AUGUST 2024

SINGAPORE SHIPPING ASSOCIATION

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

AUGUST 2024

PREAMBLE

The Singapore Shipping Association (SSA) issued the first version of this Biofuel FAQ in August 2022, at a time when the trialling and use of biofuels was gaining momentum. In view of the growing relevance of biofuels – not only in the Port of Singapore – as well as technical and regulatory developments, the SSA Marine Fuels Committee deemed it timely to issue an update of this FAQ.

SSA's 2024 Marine Fuel Survey confirmed an increased adoption of biofuels among its members, while also the monthly Singapore bunker sales reports of the Maritime and Port Authority of Singapore (MPA) indicate an upward trend in biofuel demand.

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 regards 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 in 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.

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

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Argus Media Singapore Group Pte Ltd
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RINA Hong Kong Limited Singapore Branch
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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).

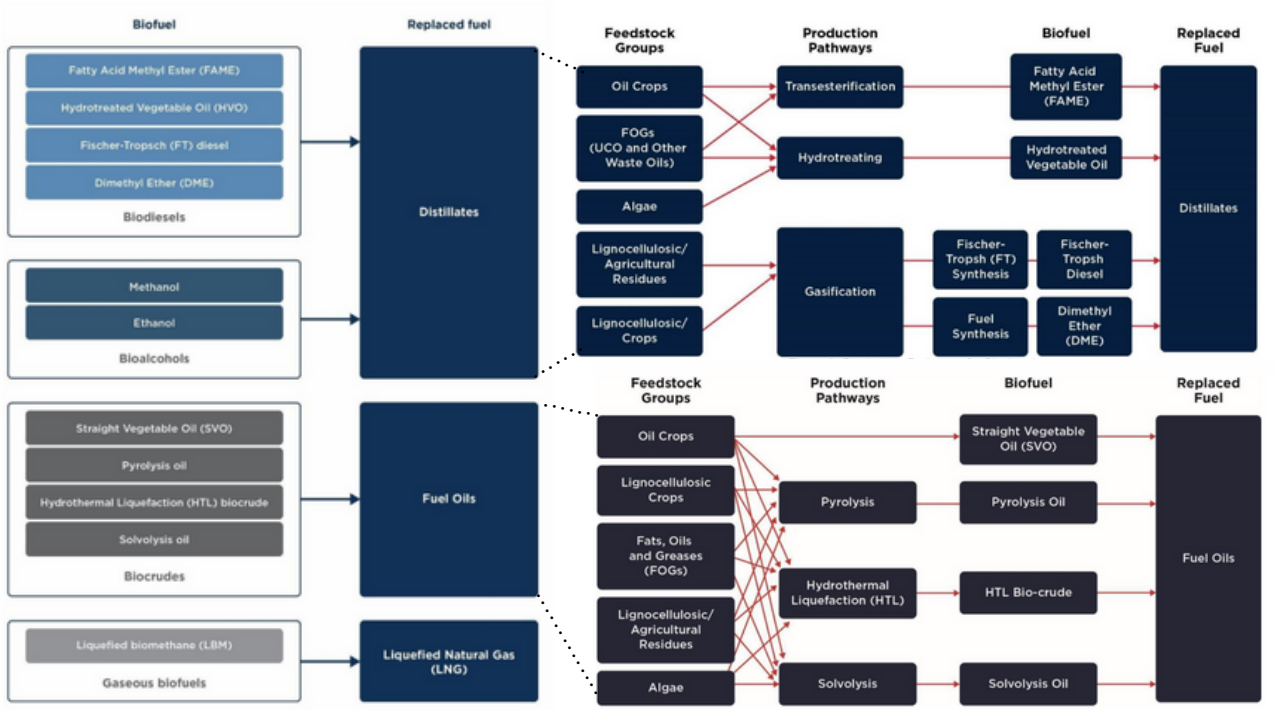
Biofuels are commonly classified based on the feedstocks and production pathways as follows:

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 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.



Source EMSA: https://www.emsa.europa.eu/newsroom/latest-news/item/4834-update-on-potential-of-biofuels-for-shipping.html

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 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 point above 60 °C.

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

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

e. On board trials have so far showed good operating results.

TECHNICAL

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. See also FAQ 5.

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. Ingress of water and a high oxygen content in biofuels increase the risk of microbial growth. See also FAQ 4.

d. Potential compatibility issues when mixing with fossil fuels or other biofuels. It is generally advised to clean 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. See also FAQ 4.

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

g. It is recommended that all ISO 8217:2024 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 get 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 biofuels is paramount. Operators have to consider modifying their standard operating procedures.

TECHNICAL

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

Biofuels are hygroscopic, meaning they can absorb water from the environment. This can potentially lead to microbial growth and corrosion in the fuel system.

Water ingress from leaking heating coils or separator malfunction may result in complication's in processing the filtration and separation of biofuel on board.

Fuel additives can help in demulsifying water from the fuel, facilitating its removal through filtration and separation processes, thereby protecting 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.

Some non-biocide additives have properties that inhibit microbial growth, maintaining cleanliness of the fuel system.

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

TECHNICAL

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 ^{0}C 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 most accurate indicator of waxing in which case Wax Appearance Temperature or other test means needs to be deployed. (Refer to more details to WA2:2022 Workshop Agreement – Specification of marine biofuel by Enterprise Singapore.)

During the storage period it is recommended to regularly check for free water by using either a drain valve or water finding paste.

A general recommendation is to use the biofuel within 3 to 6 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.

TECHNICAL

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

Should there be any signs of degradation, owner/operators are encouraged to also consult their class societies 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.

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

1.Kinematic viscosity – increases as oxidation progresses
2.Water content – higher content leads to degradation
3.Acid value – quantity of free fatty acids (FFAs) in the biodiesel
4.Oxidation stability – susceptible to oxidation

TECHNICAL

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

Guidance from the various engine makers can be found in the following embedded documents.

Cummins

MAN

CAT

Wartsila

Yanmar

RR MTU

WinGD

Volvo Penta

TECHNICAL

FAQ 7: DOES A B24 BIOFUEL BLEND CONTAIN 24% 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 EN14214 compliant B100 FAME product, the FAME content is at a minimum of 96% (mass percentage). Therefore, for a B24 VLSFO/FAME blend, considering operational variances, the FAME percentage will typically range from around 22% to nearly 24%. For such biofuel blends, its renewable energy content can be determined by means of the FAME test as specified in ISO 8217:2024.

Conversely, if the bio-component used for the B24 blend is a non-FAME or a non-EN14214 compliant FAME, the tested FAME percentage can range from 0% to 21% but still fulfils the classification of a B24. Refer also to FAQ 27. Its renewable energy content is supported by the quantity allocated by Proof of Sustainability (PoS) certification. Alternatively, or for additional assurance, a Radiocarbon Dating (Carbon-14 Analysis) can be considered. This method can differentiate between fossil-derived carbon and renewable bio-derived carbon based on the presence of carbon-14 isotope. Such testing however, is currently not available in Singapore.

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

TECHNICAL

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 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 ISO8217:2024 specs and the biofuel components should meet EN14214/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 operations conditions.

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 is 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/

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

While discussions at IMO have been initiated, it should be noted that – until amendments to MARPOL Annex I and the IBC Code are in place – biofuel blends delivered in Singapore by seagoing oil tankers remain limited to B24.

Any biofuel blends in excess of B25 will need to be carried in IMO Type 2 (chemical) tankers.

REGULATIONS

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 NOx emission limits that apply to fossil fuels.

Prior to bunkering and the use biofuels on board shipowners and operators are strongly recommended to seek the advice from their Flag States to ensure compliance with Regulation 13 of MARPOL Annex VI.

The Unified Interpretation (UI) of MARPOL Annex VI (MEPC.1/Circ.795/Rev.8) 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 NOx 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 NOx 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 NOx 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).

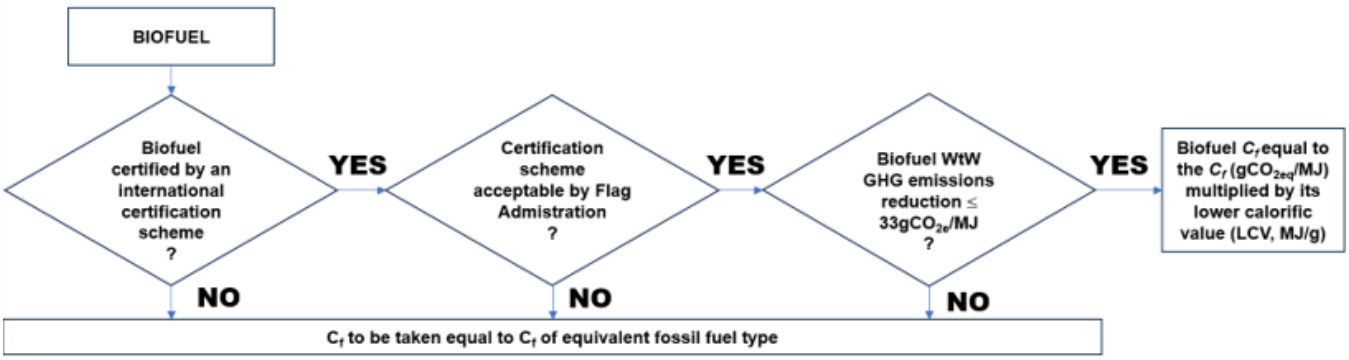
The terms "emission conversion factor", "conversion factor", "emission factor", and "carbon factor" are often used interchangeably. However, due care should be observed as the default factors and the calculation method differ between IMO and the EU regulations.

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_2e/MJ (in other words: achieving an emission intensity not exceeding 33 gCO_2e/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 [gCO_{2e}/MJ]	LCV ¶ [MJ/g]	Mass [kg]	Energy ‡ [MJ]	Energy % [%]	C_F [gCO_2/gfuel]	Weighted C_F (by energy) [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
§ 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 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.

REGULATIONS

FAQ 13: 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).

REGULATIONS

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:

- SEEMP Part II is to be updated when a vessel intends to start using biofuels of biofuel blends. Biofuels or biofuel blends have to be listed under "other' fuel types and the method of estimation of the conversion factor need to be documented.

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

    a. 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

    b. 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

REGULATIONS

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, the biofuel or biofuel blends are to be reported:

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

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

REGULATIONS

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 of biofuels or biofuel blends in the EEDI and EEXI calculations. It is therefore at the design stage not possible to establish the technical carbon footprint of ships that are designed 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.

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.

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.

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 II), 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.

Example: 125 tonnes B30 biofuel blend

1	2	3	4	5
	Mass [kg]	Mass % [%]	EF [$gCO_2/gfuel$]	Weighted EF (by mass) [$gCO_2/gfuel$]
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 not falling under the two specific categories. Companies require 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 will potentially use the biofuel as well as declare the method to determine density of fuel.

REGULATIONS

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

The EU Commission has formally recognised 15 voluntary and national certification schemes.

- Biomass Biofuels voluntary scheme (2BSvs)
- Better Biomass
- Bonsucro EU
- International Sustainability and Carbon Certification (ISCC EU)
- KZR INiG system
- REDcert
- Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme (Red Tractor)
- Roundtable of Sustainable Biofuels EU RED (RSB EU RED)
- Round Table on Responsible Soy EU RED (RTRS EU RED)
- Scottish Quality Farm Assured Combinable Crops (SQC)
- Trade Assurance Scheme for Combinable Crops (TASCC)
- Universal Feed Assurance Scheme (UFAS)
- Sustainable Resources (SURE) voluntary scheme
- Sustainable Biomass Program (SBP)
- Austrian Agricultural Certification Scheme (AACS)

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

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

REGULATIONS

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.

REGULATIONS

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 II 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_2 eq/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.

FAQ 25: 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 caloric 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 bomb calorie meter.

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 less heat release engine fuel pumps may reach maximum capacity at lower engine load compared to use of fossil fuel.

Both are more noticeable with use of B100.

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 to 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 temperature, leading 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.

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

STANDARDS & TESTING METHODS

FAQ 26: WHAT TESTS TO BE UNDERTAKEN?

TThe 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 engine OEMs.

Biodiesel blends (up to 100% FAME content) in both distillate marine fuel and residual marine fuel 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 I: Distillate 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 Blends in Distillate Marine Fuel**	**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	

FAQ 26: 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.

In addition to 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.

FAQ 26: WHAT TESTS TO BE UNDERTAKEN?

Classification societies and testing laboratories have done extensive trials with biofuels and can recommend their version of recommended 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 WA2:2022 "Workshop Agreement Specification of Marine Biofuels" issued by Enterprise Singapore. An updated version of this standard will be issued in the course of 2024.

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

STANDARDS & TESTING METHODS

FAQ 27: IS EN14214 BIODIESEL SPEC A MUST FOR ALL BIOFUEL BLENDS?

EN14214 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 adoptability and consistency, the ISO8217 committee adopted EN14214, apart from cold filter plugging point (CFPP) and sulphur requirement, for the 2024 version's bio-residual marine fuels (RF) grades.

As such, this entails a common misconception that EN14214 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 many potential and existing track records of suppliers, supplying non-FAME products outside Singapore and received positive feedback from shipowners. These products include (but are not limited to) HVOs, "offspec" 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.

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

STANDARDS & TESTING METHODS

FAQ 28: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 ISO8217:2024.

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 ISO8217:2024 specification imply that the supplier – by default – has complied with the requirement that the FAME component used for the blend meets the EN14214 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.

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

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 EN14214/ASTM D6751 as it is categorized as distillate (i.e. DF grades) under ISO8217:2024 Section 9.1.

A COC test is required for a B100 with non-FAME component or FAME that does not meet EN14214/ ASTM D6751 standards (except for sulphur content, Cloud Point and Cold Filter Plugging Point), and supplier is categorizing the B100 as RF grade.

COMMERCIAL

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	alex.pattison@bp.com masaki.low@sel.bp.com
Cathay Marine Fuel Oil Trading Pte Ltd	sales@cathaymaritime.com.sg
Chevron Singapore Pte Ltd	gmpsgb@chevron.com
CNC Petroleum Pte Ltd	patrick.ng@pseg.com.sg
Exxonmobil Asia Pacific Pte Ltd	DS-FL-MF-OPS@exxonmobil.com
Equatorial Marine Fuel Management Services Pte Ltd	bunkers@emf.com.sg
Fratelli Cosulich Bunkers (S) Pte Ltd	bunker@cosulich.com.sg newfuels@cosulish.com.sg
Global Energy Trading Pte Ltd	munee_chow@genergytrading.com
Global Marine Transportation Pte Ltd	gmtsales@globalmarinetpt.com
Golden Island Diesel Oil Trading Pte Ltd	bunker@golden-island.com.sg
GoodFuels Asia Pacific Pte Ltd	info@goodfuels.com
Kenoil Marine Services Pte Ltd	kkkam@kenoil.com

Company	Contact Details
Maersk Oil Trading Singapore Pte Ltd	enny.yeo@maersk.com
Minerva Bunkering Pte Ltd	veronicalow@minervabunkering.com
PetroChina International (S) Pte Ltd	wong-tetkeong@petrochina.com.sg
Shell Eastern Trading Pte Ltd	vincent.v.tan@shell.com
TFG Marine Pte Ltd	sooyong.koo@trafigura.com
TotalEnergies Marine Fuels Pte Ltd	jerry.lim@totsa.com
Vitol Bunkers	xsinenq@vitol.com

COMMERCIAL

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

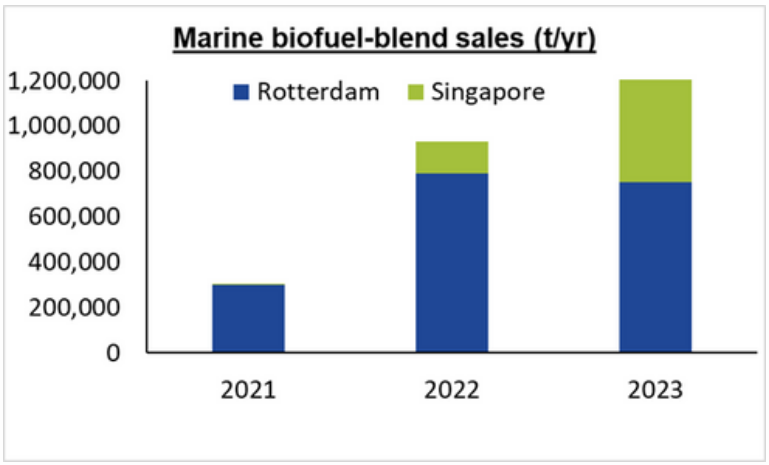
Total biodiesel demand in the Asia Pacific region is expected to reach 11.35 million tonnes in 2024, a 7.3% rise from 2023. It is estimated that demand for marine biodiesel made up about 3 - 3.5% of total biodiesel consumption in 2023.

Marine biodiesel makes up a very small portion of the total biofuels consumption globally, but the shipping industry is expected to see a sharp rise in consumption given the drop-in nature of biofuels.

The usage of fatty acid methyl ester (FAME)-based biofuels for shipping in Asia is expected to rise in 2024 and coming years, driven by the need to cut greenhouse gas (GHG) emissions for ships. This is enforced through mandates and compliance measures initiated by the International Maritime Organization (IMO) and the European Union (EU).

To comply with the EU emissions trading system (ETS) and the Carbon Intensity Index (CII) ratings, ship owners have started using FAME-based bio-blends to run ships heading to EU from the Asia-Pacific region. This increased demand for marine biodiesel, with consumption at the key ports of Singapore and Rotterdam hitting record-highs of about 1.2 million tonnes in 2023. Expectations are firm that consumption volumes will rise further this year. Demand from ports in China, South Korea and other Asian countries is also expected to emerge as more Asian ship owners turn to biofuel blends.

SOURCE: ARGUS

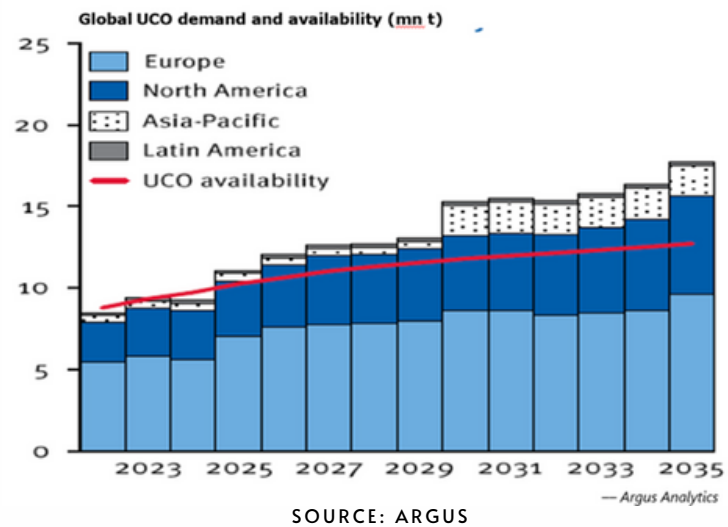


COMMERCIAL

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

Demand for biofuels from competing sectors, like road transportation and aviation, has put pressure on existing limited availability of used cooking oil (UCO) and used cooking oil methyl ester (UCOME). Global consumption of UCOME stood at an estimated 10 million tonnes in 2023.

UCO is a feedstock for biofuels and its global availability stood at close to 10 million tonnes in 2023 and is projected to reach an estimated 15 million tonnes by 2030-31. UCO collection process has been a key bottleneck in increasing supplies, with efforts underway to garner investments and build infrastructure for the collection supply chain. Countries like India, Pakistan, Indonesia are potential growth regions for such collection centres.



SOURCE: ARGUS

As the industry grapples with these challenges in increasing feedstock availability, ship owners are also looking at other alternatives like bio-methanol to fuel ships.

Production of bio-methanol is however still extremely limited, with only a few producers supplying the marine sector. Total production of bio-methanol from new projects is expected to reach about 900,000 tonnes/year globally by 2026-28, based on the existing list of bio-methanol projects compiled by Argus.

COMMERCIAL

FAQ 32: HOW ARE BIOFUELS PRICED COMPARED TO VLSFO?

Biofuels blends are still priced at a premium compared to fossil VLSFO. Pricing of biofuel blends is predominantly determined by the prices of bio feedstock component.

With increasing demand for biofuels in Singapore and a maturing supply chain, B24 UCOME-based VLSFO blends are gradually becoming commoditized.

As of mid-2024, the premium of a B24 blend over conventional VLSFO is expected to hover around 20-30%, down from 40% in 2022.

COMMERCIAL

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

Aligning with the global move towards renewable, low-carbon sources of energy such as biofuels and biomass, governments worldwide are setting ambitious targets for recycling, use of non-virgin materials and renewable energy, as well as offering tax incentives to companies that meet or exceed sustainability goals.

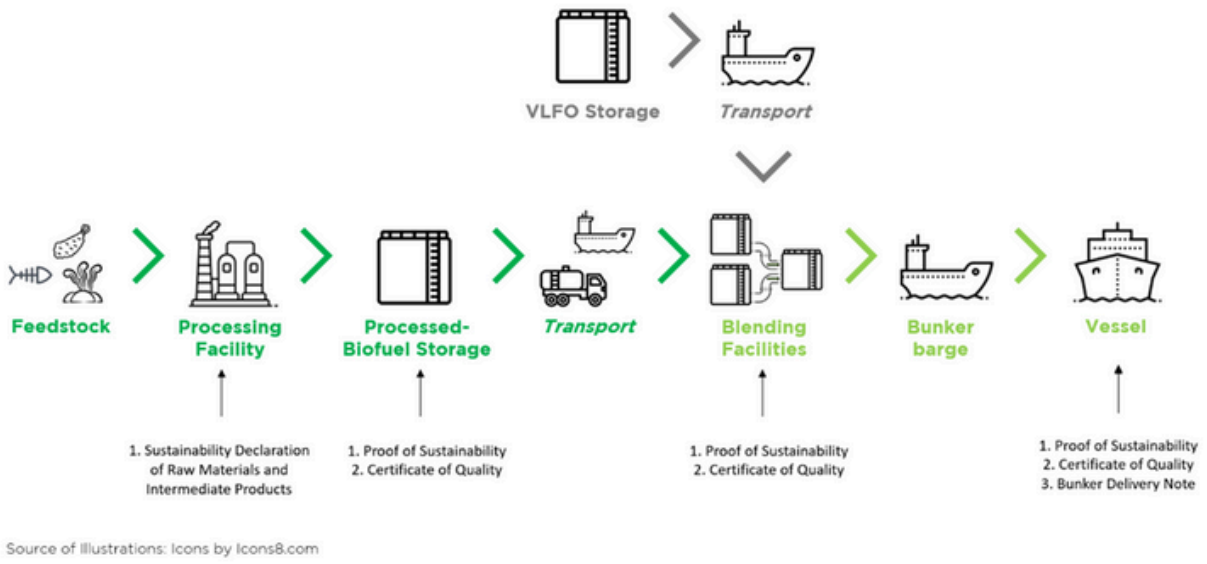
In Singapore, MPA's Green Port Programme (GPP) encourages ocean going vessels calling the Port of Singapore to operate more environmentally sustainable. Under the GPP, ocean going vessels – calling at the port of Singapore – using biofuel blends with more than 20% biofuel content are eligible for a 25% reduction in port dues.

MPA's Green Ship Programme (GSP) is in place to reward shipowners and operators of Singapore flagged ships who voluntarily adopt solutions that enable ships to exceed environmental regulatory standards set by the IMO. It should be noted that this programme ends on 31 December 2024 and currently does not incentivise the use of biofuels. MPA is currently reviewing the GSP and is expected to announce more details in the course of 2024.

The Green Energy & Technology Programme aims to encourage Singapore-based maritime companies to develop / conduct pilot trials for green technologies that can help vessels meet Maritime Singapore Decarbonisation Blueprint: Working Towards 2050 targets. Ocean going vessels registered under the SRS and harbour crafts licensed to operate within the Port of Singapore are eligible to apply. More information on the incentives under the Programme will be launched at a later date.

COMMERCIAL

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

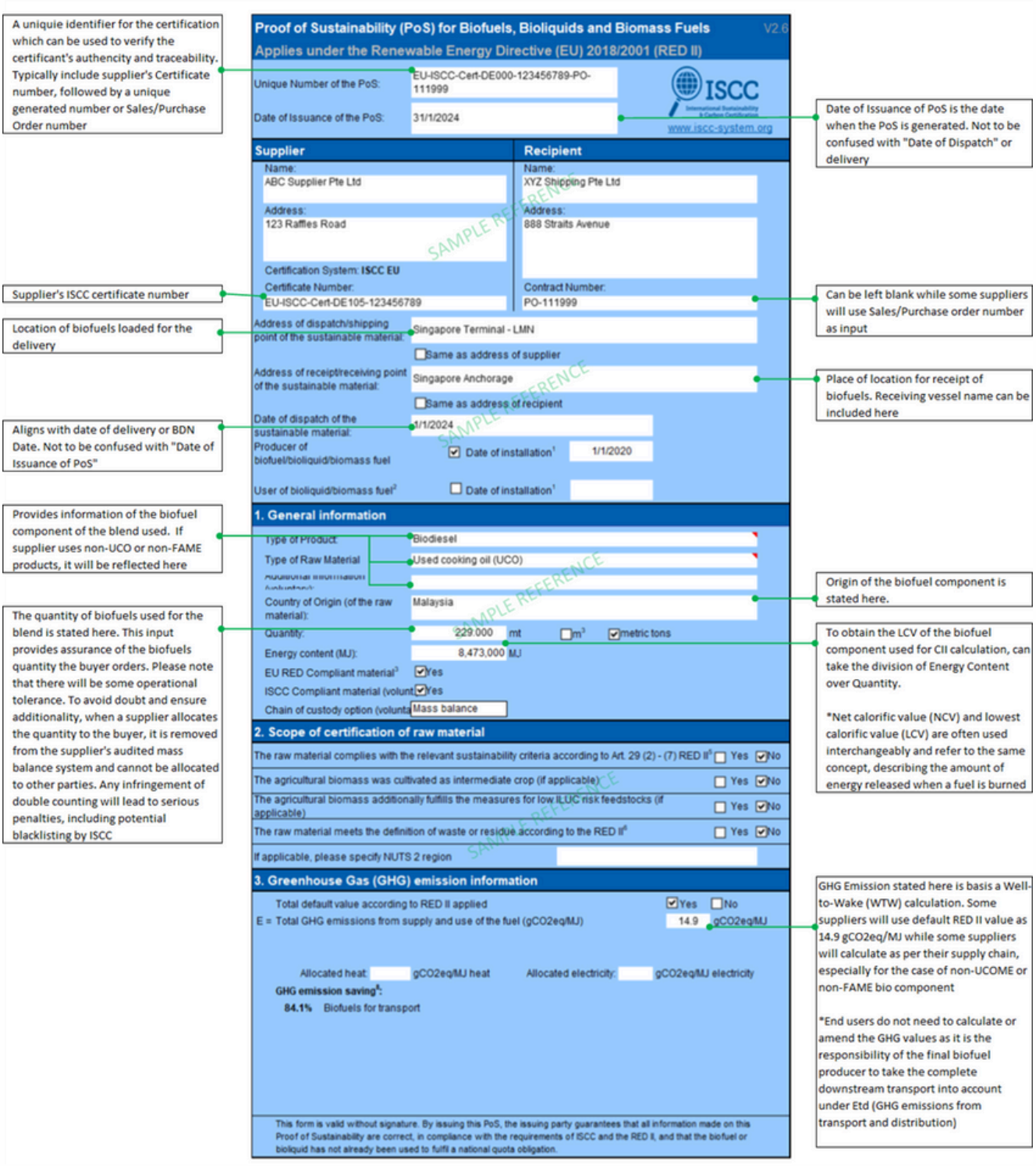


Above is a typical commercial flow for biofuel. The quantity allocation for the Proof of Sustainability (PoS) is usually determined by the delivered quantity stated in the Bunker Delivery Note (BDN). Unlike a BDN, which is issued immediately upon delivery, the PoS cannot be issued right away. This is 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.

Based on responses to the 2024 Marine Fuels Survey conducted by SSA, the typical lead time for issuance of the PoS to the end user is approximately 30 days after the date of delivery.

COMMERCIAL

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
EFCO_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
N_2O	Nitrous Oxide
NOx	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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