSTAINABILITY (POS)



ANNEX A-LIST OF ABBREVIATIONS

ABS	American Bureau of Shipping
ASTM	American Society for Testing and Materials
BDN	Bunker Delivery Note
CCAI	Calculated Carbon Aromaticity Index
CF or Cf	Emission Conversion Factor
CFPP	Cold Filter Plugging Point
CH_4	Methane
CII	Carbon Intensity Indicator
CIMAC	Conseil International des Machines à Combustion (International Council on Combustion Engines)
CNSL	Cashew Nutshell Liquid
CO_2	Carbon Dioxide
COC	Chlorinated Organic Compounds
COQ	Certificate of Quality
CORISIA	Carbon Offsetting and Reduction Scheme for International Aviation
DCS	Data Collection System
DF	Distillate Fuel
DME	Dimethyl Ether
EEDI	Energy Efficiency Design Index
EEXI	Energy Efficiency eXisting ship design Index
EF_{CO_2}	CO_2 Emission Factor
EN	European Norm
ETS	Emission Trading Scheme
EU	European Union
FAME	Fatty Acid Methyl Ester
FAQ	Frequently Asked Questions
FOG	Fats, Oils and Greases
FT	Fisher-Tropsch
GCMD	Global Center for Maritime Decarbonisation
GCMS	Gas Chromatography / Mass Spectrometry
GHG	Greenhouse Gas
GM	Genetically Modified
HEFA	Hydrotreated Esters and Fatty Acids
HTL	Hydrothermal Liquefaction
HVO	Hydrogenated Vegetable Oil

ANNEX A-LIST OF ABBREVIATIONS

ICAO	International Civil Aviation Organization
IBC	International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals
IEA	International Energy Agency
IMA	International Maritime Organisation
IP	International Petroleum - Standard Test Methods for Analysis and Testing of Petroleum and Related Products, and British Standard Parts
ISCC	International Sustainability and Carbon Certification
ISO	International Standards Organisation
LBM	Liquefied Biomethane
LCA	Life Cycle Assessment
LCV	Lower Calorific Value
LNG	Liquified Natural Gas
MARPOL	The International Convention for the Prevention of Pollution from Ships
MEPC	Marine Environment Protection Committee
MESD	Maritime Energy and Sustainable Development Centre of Excellence
MPA	Maritime and Port Authority of Singapore
MRV	Measurement, Reporting and Verification
MSDS	Material Safety Data Sheet
	Nitrous Oxide
N_2O	Nitrogen oxides
NTU	Nanyang Technological University
OEM	Original Equipment Manufacturer
PoS	Proof of Sustainability
RED	Renewable Energy Directive
RF	Residual Fuel
RO	Recognised Organisation
RSB	Roundtable on Sustainable Biomaterials
SAF	Sustainable Aviation Fuel
SEEMP	Ship Energy Efficiency Management Plan
SOx	Sulphur oxides
SSA	Singapore Shipping Association
SVO	Straight Vegetable Oil

ANNEX A-LIST OF ABBREVIATIONS

TtW	Tank to Wake
UCO	Used Cooking Oil
UCOME	Used Cooking Oils Methyl Esters
VLSFO	Very Low Sulphur Fuel Oil
WA	Workshop Agreement
WtT	Well to Tank
WtW	Well to Wake

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